SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

Program and Abstracts

October 2010

70th Anniversary Meeting
Society of Vertebrate Paleontology

David L. Lawrence Convention Center, East Lobby &
Westin Convention Center Pittsburgh
Pittsburgh, Pennsylvania USA
October 10–13, 2010

Society of Vertebrate Paleontology

Society of
Vertebrate Paleontology

Paris Las Vegas

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November 2–5, 2011

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SOCIETY OF VERTEBRATE PALEONTOLOGY

October, 2010

ABSTRACTS OF PAPERS

SEVENTIETH ANNIVERSARY MEETING

SOCIETY OF VERTEBRATE PALEONTOLOGY

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY
& WESTIN CONVENTION CENTER PITTSBURGH
PITTSBURGH, PA, USA

OCTOBER 10–13, 2010

SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

Members and Friends of the Society of Vertebrate Paleontology,

The Section of Vertebrate Paleontology at Carnegie Museum of Natural History is excited to host the 70th Annual Meeting of the Society of Vertebrate Paleontology. From its founding in 1895 right up to the present day, Carnegie Museum of Natural History has played a vital role in the development of vertebrate paleontology in North America. This meeting represents a homecoming for the Society, and it provides us with the opportunity to showcase the museum's recently renovated Mesozoic gallery, *Dinosaurs in Their Time.*

Pittsburgh is conveniently located in southwestern Pennsylvania, affording easy travel connections by air, rail, and major highways. The city is home to numerous scientific and cultural institutions, as well as several major universities. Autumn visitors to the region can enjoy the fall foliage in the Laurel Highlands, which is home to the museum's Powdermill Nature Reserve and Frank Lloyd Wright's architectural masterpiece, Fallingwater.

We look forward to hosting the meeting and seeing you in Pittsburgh!

2010 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.)

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

2010 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the David L. Lawrence Convention Center (DLCC), East Lobby, 3rd Floor unless otherwise noted with an **

Event/Function	Saturday, October 9	Sunday, October 10	Monday, October 11	Tuesday, October 12	Wednesday, October 13
Registration Desk	1 pm – 4 pm **DLCC, Spirit of Pittsburgh Ballroom Foyer**	7 am – 5 pm **DLCC, Spirit of Pittsburgh Ballroom Foyer**	7 am – 5 pm **DLCC, Spirit of Pittsburgh Ballroom Foyer**	8 am – 5 pm **DLCC, Spirit of Pittsburgh Ballroom Foyer**	8 am – 5 pm **DLCC, Spirit of Pittsburgh Ballroom Foyer**
Plenary Session/Welcome		7:45 am – 8 am **DLCC, Spirit of Pittsburgh Ballroom B**			
Symposium		8 am – 12:15 pm Advances in Paleoecology: Geochemistry, Microwear and Beyond **DLCC, Room 301**	8 am – 12:15 pm Physical Drivers and Marine Tetrapod Evolution **DLCC, Room 301**	8 am – 12:15 pm Making Connections: The Evolution and Function of Joints in Vertebrates **DLCC, Room 301**	8 am – 12:15 pm Evolution of the Modern African Fauna **DLCC, Room 301**
Technical Session Romer Session		8 am – 12:15 pm Technical Session I **DLCC, Spirit of Pittsburgh Ballroom B**	8 am – 12:15 pm Romer Session **DLCC, Spirit of Pittsburgh Ballroom B**	8 am – 12:15 pm Technical Session IX **DLCC, Spirit of Pittsburgh Ballroom B**	8 am – 12:15 pm Technical Session XIV **DLCC, Spirit of Pittsburgh Ballroom B**
Technical Session Preparators' Session		8 am – 12:15 pm Technical Session II **DLCC, Room 304**	8 am – 12:15 pm Preparators' Session **DLCC, Room 304**	8 am – 12:15 pm Technical Session X **DLCC, Room 304**	8 am – 12:15 pm Technical Session XV **DLCC, Room 304**
Technical Session		1:45 pm – 4:15 pm Technical Session III **DLCC, Room 301**	1:45 pm – 4:15 pm Technical Session VI **DLCC, Room 301**	1:45 pm – 4:15 pm Technical Session XI **DLCC, Room 301**	1:45 pm – 4:15 pm Technical Session XVI **DLCC, Room 301**
Technical Session		1:45 pm – 4:15 pm Technical Session IV **DLCC, Spirit of Pittsburgh Ballroom B**	1:45 pm – 4:15 pm Technical Session VII **DLCC, Spirit of Pittsburgh Ballroom B**	1:45 pm – 4:15 pm Technical Session XII **DLCC, Spirit of Pittsburgh Ballroom B**	1:45 pm – 4:15 pm Technical Session XVII **DLCC, Spirit of Pittsburgh Ballroom B**
Technical Session		1:45 pm – 4:15 pm Technical Session V **DLCC, Room 304**	1:45 pm – 4:15 pm Technical Session VIII **DLCC, Room 304**	1:45 pm – 4:15 pm Technical Session XIII **DLCC, Room 304**	1:45 pm – 4:15 pm Technical Session XVIII **DLCC, Room 304**
Workshops/Educational Events	9 am – Noon Paleontological Illustration Workshop Session 1 For Pre-Registered Attendees ****Art Institute of Pittsburgh**	All Day Educators' Workshop: Informal Session **DLCC**			12:30 pm – 1:30 pm Open Forum Discussion of the U.S. Paleontological Resources Preservation Act (PRPA) of 2009 **DLCC, Spirit of Pittsburgh Ballroom B**
	10 am – 3 pm Children's Workshop on Dinosaurs and Animation For Pre-Registered Attendees ****Children's Museum of Pittsburgh**	12:30 pm – 1:30 pm Effective Poster Design Workshop **DLCC, Room 304**			
	1 pm – 4 pm Paleontological Illustration Workshop Session 2 For Pre-Registered Attendees ****Art Institute of Pittsburgh**	12:30 pm – 1:30 pm Town Hall Meeting on Evolution VIII **DLCC, Spirit of Pittsburgh Ballroom B**			12:30 pm – 1:30 pm Women in Paleontology Luncheon **DLCC, Room 301**
	7pm – 8-pm A Special Presentation By Dr. C. Owen Lovejoy ****Carnegie Museum of Natural History, Carnegie Lecture Hall**				
Poster Sessions **Set-up each day: 7:30 am – 9:30 am**		Poster Session I: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	Poster Session II: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	Poster Session III: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	Poster Session IV: 9:30 am – 4:15 pm Reception: 4:15 pm – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**
Exhibit Viewing		9:30 am – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	9:30 am – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	9:30 am – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**	9:30 am – 6:15 pm **DLCC, Spirit of Pittsburgh Ballroom A**
Annual Business Meeting/ Open Executive Committee Meeting			12:30 pm – 1:30 pm Annual Business Meeting **DLCC, Spirit of Pittsburgh Ballroom B**	12:30 pm – 1:30 pm Open Executive Committee Meeting **DLCC, Spirit of Pittsburgh Ballroom B**	
Press Event			4:15 pm – 5:45 pm ****Westin Convention Center Pittsburgh, 2nd Floor, Westmoreland Room**		
Social Events		7 pm – 10 pm Welcome Reception ****Carnegie Museum of Natural History**	8 pm – 10 pm Student Roundtable Forum & Reprint Exchange ****Westin Convention Center Pittsburgh, 3rd Floor, Allegheny Ballroom**	6:30 pm – 10:30 pm Auction/Reception ****Westin Convention Center Pittsburgh, 3rd Floor, Allegheny Ballroom**	8 pm – 10 pm Awards Ceremony ****Westin Convention Center Pittsburgh, 3rd Floor, Allegheny Ballroom**
					10 pm – 2 am After Hours Party ****Westin Convention Center Pittsburgh, 2nd Floor**

2010 SVP SCHEDULE OF EVENTS (subject to change)

All events are held at the David L. Lawrence Convention Center (DLCC), East Lobby, 3rd Floor unless otherwise noted with an **

Event/Function	Saturday, October 9	Sunday, October 10	Monday, October 11	Tuesday, October 12	Wednesday, October 13
Beverage Service		10 am – 10:15 am **DLCC, Spirit of Pittsburgh Ballroom A**	10 am – 10:15 am **DLCC, Spirit of Pittsburgh Ballroom A**	10 am – 10:15 am **DLCC, Spirit of Pittsburgh Ballroom A**	10 am – 10:15 am **DLCC, Spirit of Pittsburgh Ballroom A**
Speaker Ready Room	1 pm – 4 pm **DLCC, Room 306**	7 am – 5 pm **DLCC, Room 306**	7 am – 5 pm **DLCC, Room 306**	7 am – 5 pm **DLCC, Room 306**	7 am – 3 pm **DLCC, Room 306**
Meeting Rooms	8 am – 7 pm **Westin Convention Center Pittsburgh, 2nd Floor** ****Cambria Room East** ****Cambria Room West**	7 am – 7 pm **Westin Convention Center Pittsburgh, 2nd Floor** ****Butler Room** ****Cambria Room East** ****Cambria Room West** ****Westmoreland Room**	7 am – 7 pm **Westin Convention Center Pittsburgh, 2nd Floor** ****Butler Room** ****Cambria Room East** ****Cambria Room West** ****Westmoreland Room**	7 am – 7 pm **Westin Convention Center Pittsburgh, 2nd Floor** ****Butler Room East** ****Butler Room West** ****Westmoreland Room**	7 am – 5 pm **Westin Convention Center Pittsburgh, 2nd Floor** ****Butler Room East** ****Butler Room West** ****Westmoreland Room**

PROGRAM AT A GLANCE

	Room 301	Ballroom B	Room 304	Room 301	Ballroom B	Room 304	Room 301	Ballroom B	Room 304	Room 301	Ballroom B	Room 304
	Advances in Paleoecology: Geochemistry, Microwear and Beyond	Tech I	Tech II	Physical Drivers and Marine Tetrapod Evolution	Romer Prize Session	Preparators' Session	Making Connections: The Evolution and Function of Joints in Vertebrates	Tech IX	Tech X	Evolution of Modern African Fauna	Tech XIV	Tech XV
	SUN	SUN	SUN	MON	MON	MON	TUES	TUES	TUES	WED	WED	WED
8:00	Shabel	Lee	Reisz	Fordyce	Cooper	Potapova	Holliday	A. Evans	Kellner	Gheerbrant	Brusatte	Qiao
8:15	Secord	Varricchio	Kuemmell	Kelley	Crowley	Fry	Osi	G. Wilson	Unwin	Borths	Upchurch	J. Lu
8:30	Kohn	Georgi	Fröbisch	Rieppel	de Boef Miara	Benton	Gill	Wood	Z. Zhou	Stevens	Whitlock	Swartz
8:45	Clementz	Motani	Kammerer	Fischer	Fowler	M. Smith	Ravosa	F. Smith	S. Zhou	W. Sanders	Pittman	Lund
9:00	Thewissen	Butler	Camp	Polcyn	Gignac	G. Brown	Luo	Rose	Atterholt	Domning	J. Wilson	Greenfest-Allen
9:15	D. Fox	Maidment	Botha-Brink	Jacobs	Hirasawa	Shinya	Curtis	Orcutt	Liu	Lehmann	Sues	Menasco-Davis
9:30	Widga	Mallon	Huttenlocker	Parham	Marjanović	Keyser	Bright	Marcot	Vinther	Tabuce	Irmis	Ciampaglio
9:45	Fox-Dobbs	Campione	A. Smith	Hinic-Frlog	McGuire	Nelsen	Maddin	Kingston	Heers	Gunnell	Britt	Claeson
10:00	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE	COFFEE
10:15	Krigbaum	Chinsamy-Turan	Ruf	Ando	Olori	Carlson	Vickaryous	R. Terry	David	Peigné	Sereno	Lane
10:30	DeSantis	D. Evans	T. Martin	Beatty	Sadleir	A. Andersen	Pierce	Pardi	Nesbitt	M. Lewis	Barrett	Ehret
10:45	R. Scott	Schott	Gaetano	Kohno	Scannella	Keillor	Claessens	Muldoon	N. Smith	Seiffert	Carr	Sallan
11:00	Rivals	Arbour	Parsons	E. Davis	Schachner	Davies	Ward	Tryon	A. Smith	Andanje	Loewen	Schultze
11:15	Mihlbachler	Farke	Lazzari	Gutstein	Spaulding	Van Beek	Gatesy	J. Miller	Ksepka	Uno	Kobayashi	Chang
11:30	Stromberg	Lund	Chen	Fitzgerald	Thomas	Shaw	Su	MacPhee	Stitham	Bernor	Dececchi	J. Liu
11:45	Chew	Ryan	Goswami	Marx	Wheatley	Chure	C. Sullivan	Fisher	Witmer	Werdelin	Tsuihiji	Miyashita
12:00	George	Dean-Carpentier	Schultz	Pyenson	Wilhelm	M. Brown	Bonnan	Barnosky	Boyer	Harrison	Jackson	Darras
12:15	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:30	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
12:45	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:00	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:15	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
1:30	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH	LUNCH
	Tech III	Tech IV	Tech V	Tech VI	Tech VII	Tech VIII	Tech XI	Tech XII	Tech XIII	Tech XVI	Tech XVII	Tech XVIII
1:45	Hooker	Vietti	Samuels	T. Smith	Werning	MacKenzie	Carter	E. Allen	Croft	Baermann	Csiki	Dias-da-Silva
2:00	Kraatz	Ji	L. Flynn	Y. Wang	Wu	D. Jones	Lamm	Sertich	Solé	Faith	Larsson	McHugh
2:15	Sallam	Hugi	Calede	Giallombardo	Milner	Brazeau	Peterson	Montefeltro	Friscia	Theodor	Lamanna	Angielczyk
2:30	Manz	J. Liu	D. Fraser	von Koenigswald	Lyson	Coates	Boyer	Turner	Tseng	Bormet	Watanabe	Sidor
2:45	R. Fox	Sato	MacFadden	Christensen	ElShafie	Blais	Joshi	Hastings	Polly	Sears	Pei	Báez
3:00	Woodruff	M. Jones	Campbell	Engels	Head	Jerve	Schweitzer	Brochu	Meachen-Samuels	Cuddahee	Hone	Dong
3:15	Nachman	Edwards	Bibi	Kilbourne	Hill	Long	Moses	Salisbury	O'Keefe	Hieronymus	Choiniere	Wang
3:30	Gingerich	Yi	Deng	Schmitz	D. Smith	Zhu	Longrich	Owerkowicz	Hadly	Uhen	Mori	Redelstorff
3:45	Bloch	Conrad	E. Scott	Rodgers	Wilburg	Carr	Alroy	Woodward	K. Jones	Moran	Suarez	Meyer
4:00	Zalmout	Lawing	Barron-Ortiz	Simmons	Dufeau	Cloutier	Weinstein	Porro	Gaudin	Ekdale	Montanari	Tsuji
4:15	Poster Session I			Poster Session II			Poster Session III			Poster Session IV		
4:30												
4:45												
5:00												
5:15												
5:30												
5:45												
6:00												

SUNDAY MORNING, OCTOBER 10, 2010
SYMPOSIUM: ADVANCES IN PALEOECOLOGY: GEOCHEMISTRY, MICROWEAR AND BEYOND
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Mark Clementz, Larisa DeSantis

8:00 **Shabel, A.** TRACE ELEMENT COMPOSITION OF BONE IN RELATION TO THE ECOLOGY OF AFRICAN VERTEBRATES

8:15 **Secord, R., Krigbaum, J., Bloch, J.** STABLE ISOTOPE ECOLOGY OF MODERN AMAZONIAN MAMMALS: IMPLICATIONS FOR RECOGNIZING CLOSED CANOPY HABITATS IN THE FOSSIL RECORD

8:30 **Kohn, M.** TERRESTRIAL CARBON ISOTOPE PALEOECOLOGY IN A C3 WORLD

8:45 **Clementz, M., Miller, E., El-Barkooky, A., Hamdan, M., Gawad, M.** STABLE ISOTOPE EVIDENCE OF SEMIAQUATIC HABITS AND DIETARY NICHE DIFFERENCES FOR FOUR SYMPATRIC SPECIES OF ANTHRACOTHERIIDS FROM WADI MOGHRA, EARLY MIOCENE, EGYPT

9:00 **Thewissen, J., Sensor, J., Clementz, M., Bajpai, S.** TOOTH USE AND DIET ACROSS THE ARTIODACTYL-CETACEAN TRANSITION

9:15 **Fox, D.** RECONSTRUCTION OF SMALL MAMMAL DIETS DURING THE NEOGENE EXPANSION OF C4 GRASSES IN THE GREAT PLAINS USING LA-IRMS

9:30 **Widga, C.** DEFINING THE ECOLOGICAL NICHE OF PROBOSCIDEA AND *BISON* DURING THE LATE QUATERNARY THROUGH STABLE ISOTOPE ANALYSES (MIDWESTERN NORTH AMERICA)

9:45 **Fox-Dobbs, K., Thomas, D., Koch, P.** PALEOENVIRONMENTAL AND PALEOECOLOGICAL INTERPRETATIONS OF ISOTOPIC RECORDS DERIVED FROM EASTERN BERINGIAN CARIBOU ANTLERS

10:00 **BREAK**

10:15 **Krigbaum, J.** HOLOCENE DIET AND SEASONALITY IN TROPICAL SOUTHEAST ASIA: INTEGRATING ISOTOPIC DATA WITH PALEOCLIMATE PROXIES

10:30 **DeSantis, L., Schubert, B.** THE COMBINED USE OF STABLE ISOTOPES AND DENTAL MICROWEAR TEXTURE ANALYSIS TO DECIPHER THE PALEOECOLOGY OF AUSTRALIAN MARSUPIALS

10:45 **Scott, R., Merceron, G., Tanju, K., Kostopoulos, D., Serdar, M.** DENTAL MICROWEAR TEXTURE ANALYSIS, DENTAL MESOWEAR AND DISTAL LIMB ECOMORPHOLOGY OF THE KALFA (MOLDOVA) HIPPARIONINE HORSES: A MULTI-PROXY PALEOECOLOGICAL RECONSTRUCTION

11:00 **Rivals, F., Semprebon, G., Solounias, N.** ADVANCES IN UNGULATE DENTAL WEAR TECHNIQUES REVEAL NEW PATTERNS OF NICHE BREADTH AND EXPANSION THROUGHOUT THE CENOZOIC

11:15 **Mihlbachler, M., Beatty, B., Caldera-Siu, A., Chan, D., Lee, R.** EXPLORING THE INFLUENCE OF OBSERVER BIAS IN DENTAL MICROWEAR ANALYSIS

11:30 **Stromberg, C., Dunn, R., Kohn, M., Madden, R., Carlini, A.** WAS THE EVOLUTION OF HYPSODONTY IN SOUTH AMERICA A RESPONSE TO THE SPREAD OF GRASSLAND VEGETATION?: NEW PHYTOLITH RECORDS FROM GRAN BARRANCA, ARGENTINA

11:45 **Chew, A.** APPROACHING TRUE DIVERSITY IN FOSSIL COMMUNITIES USING A COMBINATION OF RAREFACTION METHODS AND THE PIE EVENNESS INDEX

12:00 **George, C.** INCONGRUENT QUATERNARY PALEOECOLOGIC MODELS AND IMPLICATIONS FOR USING MAMMALS TO RECONSTRUCT PAST CLIMATE

SUNDAY MORNING, OCTOBER 10, 2010
TECHNICAL SESSION I
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: David Varricchio, David Evans

8:00 **Lee, A., Irmis, R., Wedel, M., Werning, S., Padian, K.** THE UNIVERSAL TEMPERATURE DEPENDENCE MODEL FAILS TO PREDICT BODY TEMPERATURES ACCURATELY FOR EXTANT AMNIOTES AND EXTINCT DINOSAURS

8:15 **Varricchio, D.** A DISTINCT DINOSAUR LIFE HISTORY?

8:30 **Georgi, J., Sipla, J., Forster, C.** TURNING SEMICIRCULAR CANAL FUNCTION ON ITS HEAD: DINOSAUR DIVERSITY SUGGESTS A NOVEL VESTIBULAR ANALYSIS

8:45 **Motani, R., Schmitz, L.** PHYLOGENETIC BIAS IN FORM-FUNCTION RELATIONSHIPS AND ITS IMPLICATION TO THE FREQUENCY OF NOCTURNAL DINOSAURS

9:00 **Butler, R., Benson, R., Carrano, M., Mannion, P., Upchurch, P.** INTERACTIONS BETWEEN SEA LEVEL, SAMPLING AND DINOSAUR DIVERSITY DURING THE MESOZOIC ERA

9:15 **Maidment, S., Barrett, P.** EVOLUTION OF LOCOMOTOR MUSCULATURE IN ORNITHISCHIAN DINOSAURS

9:30 **Mallon, J., Anderson, J.** AN ASSESSMENT OF DIFFERENTIAL FEEDING SELECTIVITY AMONG THE MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (LATE CAMPANIAN) OF ALBERTA, CANADA

9:45 **Campione, N., Evans, D.** CRANIAL MORPHOLOGY AND THE DIVERSITY OF LATE CRETACEOUS EDMONTOSAURS (ORNITHISCHIA: HADROSAURIDAE) FROM NORTH AMERICA

10:00 **BREAK**

10:15 **Chinsamy-Turan, A., Tumarkin-Deratzian, A., Thomas, D., Fiorillo, A.** THE BONE MICROSTRUCTURE OF THE POLAR HADROSAURS FROM THE NORTH SLOPE OF ALASKA

10:30 **Evans, D., Schott, R., Ryan, M., Brown, C., Larson, D.** A SANTONIAN-AGED PACHYCEPHALOSAURID FROM NORTH AMERICA AND THE EVOLUTION AND DIVERSITY OF PACHYCEPHALOSAURIA

10:45 **Schott, R., Evans, D., Goodwin, M., Brown, C., Longrich, N.** CRANIAL ONTOGENY IN *STEGOCERAS* AND THE EVOLUTION OF CRANIAL DOMING AND ORNAMENTATION IN PACHYCEPHALOSAURIA (DINOSAURIA: ORNITHISCHIA)

11:00 **Arbour, V.** A CRETACEOUS ARMOURY: MULTIPLE ANKYLOSAURID TAXA IN THE LATE CRETACEOUS OF ALBERTA, CANADA AND MONTANA, USA

11:15 **Farke, A., Ryan, M., Tanke, D., Barrett, P., Loewen, M.** A NEW CENTROSAURINE CERATOPSID FROM THE BELLY RIVER GROUP (UPPER CRETACEOUS) OF ALBERTA, CANADA AND THE EVOLUTION OF PARIETAL ORNAMENTATION

11:30 **Lund, E., Sampson, S., Loewen, M.** A NEW BASAL CENTROSAURINE DINOSAUR (ORNITHISCHIA: CERATOPSIDAE) FROM THE UPPER CRETACEOUS OF UTAH: EVIDENCE OF A PREVIOUSLY UNKNOWN CLADE OF SOUTHERN CENTROSAURINES FROM LARAMIDIA

11:45 **Ryan, M., Evans, D., Brown, C., Scott, E., Chiba, K.** PALEOBIOGEOGRAPHIC RANGE OF *CENTROSAURUS APERTUS* (ORNITHISCHIA:CERATOPSIDAE), WITH IMPLICATIONS FOR LATE CRETACEOUS DINOSAUR PROVINCIALITY AND EVOLUTION

12:00 **Dean-Carpentier, M., Porro, L., Sereno, P.** MODELLING AND RECONSTRUCTION OF THE FEEDING BIOMECHANICS OF THE BASAL CERATOPSIAN *PSITTACOSAURUS GOBIENSIS* AND ITS IMPLICATIONS FOR CERATOPSIAN EVOLUTION

SUNDAY MORNING, OCTOBER 10, 2010
TECHNICAL SESSION II
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Thomas Martin, Christian Kammerer

8:00 **Reisz, R., Fröbisch, J., Berman, D., Henrici, A.** NEW PERMO-CARBONIFEROUS CASEID SYNAPSIDS FROM NORTH AMERICA AND EUROPE, AND THEIR EVOLUTIONARY SIGNIFICANCE

8:15 **Kuemmell, S., Frey, E.** THE ROLLING MODE OF THE ACROPODIUM IN EXTINCT SYNAPSIDA

8:30 **Fröbisch, J., Angielczyk, K., Sidor, C.** *KOMBUISIA* (SYNAPSIDA, DICYNODONTIA) FROM THE TRIASSIC OF ANTARCTICA, A REFUGE FROM THE TERRESTRIAL PERMIAN-TRIASSIC MASS EXTINCTION

8:45 **Kammerer, C., Angielczyk, K., Fröbisch, J.** A COMPREHENSIVE REVISION OF THE DICYNODONT 'WASTEBASKET GENUS' *DICYNODON* (THERAPSIDA: ANOMODONTIA)

9:00 **Camp, J.** A GEOMETRIC MORPHOMETRIC ASSESSMENT OF GONDWANAN *LYSTROSAURUS* AND THEIR RELATION TO LAURASIAN FORMS

9:15 **Botha-Brink, J., Smith, R.** BONE HISTOLOGY OF CARNIVORE COPROLITES FROM THE UPPER PERMIAN SOUTH AFRICAN KAROO BASIN

9:30 **Huttenlocker, A., Botha-Brink, J., Sidor, C.** BONE HISTOLOGY AND GROWTH IN THE PERMO-TRIASSIC THEROCEPHALIAN *MOSCHORHINUS KITCHINGI* (SYNAPSIDA: THERAPSIDA) FROM THE KAROO BASIN OF SOUTH AFRICA

9:45 **Smith, A., Gill, P., Rayfield, E., Ruta, M., Hooker, J.** THE TAXONOMIC DIVERSITY OF THE STEM MAMMAL *MORGANUCODON* (MORGANUCODONTA: MORGANOCODONTIDAE) FROM LATE TRAISSIC-EARLY JURASSIC FISSURE DEPOSITS OF GLAMORGANSHIRE, WALES, UK

10:00 **BREAK**

10:15 **Ruf, I., Luo, Z., Martin, T.** CT SCANNING ANALYSIS OF THE BASICRANIUM AND THE INNER EAR OF *HALDANODON EXSPECTATUS* (DOCODONTA, MAMMALIA)

10:30 **Martin, T., Nowotny, M., Fischer, M.** NEW DATA ON TOOTH REPLACEMENT IN THE LATE JURASSIC DOCODONT MAMMAL *HALDANODON EXSPECTATUS*

10:45 **Gaetano, L., Rougier, G.** NEW SPECIMENS AND PHYLOGENETIC RELATIONSHIPS OF THE SOUTH AMERICAN JURASSIC TRICONODONT *ARGENTOCONODON FARIASORUM*

11:00 **Parsons, W., Parsons, K., Sues, H.** AN UNUSUAL LARGE NEW MAMMALIAFORM FROM THE LOWER CRETACEOUS CLOVERLY FORMATION OF MONTANA

11:15 **Lazzari, V., Schultz, J., Tafforeau, P., Martin, T.** MASTICATORY MOVEMENTS TRIGGER CUSP MORPHOLOGY IN MAMMALIAMORPHS WITH RODENT-LIKE DENTITIONS

11:30 **Chen, M., Luo, Z.** NEW STUDY OF THE CRETACEOUS MAMMAL *AKIDOLESTES* WITH ITS IMPLICATIONS FOR EARLY THERIAN MAMMAL POSTCRANIAL EVOLUTION

11:45 **Goswami, A., Prasad, G., Upchurch, P., Boyer, D., Seiffert, E.** THE PHYLOGENETIC AFFINITIES OF THE ENIGMATIC MAMMAL *DECCANOLESTES* FROM THE LATE CRETACEOUS OF INDIA AND IMPLICATIONS FOR EUTHERIAN MAMMAL EVOLUTION

12:00 **Schultz, J., Martin, T.** 3D-ANALYSIS OF FUNCTIONAL SURFACES IN THE PRE-TRIBOSPHENIC DENTITION

SUNDAY AFTERNOON, OCTOBER 10, 2010
TECHNICAL SESSION III

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Brian Kraatz, Jonathan Bloch

1:45 **Hooker, J., Russell, D.** EUROPEAN EARLY PALEOGENE LOUISININES: HIGH DIVERSITY AND ENIGMATIC RELATIONSHIPS

2:00 **Kraatz, B., Meng, J., Wang, Y., Li, C.** MIMOTONID TARSAL BONES FROM THE EOCENE OF CHINA AND THE EVOLUTION OF LOCOMOTION IN DUPLICIDENTATA

2:15 **Sallam, H., Seiffert, E., Bouer, D., Simons, E.** POSTCRANIAL MORPHOLOGY OF AN ANOMALUROID RODENT FROM THE LATE EOCENE EGYPT

2:30 **Manz, C., Bloch, J., Boyer, D.** TARSAL BONES OF NORTH AMERICAN PALEOCENE *LEPTACODON* (MAMMALIA, EULIPOTYPHLA?) AND EVIDENCE FOR SCANSORIALITY IN NYCTITHERIIDAE

2:45 **Fox, R., Scott, C.** A NEW, EARLY PUERCAN (EARLIEST PALEOCENE) SPECIES OF PURGATORIUS (PLESIADAPIFORMES, PRIMATES) FROM SASKATCHEWAN, CANADA

3:00 **Woodruff, E., Ruta, M., Bloch, J., Benton, M.** DISPARITY AND EVOLUTIONARY NOVELTY IN TWO PALEOGENE PRIMATE RADIATIONS

3:15 **Nachman, B., Beard, K., Anemone, R.** NEW PRIMATES (OMOMYIDAE) FROM THE GREAT DIVIDE BASIN, WYOMING

3:30 **Gingerich, P., Franzen, J., Habersetzer, J., Hurum, J., Smith, B.** SYSTEMATIC POSITION OF THE EOCENE PRIMATE *DARWINIUS MASILLAE*

3:45 **Bloch, J., Randall, Z., Silcox, M., Chester, S., Boyer, D.** DISTAL PHALANGES OF EOCENE NORTH AMERICAN NOTHARCTINES (MAMMALIA, PRIMATES): IMPLICATIONS FOR PRIMATE AND ANTHROPOID ORIGINS

4:00 **Zalmout, I., Ali, M., MacLatchy, L., Sanders, W., Gingerich, P.** CRANIUM OF A NEW OLIGOCENE PRIMATE FROM SAUDI ARABIA AND THE DIVERGENCE OF APES AND OLD WORLD MONKEYS

SUNDAY AFTERNOON, OCTOBER 10, 2010
TECHNICAL SESSION IV

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Jack Conrad, Michelle Lawing

1:45 **Vietti, L., Rogers, R., Fox, D.** PRELIMINARY DESIGNATION OF MARINE TETRAPOD TAPHOFACIES

2:00 **Ji, C., Jiang, D., Motani, R., Hao, W., Sun, Z.** PHYLOGENETIC ANALYSIS OF SHASTASAURIDAE ILLUMINATED BY *GUIZHOUICHTHYOSAURUS* FROM CHINA INDICATES A POSSIBLE PATHWAY OF THE MIGRATION OF THIS FAMILY

2:15 **Hugi, J., Scheyer, T., Sánchez-Villagra, M.** ON BECOMING AQUATIC: THE CASE OF THE MARINE IGUANA (*AMBLYRHYNCHUS CRISTATUS*) AND THE PACHYPLEUROSAURS FROM THE TRIASSIC OF MONTE SAN GIORGIO, SWITZERLAND

2:30 **Liu, J., Rieppel, O., Jiang, D., Aitchison, J., Zhang, Q.** A SMALL PACHYPLEUROSAUR FROM THE LOWER MIDDLE TRIASSIC OF SW CHINA WITH COMMENTS ON THE PHYLOGENY OF EOSAUROPTERYGIA

2:45 **Sato, T., Wu, X.** BRAINCASE OF A POLYCOTYLID PLESIOSAUR (REPTILIA: SAUROPTERYGIA) FROM THE UPPER CRETACEOUS OF MANITOBA, CANADA

3:00 **Jones, M., Curtis, N., O'Higgins, P., Fagan, M., Evans, S.** CRANIAL JOINTS IN *SPHENODON* (RHYNCHOCEPHALIA) AND ITS FOSSIL RELATIVES WITH IMPLICATIONS FOR LEPIDOSAUR SKULL MECHANICS

3:15 **Edwards, N., Bergmann, U., Larson, P., Manning, P., Wogelius, R.** FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR) OF SOFT-TISSUE PRESERVATION FROM THE EOCENE GREEN RIVER FORMATION (COLORADO, USA)

SUNDAY AFTERNOON, OCTOBER 10, 2010
TECHNICAL SESSION IV (continued)

3:30 **Yi, H., Norell, M.** NEW MATERIALS OF *ESTESIA MONGOLIENSIS* (REPTILIA: SQUAMATA) FROM THE LATE CRETACEOUS OF MONGOLIA CAST DOUBT ON THE MONOPHYLY OF THE MONSTERSAURIA

3:45 **Conrad, J., Sidor, C.** A FOSSIL JESUS LIZARD (SQUAMATA, CORYTOPHANIDAE) FROM THE EOCENE OF NORTH AMERICA

4:00 **Lawing, A., Polly, P.** MODELLING EFFECTS OF PLEISTOCENE CLIMATE CYCLES ON SPECIES' DISTRIBUTIONS: IMPLICATIONS FOR THE NEAR FUTURE

SUNDAY AFTERNOON, OCTOBER 10, 2010
TECHNICAL SESSION V

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Larry Flynn, Bruce MacFadden

1:45 **Samuels, J., Janis, C.** IMPACTS OF CENOZOIC CLIMATE AND HABITAT CHANGES ON RODENT COMMUNITIES

2:00 **Flynn, L.** Z-113

2:15 **Calede, J., Hopkins, S.** MICROWEAR, DIET AND FOSSORIALITY IN MIOCENE RODENTS FROM THE GREAT BASIN

2:30 **Fraser, D., Theodor, J.** UNGULATE DIETS REVEAL PATTERNS OF NORTH AMERICAN GRASSLAND EXPANSION DURING THE LATE MIOCENE

2:45 **MacFadden, B.** MIOCENE MAMMALS OF PANAMA: TROPICAL REFUGIUM OR CRADLE OF BIODIVERSITY?

3:00 **Campbell, K., Prothero, D., Romero-Pittman, L., Hertel, F., Rivera, N.** AMAZONIAN MAGNETOSTRATIGRAPHY: DATING THE FIRST PULSE OF THE GREAT AMERICAN FAUNAL INTERCHANGE

3:15 **Bibi, F.** MIO-PLIOCENE FAUNAL EXCHANGES BETWEEN EURASIA AND AFRICA: THE RECORD OF RARE BOVID TAXA

3:30 **Deng, T., Hou, S.** A DENSELY CONCENTRATED EARLY PLIOCENE MAMMALIAN FAUNA FROM THE LINXIA BASIN IN GANSU, CHINA

3:45 **Scott, E., Springer, K., Sagebiel, J., Manker, C.** THE TULE SPRINGS LOCAL FAUNA FROM SOUTHERN NEVADA: CONSTRAINING THE RANCHOLABREAN NORTH AMERICAN LAND MAMMAL AGE IN SOUTHWESTERN NORTH AMERICA

4:00 **Barron-Ortiz, C., Theodor, J.** NORTH AMERICAN LATE PLEISTOCENE EQUIDS (MAMMALIA, PERISSODACTYLA): A GEOMETRIC MORPHOMETRIC STUDY OF THE UPPER PREMOLARS

SUNDAY AFTERNOON, OCTOBER 10, 2010
POSTER SESSION I

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM A
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Fillmore, D., Lucas, S., Simpson, E., Szajna, M.** AN EXAMPLE OF *UNDICHNA,* THE FISH SWIMMING TRACE, FROM THE DEVONIAN CATSKILL FORMATION, EASTERN PENNSYLVANIA

2 **Scott, B., Wendruff, A., Wilson, M.** MORPHOLOGY AND ASPECT RATIO OF THE TAIL OF THE LOWER DEVONIAN OSTEOSTRACAN *SUPERCILIASPIS GABRIELSEI*

3 **Potvin-Leduc, D., Cloutier, R., Landing, E., VanAller Hernick, L., Mannolini, F.** NEW CHONDRICHTHYAN MICROREMAINS FROM NEW YORK, USA: INSIGHTS INTO MIDDLE-LATE DEVONIAN CHONDRICHTHYAN GLOBAL DISPERSION

SUNDAY AFTERNOON, OCTOBER 10, 2010
POSTER SESSION I (continued)

4 **Andermann Jr., R., Grogan, E., Lund, R.** PECTORAL GIRDLE AND FIN SEXUAL DIMORPHISM IN THE HOLOCEPHALAN *HARPAGOFUTUTOR VOLSELLORHINUS* FROM THE BEAR GULCH LIMESTONE OF MONTANA (HEATH FORMATION, BIG SNOWY GROUP, SERPUKHOVIAN) WITH COMMENTS ON *CHONDRENCHELYS PROBLEMATICA*

5 **Elliott, D., Hodnett, J., Olsen, T.** CTENACANTHIFORM SHARKS FROM THE PERMIAN KAIBAB FORMATION, NORTHERN ARIZONA

6 **Fischer, J., Voigt, S., Buchwitz, M., Schneider, J.** THE TRIASSIC MADYGEN LAKE ENVIRONMENT — A SHARK NURSERY GROUND?

7 **Hamm, S.** A NEW GENUS OF PTYCHODONTID SHARK FROM THE ALBIAN OF TEXAS AND ITS PHYLOGENETIC PLACEMENT WITHIN PTYCHDONTIDAE

8 **Sankey, J.** NUMEROUS SHARKS FROM LATEST CRETACEOUS UPPERMOST HELL CREEK FORMATION, NORTH DAKOTA: SEA LEVEL RISE DUE TO THE LATE MAASTRICHTIAN GREENHOUSE EVENT?

9 **Cook, T., Newbrey, M., Murray, A., Wilson, M., Shimada, K.** ESTIMATED AGE AND SIZE OF THE LATE CRETACEOUS SHARK *ARCHAEOLAMNA KOPINGENSIS*

10 **Popov, E.** THE DIVERSITY AND NOMENCLATURAL REVISION OF THE HOLOCEPHALIAN FISHES (CHIMAERIFORMES) FROM THE HORNERSTOWN FORMATION (K/T TRANSITION) OF NEW JERSEY, USA

11 **Tulu, Y.** BIOGEOGRAPHY OF THE LATE CRETACEOUS CHONDRICHTHYAN FAUNA FROM THE JUDITH RIVER FORMATION (CAMPANIAN), MONTANA: WHEN TO USE GENERIC LEVEL DATA OVER SPECIES LEVEL DATA IN PARSIMONY ANALYSIS OF ENDEMICITY

12 **Tanoue, K., Shimada, K., Rigsby, C., Nicholas, A.** JAW MECHANICS IN LAMNIFORM SHARKS AND ITS EVOLUTIONARY IMPLICATIONS

13 **DeMar, Jr., D., Wilson, G.** AMPHIBIANS INDICATE ECOSYSTEM INSTABILITY PRIOR TO AND AFTER THE K-PG BOUNDARY: FOSSIL EVIDENCE FROM GARFIELD COUNTY, NE MONTANA

14 **Folie, A., Smith, R., Smith, T.** AMPHIBIAN DIVERSITY FROM THE EARLY OLIGOCENE BORGLOON FORMATION AT BOUTERSEM, BELGIUM

15 **Ikeda, T., Saegusa, H., Handa, K.** A FOSSIL ANURAN FROM THE LOWER CRETACEOUS SASAYAMA GROUP OF HYOGO PREFECTURE, SW JAPAN

16 **Ruta, M., Bolt, J.** MAXIMUM PARSIMONY AND BAYESIAN INFERENCE ANALYSES OF PALAEOZOIC TEMNOSPONDYLS: SUPPORT FOR A CLADE OF HETEROCHRONIC TAXA AND RAPID CHARACTER EXHAUSTION IN EARLY DIVERGING BRANCHES

17 **Madalena, K., Zeigler, K., Sumida, S.** PRELIMINARY REPORT OF NORIAN TRIASSIC AGE VERTEBRATE FAUNA FROM LANDS BELONGING TO THE PUEBLO OF JEMEZ, NORTH CENTRAL NEW MEXICO, INCLUDING AN UNUSUALLY LARGE TEMNYSPONDYL METOPOSAURID AMPHIBIAN

18 **Gardner, N., Holliday, C., Zhu, H., O'Keefe, F.** BRAINCASE ANATOMY OF THE BASAL DIAPSID *YOUNGINA CAPENSIS* FROM HIGH-RESOLUTION X-RAY CT SCANNING

19 **Mazierski, D., Reisz, R.** A NEW, NEARLY COMPLETE SPECIMEN OF *PETROLACOSAURUS KANSENSIS* (DIAPSIDA: ARAEOSCELIDAE) THE EARLIEST KNOWN DIAPSID FROM THE UPPER PENNSYLVANIAN OF KANSAS

20 **Buchwitz, M., Witzmann, F., Kogan, I., Voigt, S.** CHRONIOSUCHIANS AS CROCODILE MIMICS

21 **Modesto, S.** THE POSTCRANIAL SKELETON OF THE AQUATIC PARAREPTILE *MESOSAURUS TENUIDENS* FROM THE GONDWANAN PERMIAN

22 **MacDougall, M., Modesto, S.** NEW INFORMATION ON THE SKULL OF THE EARLY TRIASSIC PARAREPTILE *SAUROPAREION ANOPLUS*

23 **Heckert, A.** BIOSTRATIGRAPHIC SIGNIFICANCE AND REDESCRIPTION OF THE ENIGMATIC VERTEBRATE *COLOGNATHUS OBSCURUS* FROM THE UPPER TRIASSIC CHINLE GROUP, SOUTHWESTERN U.S.A.

24 **Hao, W., Jiang, D., Rieppel, O., Motani, R., Tintori, A.** NEW SPECIMEN OF THE TERRESTRIAL REPTILE *MACROCNEMUS* FROM THE LATEST LADINIAN XINGYI-FUYUAN MARINE REPTILE LEVEL, SOUTHWESTERN CHINA

25 **Bennett, S.** INCONGRUENCE BETWEEN MORPHOLOGICAL DATA PARTITIONS: AN EXAMPLE FROM THE FOSSIL RECORD OF THE ARCHOSAUROMORPHA

26 **Voigt, S., Schneider, J., Saber, H., Klein, H., Hminna, A.** COMPLEX TETRAPOD BURROWS FROM THE TRIASSIC TIMEZGADIOUINE FORMATION (ARGANA BASIN, WESTERN HIGH ATLAS, MOROCCO)

27 **Pérez García, A., Xabier, M., Ortega, F.** TURTLE DIVERSITY FROM THE UPPER JURASSIC AND LOWER CRETACEOUS OF GALVE (TERUEL, SPAIN)

28 **Sullivan, R., Jasinski, S., Lucas, S.** LATE CRETACEOUS (KIRTLANDIAN) TURTLES FROM THE FRUITLAND AND KIRTLAND FORMATIONS, SAN JUAN BASIN NEW MEXICO

29 **Larson, D., Brinkman, D., Morin, J.** LATE CRETACEOUS CANADIAN SPECIMENS OF FAMILY SOLEMYDIDAE (TESTUDINES) WITH SPECIAL MENTION OF A NEW GENUS AND SPECIES

30 **Burk, D., Sandau, S., Klimek, J.** TWO PREVIOUSLY UNREPORTED TURTLES FROM THE EOCENE UINTA FORMATION, UTAH

31 **Hirayama, R., Shikano, K., Sonoda, T.** OLIGOCENE *MALAYEMYS* AND MIOCENE *GEOEMYDA* (GEEMYDIDAE; TESTUDINES) FROM JAPAN

32 **Georgalis, G., Kear, B.** NEW RECORDS OF FOSSIL TURTLES FROM GREECE

33 **Vitek, N.** CHARACTER REINTERPRETATION AND FOSSIL SOFT-SHELLED TURTLE TAXA (TRIONYCHIDAE) WORK TOGETHER TO RECOVER NEW RELATIONSHIPS

34 **Rubilar-Rogers, D.** NEW LOCALITY WITH DINOSAUR TRACKS FROM THE LATE JURASSIC OF THE ATACAMA DESERT, NORTHERN CHILE

35 **Coria, R., Currie, P., Koppelhus, E., Braun, A., Cerda, I.** FIRST RECORD OF A VALANGINIAN (EARLY CRETACEOUS) DINOSAUR ASSOCIATION FROM SOUTH AMERICA

36 **Shibata, M., Azuma, Y.** NEW DINOSAURS FROM THE LOWER CRETACEOUS KITADANI FORMATION OF THE TETORI GROUP, FUKUI, CENTRAL JAPAN

37 **de Santisteban, C., Santos-Cubedo, A., Suñer, M., Poza, B.** DINOSAUR FOSSIL SITES INSIDE INCISED CHANNELS. AN EXAMPLE FROM THE ARCILLAS DE MORELLA FORMATION (LOWER CRETACEOUS, SPAIN)

38 **Lynch, E., Novak, B., Bridges, T.** EVIDENCE OF A BACTERIAL ORIGIN FOR DINOSAUR "BLOOD VESSELS" FROM UPPER CRETACEOUS DINOSAUR BONE

39 **Fiorillo, A., Adams, T., Kobayashi, Y.** A NEW DINOSAUR ICHNOFAUNA FROM THE LATE CRETACEOUS OF WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE, ALASKA

40 **Kong, D., Lim, J., Kim, T., Kim, K.** DISCOVERY OF A LARGE REPTILIAN TRACKWAY FROM THE CRETACEOUS JINDONG FORMATION OF GOSEONG COUNTY, KOREA

41 **Stout, J., Boardman, G.** MORPHOLOGY AND SYSTEMATICS OF DINOSAUR EGGSHELLS AND THE IDENTIFICATION OF PROBLEMATIC OOSPECIES

42 **Porter, W., Witmer, L.** VASCULATURE AND DINOSAUR PHYSIOLOGY: VASCULAR PATTERNS IN EXTANT DIAPSIDS

43 **Trevethan, I., Scannella, J.** A MORPHOMETRIC ANALYSIS OF CRANIAL SEXUAL VARIATION IN THE EXTANT PHYLOGENETIC BRACKET OF THE DINOSAURIA: IMPLICATIONS FOR FOSSIL STUDIES

44 **Padian, K., Horner, J., Fowler, D., Scannella, J.** HOW A SYNERGY OF SPECIES RECOGNITION AND SOCIAL SIGNALING EXPLAINS CRANIAL ANATOMY AND ONTOGENY IN SEVERAL GROUPS OF DINOSAURS

45 **Falkingham, P., Margetts, L., Manning, P.** MUDDYING THE WATER: TRACK FEATURES TYPICAL OF LIMB KINEMATICS FORMED THROUGH NORMAL SUBSTRATE DEFORMATION, AS SHOWN BY FINITE ELEMENT ANALYSIS EXPERIMENTATION

46 **Habib, M.** 10,000 MILES: MAXIMUM RANGE AND SOARING EFFICIENCY OF AZHDARCHID PTEROSAURS

47 **Rodrigues, T., Kellner, A.** REAPPRAISAL OF BASAL PTEROSAUR RELATIONSHIPS THROUGH THE REDUCED CONSENSUS METHOD

48 **Sumida, S., Pelletier, V.** PARTIAL BODY RECONSTRUCTION OF THE BASAL PELYCOSAURIAN-GRADE SYNAPSID *OEDALEOPS*

49 **Spielmann, J., Rinehart, L., Lucas, S., Berman, D., Henrici, A.** THE SPECIES-LEVEL TAXONOMY OF *SPHENACODON FEROX* MARSH (EUPELYCOSAURIA: SPHENACODONTIDAE) FROM THE LATE PENNSYLVANIAN-EARLY PERMIAN OF NEW MEXICO

50 **Hawthorn, J., Scott, D., Reisz, R.** CRANIAL ANATOMY OF *OPHIACODON UNIFORMIS*: NEW INSIGHTS FROM AN EXCEPTIONALLY PRESERVED SPECIMEN USING COMPUTED TOMOGRAPHY

51 **Harris, S., Lucas, S., Spielmann, J.** POSTCRANIAL ANATOMY OF *OPHIACODON NAVAJOVICUS* (EUPELYCOSAURIA: OPHIACODONTIDAE), FROM THE UPPER PENNSYLVANIAN OF CANYON DEL COBRE, NEW MEXICO

52 **Spindler, F., Schneider, J., Voigt, S.** TAPHONOMIC ANALYSIS OF THE SKELETAL AGGREGATION OF *PANTELOSAURUS* (SPHENACODONTIA, EUPELYCOSAURIA)

53 **Wong Ken, N., Reisz, R., May, W.** A NEW VARANOPID SYNAPSID FROM THE LOWER PERMIAN OF OKLAHOMA, WITH EVIDENCE OF HYPERCARNIVORY

54 **Scott, K., Sumida, S.** PLACEMENT OF THE PERMO-CARBONIFEROUS BOUNDARY IN THE HALGAITO FORMATION, CUTLER GROUP, SOUTHEASTERN UTAH

55 **Krainer, K., Lucas, S., Harris, S., Spielmann, J., Rinehart, L.** VERTEBRATE PALEONTOLOGY, BIOSTRATIGRAPHY AND BIOCHRONOLOGY OF THE PENNSYLVANIAN-PERMIAN CUTLER GROUP, CANYON DEL COBRE, NORTHERN NEW MEXICO

56 **Martens, T., Berman, D., Henrici, A., Sumida, S.** THE BROMACKER HORIZON - THE MOST IMPORTANT SEQUENCE OF STRATA OF LOWER PERMIAN TERRESTRIAL VERTEBRATE FOSSILS OUTSIDE OF NORTH AMERICA

57 **Weinbaum, J., Martz, J.** A NEW VERTEBRATE FOSSIL LOCALITY IN THE UPPER TRIASSIC CHINLE FORMATION OF NORTHEASTERN ARIZONA

58 **Gold, M.** BIOSTRATIGRAPHIC CORRELATION OF A NEW TRIASSIC FOSSIL LOCALITY WITHIN THE GETTYSBURG BASIN, MARYLAND

59 **Martz, J., Parker, W.** UNDERSTANDING AND UTILIZING DETAILED BIOSTRATIGRAPHIC DATA TO CHARACTERIZE LATE TRIASSIC FAUNAL CHANGE: EXAMPLES FROM WESTERN NORTH AMERICA

60 **Carpenter, K.** TAPHONOMY OF THE DOUGLASS QUARRY, DINOSAUR NATIONAL MONUMENT, UTAH

61 **O'Connor, P., Sertich, J., Sallam, H., Seiffert, E.** RECONNAISSANCE PALEONTOLOGY IN THE LATE CRETACEOUS OF DAKHLA AND KHARGA OASES, WESTERN DESERT, EGYPT

62 **Torices, A., Barroso-Barcenilla, F., Cambra-Moo, O., Pérez-García, A., Segura, M.** THE NEW CENOMANIAN VERTEBRATE SITE ALGORA; (GUADALAJARA, SPAIN)

63 **Nagrodski, M., Shimada, K., Schumacher, B.** FOSSIL MARINE VERTEBRATES FROM THE UPPER CRETACEOUS HARTLAND SHALE IN SOUTHEASTERN COLORADO

64 **Gates, T., Makovicky, P., Rieppel, O.** MICROVERTEBRATE FAUNA FROM THE MAASTRICHTIAN (LATE CRETACEOUS) "SUE" QUARRY: IMPLICATIONS FOR MICROSITE ORIGINATION AND FINE-SCALED HELL CREEK FORMATION BIODIVERSITY

65 **Gillette, D., Albright III, L., Titus, A.** FOSSIL VERTEBRATES OF THE UPPER CRETACEOUS TROPIC SHALE, SOUTHERN UTAH

66 **Ullmann, P., Varricchio, D., Knell, M., Lacovara, K.** TAPHONOMY AND TAXONOMY OF A VERTEBRATE MICROSITE IN THE CRETACEOUS BLACKLEAF FORMATION IN SOUTHWEST MONTANA

67 **Crane, C., Rigsby, C., Culver, S., Russell, D.** VERTEBRATE FAUNAL ANALYSIS OF THE LATE CRETACEOUS BLACK CREEK GROUP, BLADEN COUNTY, NORTH CAROLINA

68 **Callahan, W., Johnson, R., Mehling, C.** A NEW VERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS (MAASTRICHTIAN) NEW EGYPT FORMATION OF NEW JERSEY

69 **Kaye, T., Martin, L., Burnham, D., Gong, E.** MULTISPECTRAL IMAGING AND ANALYSIS OF A LIAONING "MYSTERY SPECIMEN"

70 **Cumbaa, S., Shimada, K., Cook, T.** MID-CENOMANIAN VERTEBRATE FAUNAS OF THE NORTH AMERICAN WESTERN INTERIOR SEAWAY

71 **Egerton, V., Williams, C., Lacovara, K.** CLIMATIC AND FLORAL LATITUDINAL GRADIENTS BETWEEN LATE CRETACEOUS SOUTH AMERICA AND ANTARCTICA: PALEOBIOGEOGRAPHICAL IMPLICATIONS FOR SOUTHERNMOST GONDWANA

72 **Peyrot, D., Barroso-Barcenilla, F., Berreteaga, A., Cambra-Moo, O.** FIRST PALYNOLOGICAL DATA AND INTERPRETATION OF "LO HUECO" VERTEBRATE SITE (UPPER CRETACEOUS, CUENCA, SPAIN)

73 **Rogers, R., Krause, D.** NEW INSIGHTS INTO THE GEOLOGICAL CONTEXT OF THE LATE CRETACEOUS VERTEBRATE ASSEMBLAGE FROM THE MAEVARANO FORMATION, MAHAJANGA BASIN, MADAGASCAR

74 **Foreman, B., Roberts, E., Tapanila, L., Ratigan, D.** PALEOCLIMATE, HYDROLOGY AND TAPHONOMY OF THE KAIPAROWITS FORMATION (SOUTH-CENTRAL UTAH): THE STABLE ISOTOPE PERSPECTIVE

75 **González-Acebrón, L., Barroso-Barcenilla, F., Cambra-Moo, O., Carenas, B.** DIAGENETIC OVERVIEW ON VERTEBRATE FOSSILS FROM THE SANDY CHANNEL OF "LO HUECO" SITE (UPPER CRETACEOUS, SPAIN)

76 **Ikegami, N.** TAPHONOMY AND SEDIMENTOLOGY OF A BONEBED FROM THE UPPER CRETACEOUS MIFUNE GROUP IN KYUSHU, JAPAN

77 **Meyers, V., Rowland, S.** COMPARISON OF TWO PLIOCENE (BLANCAN) VERTEBRATE FOSSIL ASSEMBLAGES: PANACA LOCAL FAUNA (LINCOLN COUNTY, NEVADA) AND HAGERMAN LOCAL FAUNA (TWIN FALLS COUNTY, IDAHO)

78 **Randall, K., Gensler, P.** A PRELIMINARY REPORT ON A BLANCAN MICRO MAMMAL ASSEMBLAGE FROM THE OTAY RANCH VILLAGE 2 NORTH HOUSING DEVELOPMENT PROJECT, SAN DIEGO FORMATION, CHULA VISTA, CALIFORNIA

79 **Reed, D., Geraads, D.** A NEW PLIO-PLEISTOCENE MICROMAMMAL ASSEMBLAGE FROM HADAR A.L. 894, AFAR ETHIOPIA

80 **Seymour, K.** PAWS FOR THOUGHT: THE LATE PLEISTOCENE FOSSIL VERTEBRATES FROM THE TALARA TAR SEEPS, PERU, AND CORRALITO, ECUADOR

SUNDAY AFTERNOON, OCTOBER 10, 2010
POSTER SESSION I (continued)

81 **Atwater, A., Davis, E.** TOPOGRAPHIC CHANGE AND PLIO-PLEISTOCENE BETA DIVERSITY OF THE NORTH AMERICAN GREAT BASIN AND GREAT PLAINS

82 **Hakala, S., Bobe, R.** LATERAL AND TEMPORAL DISTRIBUTION OF MAMMALIAN FAUNA FROM EARLY PLEISTOCENE KOOBI FORA FORMATION, EAST TURKANA

83 **Milideo, L.** ACTUALISTIC TAPHONOMY OF COLD AND TEMPERATE CLIMATES: APPLICATIONS FOR PLEISTOCENE PALEONTOLOGY

84 **Slepkov, R., Kovarovic, K., McNulty, K.** REFINING ECOLOGICAL DIVERSITY ANALYSIS IN A PALEOECOLOGICAL RECONSTRUCTION OF OLDUVAI GORGE BED II

85 **France, C., Kaufman, A.** TROPHIC RELATIONSHIPS BETWEEN LATE PLEISTOCENE MAMMALS FROM AUCILLA RIVER, FLORIDA: EVIDENCE FROM NITROGEN AND CARBON STABLE ISOTOPES

86 **Garrett, N., Fox, D., McNulty, K., Tryon, C., Peppe, D.** ISOTOPE PALEOECOLOGY OF THE PLEISTOCENE WASIRIYA BEDS OF RUSINGA ISLAND, KENYA

87 **Jass, C., Burns, J., Milot, P.** RELATIVE ABUNDANCE OF LATE PLEISTOCENE MEGAFAUNA IN CENTRAL ALBERTA, CANADA

88 **Tamma, K., Ramakrishnan, U.** TEMPORAL VARIABILITY IN THE COMPOSITION OF A FOSSIL SMALL MAMMAL ASSEMBLAGE FROM SOUTH INDIA

89 **Pons-Monjo, G., Furió, M., Moyà-Solà, S.** THE UNUSUAL PELVIC CONSTRUCTION OF THE INSULAR SHREW *NESIOTITES HIDALGO* (SORICIDAE, MAMMALIA) FROM MALLORCA (BALEARIC ISLANDS, SPAIN)

90 **Arney, I., Lewis, P., Thies, M.** THE UTILITY OF POSTCRANIAL ELEMENTS IN DIAGNOSING SOUTHERN AFRICAN MICROFAUNA

91 **Rowland, S.** AGE PROFILE OF COLUMBIAN MAMMOTHS FROM THE TULE SPRINGS FOSSIL BEDS, UPPER LAS VEGAS WASH, NEVADA

92 **Patterson, D., Mead, A.** NEW SKELETAL REMAINS OF *MAMMUTHUS COLUMBI* FROM COASTAL GEORGIA

93 **Smith, K., Fisher, D.** SEXUAL DIMORPHISM IN TUSKS OF AMERICAN MASTODONS (*MAMMUT AMERICANUM*) AND AFRICAN ELEPHANTS (*LOXODONTA AFRICANA, LOXODONTA CYCLOTIS*): A MULTIVARIATE COMPARISON

94 **Green, J.** USING TUSK MICROWEAR TO RECONSTRUCT FEEDING BEHAVIOR IN EXTINCT PROBOSCIDEANS (MAMMALIA)

95 **Peek, S., Clementz, M.** THE EFFECT OF DIAGENESIS ON SR/CA AND BA/CA RATIOS OF TOOTH ENAMEL

96 **Schmitt, E., Schubert, B., Ungar, P., Scott, J.** ANALYSIS OF THE BONE CRUSHING BEHAVIOR OF *CANIS DIRUS* USING DENTAL MICROWEAR TEXTURE ANALYSIS

MONDAY MORNING, OCTOBER 11, 2010
SYMPOSIUM: PHYSICAL DRIVERS AND MARINE TETRAPOD EVOLUTION
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Robert Fordyce, Neil Kelley

8:00 **Fordyce, R., Marx, F., Aguirre-Fernández, G.** PHYSICAL TRENDS, RHYTHMS AND ABERRATIONS IN THE WORLD OF MARINE TETRAPODS: THE CASE OF PLATANISTOID AND DELPHINOID DOLPHINS

8:15 **Kelley, N., Motani, R., Jiang, D., Rieppel, O.** GLOBAL GEOCHEMICAL CONTEXT OF EARLY MESOZOIC MARINE REPTILE EVOLUTION

MONDAY MORNING, OCTOBER 11, 2010
SYMPOSIUM: PHYSICAL DRIVERS AND MARINE TETRAPOD EVOLUTION (continued)

8:30 **Rieppel, O.** THE DIVERSIFICATION AND DECLINE OF SAUROPTERYGIA IN THE TRIASSIC WESTERN TETHYS

8:45 **Fischer, V.** RECONSIDERING THE EXTINCTION OF ICHTHYOSAURS

9:00 **Polcyn, M.** SENSORY ADAPTATIONS IN MOSASAURS

9:15 **Jacobs, L., Polcyn, M., Araújo, R., Strganac, C., Mateus, O.** PHYSICAL DRIVERS OF EVOLUTION AND THE HISTORY OF THE MARINE TETRAPOD FAUNA OF ANGOLA

9:30 **Parham, J., Joyce, W.** PHYSICAL DRIVERS AND THE ORIGINS, EVOLUTION AND DIVERSITY OF MARINE TURTLES

9:45 **Hinic-Frlog, S., Rowe, G., Rybczynski, N.** SKELETAL SPECIALIZATIONS FOR LOCOMOTION IN AQUATIC BIRDS: PHYLOGENETIC AND PHYSICAL ASPECTS

10:00 **BREAK**

10:15 **Ando, T.** FLIGHTLESS WING-PROPELLED DIVERS: SOUTHERN PROSPERITY VS. NORTHERN EXTINCTIONS

10:30 **Beatty, B., Mihlbachler, M.** DENTAL MICROWEAR OF MODERN AND FOSSIL SIRENIA REFLECTS CHANGES IN THE PHYSICAL ENVIRONMENT IN THE NEOGENE OF FLORIDA

10:45 **Kohno, N.** ENVIRONMENTAL CHANGES AND EVOLUTIONARY DIVERSIFICATION OF PINNIPEDS

11:00 **Davis, E., Pyenson, N.** USING THE HIGH FIDELITY OF CETACEAN STRANDINGS TO REVEAL THE SPATIOTEMPORAL SCALES OF CETACEAN MACROECOLOGY

11:15 **Gutstein, C., Cozzuol, M., Rubilar-Rogers, D., Pyenson, N., Canals, M.** MODERN ODONTOCETE EVOLUTION: MORPHOMETRIC DISCRIMINATION OF THE ACOUSTIC SYSTEM REVEALS ECOLOGICAL PARTITIONING BETWEEN RIVERINE AND MARINE TAXA SINCE THE MIOCENE

11:30 **Fitzgerald, E.** EVOLUTION AND EXTINCTION OF RIVER DOLPHINS (CETACEA: PLATANISTOIDEA) IN CENTRAL AUSTRALIA

11:45 **Marx, F., Fordyce, R.** LEVIATHANS SPORTING ON THE FOAMING WAVES - AN INTEGRATED VIEW OF BALEEN WHALE DIVERSITY, DISPARITY AND EVOLUTIONARY RELATIONSHIPS

12:00 **Pyenson, N., Lindberg, D.** WHAT HAPPENED TO GRAY WHALES DURING THE PLEISTOCENE? RECONSTRUCTING THE ECOLOGICAL IMPACT OF SEA-LEVEL CHANGE ON CRITICAL BENTHIC FEEDING HABITATS IN THE NORTH PACIFIC OCEAN

MONDAY MORNING, OCTOBER 11, 2010
ROMER PRIZE SESSION

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: David Fox, Leon Claessens

8:00 **Cooper, L.** THE EVOLUTION AND DEVELOPMENT OF HYPERPHALANGY AND HYDROFOILS IN CETACEANS

8:15 **Crowley, B.** COMPETITIVE RELEASE OR ECOLOGICAL RETREAT: ECOLOGICAL RAMIFICATIONS OF EXTINCTION AND HABITAT TRANSFORMATION FOR MADAGASCAR'S LEMURS

8:30 **de Boef Miara, M.** THE EFFECTS OF PHYLOGENY, FUNCTION AND PHYSIOLOGY ON BONE MICROSTRUCTURE

8:45 **Fowler, D.** ANAGENESIS AND LONG-TERM MORPHOLOGIC TRENDS IN CHASMOSAURINAE (DINOSAURIA: CERATOPSIDAE) REVEALED BY A NEW HIGH-RESOLUTION CHRONOSTRATIGRAPHIC FRAMEWORK, ONTOGENETIC ANALYSIS AND DESCRIPTION OF TWO NEW TAXA

9:00 **Gignac, P.** TOOTH PRESSURES, NICHE OCCUPATION AND THE EVOLUTION OF THE CRANIAL ECOMORPHOLOGY OF CROCODYLIANS

MONDAY MORNING, OCTOBER 11, 2010
ROMER PRIZE SESSION (continued)

9:15 **Hirasawa, T.** THE EVOLUTION OF RIBCAGE ANATOMY AND BREATHING FUNCTION IN THE MESOZOIC THEROPODS

9:30 **Marjanovi□, D.** AGE AND RELATIONSHIPS OF THE MODERN AMPHIBIANS (TETRAPODA: SALIENTIA, CAUDATA, GYMNOPHIONA, ALBANERPETONTIDAE)

9:45 **McGuire, J.** INTERPRETING RECENT SMALL-MAMMAL RANGE SHIFTS IN YOSEMITE IN LIGHT OF THE QUATERNARY FOSSIL RECORD

10:00 **BREAK**

10:15 **Olori, J.** DEVELOPMENTAL FEATURES OF MICROSAURS (LEPOSPONDYLI), AND CONSEQUENCES FOR THE EVOLUTION OF DEVELOPMENT AND PHYLOGENETIC RELATIONSHIPS WITHIN TETRAPODA

10:30 **Sadleir, R.** SEASONALITY AS A POTENTIAL SOURCE OF VARIATION IN *ALLIGATOR* CRANIAL EVOLUTION

10:45 **Scannella, J.** *TRICERATOPS*: A MODEL ORGANISM FOR DECIPHERING DINOSAUR HETEROCHRONY

11:00 **Schachner, E.** EVOLUTION OF THE DINOSAURIFORM RESPIRATORY SYSTEM: NEW EVIDENCE FROM THE POSTCRANIAL AXIAL SKELETON

11:15 **Spaulding, M.** PHYLOGENY OF THE CARNIVORAMORPHA, WITH IMPLICATIONS FOR LOCOMOTOR RECONSTRUCTION

11:30 **Thomas, D.** EVOLUTION OF HEAT RETENTION IN PENGUINS

11:45 **Wheatley, P.** EVOLUTION OF SALT-WATER TOLERANCE IN THE CROCODYLIA AND RELATED CROCODYLOMORPHS: NEW INSIGHTS FROM STABLE ISOTOPES

12:00 **Wilhelm, B.** OSTEOLOGICAL EVIDENCE FOR A TAIL FIN IN CRYPTOCLEIDOID PLESIOSAURS AND THE ROLE OF THE TAIL IN PLESIOSAUR LOCOMOTION

MONDAY MORNING, OCTOBER 11, 2010
PREPARATORS' SESSION

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Kyle Davies, William Simpson

8:00 **Potapova, O., Agenbroad, L., Wilkins, W.** FROM THE BONEBED TO THE BASEMENT: COLLECTION PROCEDURES AT THE MAMMOTH SITE OF HOT SPRINGS, SOUTH DAKOTA

8:15 **Fry, R., Main, D.** MAPPING AND RECORDING THE EXCAVATION OF A MID-CRETACEOUS CROCODILE (ARCHOSAURIA: GONIOPHOLIDAE) AT AN URBAN DIG UTILIZING A CARTESIAN MAPPING SYSTEM

8:30 **Benton, R., Weiler, M., Thompson, W.** LONG TERM DOCUMENTATION OF THE CONATA PICNIC GROUND SITE (BIG PIG DIG) BADLANDS NATIONAL PARK, SOUTH DAKOTA

8:45 **Smith, M.** CSI KIMBERLY: FOSSIL CRIME SCENE INVESTIGATION PRIOR TO THE ESTABLISHMENT OF THE PALEONTOLOGICAL RESOURCES PROTECTION ACT

9:00 **Brown, G.** BONE BANDAGES: A CONSERVATIONALLY-SOUND REPAIR TECHNIQUE FOR BROKEN BONES HAVING LIMITED CONTACT SURFACE AREA

9:15 **Shinya, A.** USE OF RIGID, SEMI-RIGID AND TRANSPARENT CRADLES FOR PREPARATION AND LONG TERM STORAGE OF DELICATE SPECIMENS

9:30 **Keyser, W., Kroehler, P., Jabo, S.** CONTINUED IMPROVEMENTS IN THE USE OF ARCHIVAL MATERIALS FOR THE PADDED PLASTER JACKET STORAGE METHOD: WHAT WE HAVE LEARNED IN TWENTY YEARS

MONDAY MORNING, OCTOBER 11, 2010
PREPARATORS' SESSION (continued)

9:45 **Nelsen , T., Grasso, J., Haulton, K., Gensler, P.** ADDRESSING A CRITICAL NEED WITHIN THE COLLECTIONS AT HAGERMAN FOSSIL BEDS NATIONAL MONUMENT: REFINED AND IMPROVED TECHNIQUES AND MATERIALS FOR THE PRODUCTION OF MULTI-SIZE, CLAM SHELL SPECIMEN CRADLES

10:00 **BREAK**

10:15 **Carlson, K., Smilg, J., DeClerk, B., Yates, C., Berger, L.** CT IMAGING OF FOSSIL-BEARING CALCIFIED CLASTIC SEDIMENTS FROM THE MALAPA SITE, SOUTH-AFRICA – ADVANCES IN DISCOVERY, IDENTIFICATION AND PREPARATION OF FOSSIL HOMININS AND FAUNA

10:30 **Andersen, A., Lichko, J., Jones, M., Larson, P.** HOW TO MOLD AND CAST A MUMMY DINOSAUR

10:45 **Keillor, T., Sereno, P., Masek, R.** RANGE OF MOVEMENT IN A NOASAURID FORELIMB: *IN SITU* DATA AND JOINT RECONSTRUCTION

11:00 **Davies, K., Cifelli, R., Davis, B., Gordon, C.** A SIMPLE MICROVERTEBRATE MOLDING AND CASTING TECHNIQUE: A 20-YEAR RETROSPECTIVE

11:15 **Van Beek, C.** PREPARATION OF MICRO-FEATURES OF EOCENE GREEN RIVER SPECIMENS: METHODS AND MATERIALS

11:30 **Shaw, T., Nydegger, L.** CREATION OF A LARGE SCALE INTERPRETIVE TRACKWAY DISPLAY

11:45 **Chure, D.** RACING AGAINST DISASTER: THE DEMOLITION, REHABILITATION AND RECONSTRUCTION OF THE QUARRY VISITOR CENTER, CARNEGIE QUARRY, DINOSAUR NATIONAL MONUMENT

12:00 **Brown, M., Rowe, T.** DESIGNING THE MODERN PREPARATION LAB: INTEGRATING NEW TECHNOLOGIES

MONDAY AFTERNOON, OCTOBER 11, 2010
TECHNICAL SESSION VI

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Wighart von Koenigswald, Nancy Simmons

1:45 **Smith, T., de Ploëg, G., Métais, G., Eric, D., Floréal, S.** FIRST MODERN MAMMALS FROM THE LATEST PALEOCENE OF EUROPE

2:00 **Wang, Y., Tong, Y., Li, Q.** UPDATED ASIAN PALEOCENE MAMMALIAN BIOCHRONOLOGY AND ITS IMPLICATIONS TO INTERCONTINENTAL FAUNAL INTERCHANGE

2:15 **Giallombardo, A., AToL Mammal Morphology Team** POSTCANINE TEETH HOMOLOGIES IN MAMMALIA

2:30 **von Koenigswald, W.** THREE MAJOR ASPECTS DESCRIBING THE DIVERSITY OF HYPSODONTY IN MAMMALIAN DENTITIONS

2:45 **Christensen, H.** CONVERGENT MICROWEAR PATTERNS IN EXTANT METATHERIAN AND EUTHERIAN HERBIVORES: A PROXY FOR THE ANALYSIS OF MAMMALIAN DIET IN THE LATEST CRETACEOUS AND EARLY PALEOCENE

3:00 **Engels, S., von Koenigswald, W., Martin, T.** CHANGES IN MOLAR FUNCTIONAL MORPHOLOGY OF EARLY HIPPOMORPHA

3:15 **Kilbourne, B.** THE SCALING OF LIMB ROTATIONAL INERTIA IN CURSORIAL MAMMALS: A PRECURSOR TO MODELING LIMB INERTIA IN EXTINCT TAXA

3:30 **Schmitz, L., Price, S.** INFLUENCE OF BODY MASS ON THE EVOLUTION OF DIEL ACTIVITY PATTERN IN HERBIVOROUS MAMMALS AND IMPLICATIONS FOR PALEOBIOLOGY

3:45 **Rodgers, J., Rodgers, M.** ROTATIONAL AND NAVIGATIONAL VESTIBULAR SENSITIVITY DIRECTIONS IN THERIAN MAMMALS

4:00 **Simmons, N., Seymour, K., Habersetzer, J., Gunnell, G.** INFERRING ECHOLOCATION IN ANCIENT BATS

MONDAY AFTERNOON, OCTOBER 11, 2010
TECHNICAL SESSION VII

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Sarah Werning, Jason Head

1:45 **Werning, S., Irmis, R.** RECONSTRUCTING THE ONTOGENY OF THE TRIASSIC BASAL ARCHOSAUROMORPH *TRILOPHOSAURUS* USING BONE HISTOLOGY AND LIMB BONE MORPHOMETRICS

2:00 **Wu, X., Ji, Q., Cheng, Y.** CRETACEOUS CHORISTODERAN REPTILES GAVE BIRTH TO LIVE YOUNG

2:15 **Milner, A., Milner, A.** ONTOGENY AND PHYLOGENY IN PROCOLOPHONIDS - EVIDENCE FROM A NEW LEPTOPLEURONINE FROM THE MIDDLE TRIASSIC OTTER SANDSTONE OF SIDMOUTH, DEVON

2:30 **Lyson, T., Bhullar, B., Bever, G., Joyce, W., Gauthier, J.** VERTICAL SPLIT OF THE TURTLE SHOULDER GIRDLE PUSHES THE LIMITS OF MUSCULAR SCAFFOLD HOMOLOGY

2:45 **ElShafie, S.** A COMPLETE SKULL AND SKELETON OF A LONG-NECKED PLEURODIRE (PLEURODIRA: ARARIPEMYDIDAE) FROM NIGER

3:00 **Head, J.** CLIMATIC REGULATION OF MAXIMUM BODY SIZE IN POIKILOTHERMIC VERTEBRATES: AN EMPIRICAL TEST USING THE CRETACEOUS AND PALEOGENE RECORD OF NORTH AMERICAN TRIONYCHID TURTLES

3:15 **Hill, R., Sertich, J., Roberts, E., O'Leary, M.** FOSSIL CROCODYLIFORMS AND TURTLES FROM THE EARLY CRETACEOUS OF NORTHEASTERN MALI

3:30 **Smith, D., Sanders, R., Parker, W., Cavanaugh, J.** THE ENDOCRANIUM, INNER EAR AND PNEUMATIC STRUCTURE OF THE UPPER TRIASSIC PHYTOSAUR *PSEUDOPALATUS PRISTINUS*

3:45 **Wilberg, E.** THE PHYLOGENETIC POSITION OF THALATTOSUCHIA (CROCODYLOMORPHA) AND THE IMPORTANCE OF OUTGROUP CHOICE

4:00 **Dufeau, D., Witmer, L.** OPPORTUNISM, ACOUSTICS AND MASS: EXAPTATION AND PATTERNS OF MIDDLE-EAR EXPANSION IN ARCHOSAURIA

MONDAY AFTERNOON, OCTOBER 11, 2010
TECHNICAL SESSION VIII

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Michael Cotes, John Long

1:45 **MacKenzie, L.** UNCOVERING THE TAPHONOMY OF THE CHENGJIANG BIOTA USING GEOCHEMISTRY AND SEDIMENTOLOGY

2:00 **Jones, D., Evans, A.** FUNCTIONAL MORPHOLOGY OF THE EARLIEST VERTEBRATE FEEDING STRUCTURES

2:15 **Brazeau, M., Friedman, M.** PHYLOGENETIC EXPERIMENTS ON CURRENT SCENARIOS OF EARLY GNATHOSTOME EVOLUTION

2:30 **Coates, M., Davis, S.** ABOUT THE EARS: *ACANTHODES* RE-EXAMINED AND GNATHOSTOME ORIGIN RE-ANALYZED

2:45 **Blais, S., Mackenzie, L., Wilson, M.** TOOTH-LIKE LIP AND CHEEK SCALES IN EARLY GNATHOSTOMES FROM THE MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES, CANADA

3:00 **Jerve, A.** MODES OF GNATHOSTOME FIN SPINE DEVELOPMENT INFERRED FROM THREE-DIMENSIONAL HISTOLOGY

3:15 **Long, J., Trinajstic, K., Young, G., Johanson, Z.** PLACODERM COPULATION AND VIVIPARITY: IMPLICATIONS FOR PELVIC GIRDLE DEVELOPMENT

3:30 **Zhu, M., Zhao, W., Jia, L.** PLACODERM JAW BONES FROM THE XIAOXIANG FAUNA (LUDLOW, SILURIAN) AND THE DENTITION OF EARLY GNATHOSTOMES

MONDAY AFTERNOON, OCTOBER 11, 2010
TECHNICAL SESSION VIII (continued)

3:45 **Carr, R.** PLACODERM REPRODUCTIVE STRATEGIES

4:00 **Cloutier, R., Potvin-Leduc, D., Landing, E., Stein, W., VanAller Hernick, L.** A NEW DEVONIAN FISH *LAGERSTATTE* FROM NEW YORK STATE: TAPHONOMY, PALEOENVIRONMENT AND PALEODIVERSITY

MONDAY AFTERNOON, OCTOBER 11, 2010
POSTER SESSION II

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM A
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Pellegrini, R., Jehle, A., Grandstaff, B., Albright, S., Parris, D.** BEESWAX AS A REMEDIAL TREATMENT FOR PYRITE DISEASE

2 **Davidson, A.** POLYTETRAFLUOROETHYLENE (PLUMBER'S) TAPE, TISSUE AND PLASTER BANDAGE USED AS A REMOVABLE SUPPORT FOR FOSSIL PREPARATION

3 **Fox, M.** USING DIFFERENT MOLECULAR WEIGHTS OF CARBOWAX

4 **Finlayson, H., Temme IV, T., Gray, D.** BLOCK 124: A LOOK INTO THE HISTORY OF A 100-YEAR-OLD FIELD JACKET FROM THE CARNEGIE QUARRY, DINOSAUR NATIONAL MONUMENT, UT

5 **Santucci, V., Kenworthy, J., Tweet, J., Woods, J.** INVENTORY AND MONITORING OF VERTEBRATE PALEONTOLOGICAL RESOURCES FROM NATIONAL PARK SERVICE AREAS

6 **Hartman, J., Weiler, M., Schumaker, K.** BENEFITS, CHALLENGES AND SOLUTIONS OF COLLECTIONS AT SMALL PROGRAMS AND INSTITUTIONS USING EXPERIENCE FROM THE UNIVERSITY OF NORTH DAKOTA

7 **DeBlieux, D., Santucci, V., Kirkland, J., Madsen, S., Madsen, M.** DEVELOPING A PILOT PALEONTOLOGICAL RESOURCE MONITORING PROGRAM FOR THE NATIONAL PARK SERVICE AT GLEN CANYON NATIONAL RECREATION AREA, UTAH

EDWIN H. AND MARGARET M. COLBERT PRIZE COMPETITION BEGINS

8 **Racicot, R.** PHYLOGENETICS OF FOSSIL AND EXTANT DELPHINOIDEA (CETACEA: DELPHINOIDEA) USING BAYESIAN INFERENCE

9 **Martin, J.** A NEW FOSSIL BALAENOPTERID (CETACEA, MYSTICETI) FROM THE LATE PLIOCENE SAN DIEGO FORMATION, CALIFORNIA

10 **Field, D.** THE MECHANICAL DESIGN OF RORQUAL MANDIBLES: IMPLICATIONS FOR LUNGE-FEEDING FROM QUANTITATIVE COMPUTED TOMOGRAPHY

11 **Rankin, B.** LATE MIDDLE TIFFANIAN (LATE PALEOCENE) MAMMALS FROM SOUTHEASTERN SASKATCHEWAN, CANADA

12 **Pilbro, C.** COMPARISON OF EARLY EOCENE SAN JUAN BASIN, NM *PHENACOLEMUR JEPSENI* WITH *PHENACOLEMUR CITATUS* AND *PHENACOLEMUR PRAECOX* FROM BIGHORN BASIN, WY - STUDY OF THE VARIATION AND VALIDITY OF THESE *PHENACOLEMUR* SPECIES

13 **Frazier, B.** UNCOVERING THE EVOLUTIONARY HISTORY OF A LINEAGE WITH NO FOSSIL RECORD: AN ODD PATTERN OF ENCEPHALIZATION IN AN ODD-NOSED MONKEY

14 **Hensley-Marschand, B.** SEXUAL DIMORPHISM IN CRANIAL SHAPE OF THE SPOTTED HYENA (*CROCUTA CROCUTA*)

15 **Smith, M.** REGIONAL DISJUNCTION IN PLEISTOCENE FAUNAS FROM INDIANA AND THE MIDWEST

16 **Worthington, S.** CHARACTER WINNOWING: A NEW CHARACTER SELECTION PROTOCOL BASED ON PHYLOGENETIC SIGNAL

17 **Anne, J.** USING GEOLOGY TO INFER BIOLOGY: GEOCHEMICAL TECHNIQUES FOR ASSESSING DIFFERENCES BETWEEN PATHOLOGICAL AND NORMAL BONE

18 **Tomita, T.** ORIGIN OF SHARK JAW PROTRUSIONS: EVOLUTION OF SUCTION FEEDING CAPABILITIES IN FOSSIL SHARKS RECONSTRUCTED FROM THEIR HYOID ARCHES

19 **Redman, C.** LONG-TERM TRENDS IN THE RICHNESS OF LATE CRETACEOUS NONMARINE VERTEBRATE FAUNAS FROM SOUTHERN UTAH

20 **Tschopp, E.** BONY OVERGROWTH IN PHALANGES OF A *CAMARASAURUS* (DINOSAURIA: SAUROPODA) INDICATES OLD ONTOGENETIC AGE AND PROVIDES INSIGHTS INTO THE PROCESS OF PHALANGEAL REDUCTION IN SAUROPODS

21 **Mitchell, J.** THE FUNCTION AND EVOLUTION OF CANALS IN THE TEETH OF THE TRIASSIC ARCHOSAURIFORM *UATCHITODON*

22 **Smith, A.** A MORPHOLOGICAL AND MORPHOMETRIC REDESCRIPTION OF *TANYTRACHELOS AHYNIS*

23 **Fronimos, J.** ADULT DORSAL VERTEBRAE OF THE TITANOSAURIAN SAUROPOD *ALAMOSAURUS SANJUANENSIS*, BIG BEND NATIONAL PARK, TEXAS

24 **Zammit, M.** ICHTHYOSAURS OF AUSTRALASIA: A REVIEW OF DIVERSITY AND DISTRIBUTION

25 **Beardmore, S.** VARIATION IN SKELETAL TAPHONOMY OF MARINE REPTILES FROM THE MIDDLE TRIASSIC OF MONTE SAN GIORGIO, SWITZERLAND

EDWIN H. AND MARGARET M. COLBERT PRIZE COMPETITION ENDS

26 **Druckenmiller, P., Whalen, M., Kelley, N.** AN UPPER TRIASSIC (NORIAN) ICHTHYOSAUR WITH GUT CONTENTS FROM THE OTUK FORMATION, WESTERN BROOKS RANGE, ALASKA

27 **Cuthbertson, R., Russell, A., Anderson, J.** NEW INFORMATION ON THE CRANIAL ANATOMY OF A JUVENILE ICHTHYOPTERYGIAN FROM THE VEGA-PHROSO SILTSTONE MEMBER (EARLY TRIASSIC) OF BRITISH COLUMBIA, CANADA

28 **Wahl, W.** SALT GLAND STRUCTURES IDENTIFIED IN A LATE JURASSIC ICHTHYOSAUR

29 **Bolet, A., Evans, S.** NEW LIZARDS (LEPIDOSAURIA, SQUAMATA) FROM THE EARLY CRETACEOUS OF LAS HOYAS (CUENCA, SPAIN)

30 **Jiménez-Huidobro, P., Otero, R., Rubilar-Rogers, D.** FIRST EVIDENCE OF A TYLOSAURINE MOSASAUR FROM CHILE

31 **Schumacher, B., Schumacher, B.** A 'WOOLLGARI-ZONE MOSASAUR' (SQUAMATA: MOSASAURIDAE) FROM THE CARLILE SHALE (LOWER MIDDLE TURONIAN) OF CENTRAL KANSAS AND STRATIGRAPHIC OVERLAP OF EARLY MOSASAURS AND PLIOSAURID PLESIOSAURS

32 **Schulp, A., Vonhof, H.** γ13C ISOTOPE ANALYSIS OF THE TYPE MAASTRICHTIAN MOSASAURS

33 **Robbins, J., Polcyn, M., Ferguson, K., Jacobs, L.** STABLE CARBON ISOTOPE VALUES IN MOSASAUR TOOTH ENAMEL REFLECT NICHE DIFFERENTIATION

34 **Konishi, T.** TO TILT OR NOT TO TILT? A NEW WAY OF ORIENTING QUADRATES IN PLIOPLATECARPINES (SQUAMATA: MOSASAURIDAE), AND ITS IMPLICATIONS FOR STREPTOSTYLY IN THESE MOSASAURS

35 **Smith, A., Araújo, R., Mateus, O.** A PLESIOSAUROID SKULL FROM THE TOARCIAN (LOWER JURASSIC) OF ALHADAS, PORTUGAL

36 **Araújo, R., Polcyn, M., Mateus, O., Schulp, A.** PLESIOSAURS FROM THE MAASTRICHTIAN OF BENTIABA, NAMIBE PROVINCE, ANGOLA

37 **Simões, T., Kellner, A., Riff, D., Grillo, O., Romano, P.** EVIDENCE FOR AN EARLIER PRESENCE OF PLESIOSAURS (REPTILIA, SAUROPTERYGIA) IN ANTARCTICA

38 **Kennedy, A., Bauer, A.** A HOLOCENE HERPETOFAUNA FROM NEW CALEDONIA: INSIGHTS INTO THE EFFECT OF HUMAN HABITATION ON INSULAR BIOTAS

39 **McCartney, J., Simons, E.** A NEW FOSSIL SNAKE ASSEMBLAGE FROM THE LATE EOCENE OF THE FAYUM DEPRESSION, EGYPT

40 **Gelnaw, W., Mead, J.** THE FIRST CHARACTERS USEFUL FOR IDENTIFYING FOSSIL SCOLECOPHIDIAN VERTEBRAE TO THE FAMILY LEVEL

41 **Moscato, D., Graham, R.** PALEOECOLOGY OF LATE PLEISTOCENE SNAKES AND SALAMANDERS FROM PARKER'S PIT CAVE IN THE BLACK HILLS, SD

42 **Nydam, R., Nydam, R.** SQUAMATA FROM THE CONIACIAN THROUGH EARLY CAMPANIAN OF SOUTHERN UTAH

43 **Hipsley, C., Müller, J.** REVISION OF THE EOCENE AMBER LACERTID *SUCCINILACERTA SUCCINEA* (SQUAMATA) BASED ON 3-DIMENSIONAL X-RAY COMPUTED TOMOGRAPHY

44 **Humphries, E., Jones, M.** GEOGRAPHIC VARIATION IN THE JAWS OF HOLOCENE *SPHENODON* (LEPIDOSAURIA: RHYNCHOCEPHALIA) DEMONSTRATED BY LANDMARK ANALYSIS

45 **Xu, G., Gao, K.** TAXONOMIC REVISION OF *FUKANGICHTHYS* (ACTINOPTERGYII: SCANILEPIFORMES) FROM THE MIDDLE TRIASSIC OF XINJIANG, CHINA

46 **Lin, H., Sun, Z., Tintori, A., Jiang, D., Hao, W.** NEW FINDS OF THE SUBHOLOSTEAN GENUS *HABROICHTHYS* FROM MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

47 **Wilson, M., Murray, A.** A NEW MARINE CLUPEOMORPH FISH IN THE FAMILY SORBINICHTHYIDAE FROM THE EARLY LATE CRETACEOUS AKRABOU FORMATION OF MOROCCO

48 **Kim, H., Chang, M., Seo, S., Kim, Y.** A POSSIBLE ICHTHYODECTIFORM (PISCES, TELEOSTEI) FROM THE EARLY CRETACEOUS OF SOUTH KOREA

49 **Gottfried, M., Ostrowski, S., Roberts, E., Stevens, N., O'Connor, P.** A NEW AFRICAN RECORD FOR POLYPTERID FISHES, FROM THE LATE OLIGOCENE OF TANZANIA

50 **Davis, M., Fielitz, C.** ESTIMATING DIVERGENCE TIMES OF LIZARDFISHES AND THEIR ALLIES (EUTELEOSTEI: AULOPIFORMES) AND THE TIMING OF DEEP-SEA ADAPTATIONS

51 **Mickle, K.** REVISITING THE ACTINOPTERYGIAN PREOPERCULUM

52 **Kirkland, J., Hunt-Foster, R., Foster, J., Loewen , M.** NEWLY RECOVERED SKELETAL ELEMENTS OF THE LATE JURASSIC DINOSAUR *MYMOORAPELTA* FROM ITS TYPE LOCALITY IN THE MORRISON FORMATION PERMITS REEVALUATION OF ANKYLOSAUR PHYLOGENY

53 **Leahey, L., Molnar, R., Salisbury, S.** POSTCRANIAL OSTEOLOGY OF *MINMI* SP., A BASAL ANKYLOSAUROMORPH (DINOSAURIA: ORNITHISCHIA) FROM THE EARLY CRETACEOUS (ALBIAN) ALLARU MUDSTONE OF QUEENSLAND, AUSTRALIA

54 **Jasinski, S., Sullivan, R.** A NEW SMALL PACHYCEPHALOSAURID FROM THE SAN JUAN BASIN, NEW MEXICO AND A RE-EVALUATION OF PACHYCEPHALOSAURIDS FROM THE KIRTLANDIAN LVA (LATE CAMPANIAN)

55 **Rivera-Sylva, H., Ortiz-Mendieta, J., de la Peña-Oviedo, I.** FIRST RECORD OF A PACHYCEPHALOSAURID FROM MEXICO

56 **Ridgwell, N., Sereno, P.** A BASAL THYREOPHORAN (DINOSAURIA, ORNITHISCHIA) FROM THE TIOURAREN FORMATION OF NIGER

57 **Frederickson, J.** CRANIOFACIAL ONTOGENY IN PACHYRHINOSAURUS LAKUSTAI: EVIDENCE FOR SEXUAL DIMORPHISM IN AN ORNITHISCHIAN DINOSAUR

58 **Brandau, D., Getty, M.** DISCOVERY OF A NEW CHASMOSAURINE BONEBED FROM THE KAIPAROWITS FORMATION (CAMPANIAN) OF SOUTHERN UTAH

59 **Lee, Y., Ryan, M., Kobayashi, Y.** THE FIRST CERATOPSIAN FROM KOREA

60 **Penkalski, P., Skulan, J.** AN UNUSUAL CERATOPSID QUARRY FROM THE HELL CREEK FORMATION OF MONTANA

61 **Clayton, K., Loewen, M., Farke, A., Sampson, S.** A REEVALUATION OF EPIPARIETAL HOMOLOGY WITHIN CHASMOSAURINE CERATOPSIDS (ORNITHISCHIA) BASED ON NEWLY DISCOVERED TAXA

62 **Rothschild, B.** ACTUALISTIC APPROACH TO CERATOPSIAN CRANIAL ONTOGENY AND SCARS: THE FLIP SIDE OF THE JUGAL

63 **Borkovic, B., Russell, A., Ryan, M.** QUANTIFYING VARIATION IN CERATOPSID HORNCORES AND PARIETALS

64 **Sissons, R.** ANKYLOSAUR FOOT MORPHOLOGY AND FUNCTION

65 **Burns, M.** USING SKIN TO INFER PHYLOGENY: QUANTITATIVE AND QUALITATIVE ANALYSES OF VARIATION IN THE STRUCTURE OF ANKYLOSAUR (DINOSAURIA: ORNITHISCHIA) OSTEODERMS

66 **Spencer, M.** THE PHYLOGENETIC LABILITY OF PROBLEMATIC BASAL ORNITHISCHIANS

67 **Donohue, S., Wilson, G., Breithaupt, B.** NEW LATEST CRETACEOUS MAMMALS FROM THE LANCE FORMATION NEAR BLACK BUTTE STATION, SOUTHWESTERN WYOMING

68 **Ladevèze, S., de Muizon, C., Matthew, C., Smith, T.** PETROSAL ANATOMY AND INNER EAR STRUCTURES OF A NEW MULTITUBERCULATE MAMMAL FROM THE LATE CRETACEOUS OF CHINA: NEW DATA FROM MICRO-CT ANALYSIS AND PALEOBIOLOGIC INFERENCES

69 **Zhang, Y., Hunter, J.** INTERRELATIONSHIPS OF CRETACEOUS AND PALEOGENE NEOPLAGIAULACIDAE (MULTITUBERCULATA, MAMMALIA)

70 **Case, J.** THE DEVELOPMENT OF CRUSHING PREMOLARS IN THE STAGODONTID, *DIDELPHODON*

71 **Denton Jr., R., O'Neill, R.** A NEW STAGODONTID METATHERIAN FROM THE CAMPANIAN OF NEW JERSEY, AND ITS IMPLICATIONS FOR A LACK OF EAST-WEST DISPERSAL ROUTES IN THE LATE CRETACEOUS OF NORTH AMERICA

72 **Williamson, T., Brusatte, S., Weil, A.** PHYLOGENY OF CRETACEOUS-PALEOCENE METATHERIANS: IMPLICATIONS FOR THE METATHERIAN RADIATION AND SURVIVORSHIP OF LINEAGES ACROSS THE K/PG BOUNDARY

73 **Rose, K., Storch, G.** POSTCRANIA OF SMALL MAMMALS FROM THE LATE PALEOCENE OF WALBECK, GERMANY

74 **Gould, F., Rose , K.** THE POSTCRANIAL SKELETON OF *ARCTOCYON MUMAK*, THE LARGEST ARCTOCYONID, AND ECOMORPHOLOGICAL DIVERSITY IN PROCREODI

75 **De Bast, E., Sigé, B., Smith, T.** NEW DATA ON THE SMALL ARCTOCYONID *PROLATIDENS WAUDRUAE* FROM THE EARLY PALEOCENE OF HAININ, BELGIUM, AND ITS RELATIONSHIPS WITH NORTH AMERICAN OXYCLAENINES

76 **Stefen, C., Lehmann, T.** NEW JUVENILE AND ADULT MATERIAL OF KOPIDODON MACROGNATHUS (MAMMALIA: PAROXYCLAENIDAE) FROM MESSEL, GERMANY

77 **Shoup, B., Adams, J., Schaaf, C.** NEW LOCALITIES FROM THE PALEOCENE-EOCENE THERMAL MAXIMUM TRANSITION DISCOVERED AS THE RESULT OF PROPOSED SURFACE COAL MINE EXPANSIONS IN THE POWDER RIVER BASIN OF NORTHEASTERN WYOMING

78 **Ravel, A., Marivaux, L., Tabuce, R., Mahboubi, M.** OLDEST BAT (CHIROPTERA, EOCHIROPTERA) FROM AFRICA: EARLY EOCENE FROM EL KOHOL (ALGERIA)

79 **Dunn, R., Rose, K.** EVOLUTION OF EARLY EOCENE *PALAEOSINOPA* (MAMMALIA, PANTOLESTIDAE) IN THE BIGHORN BASIN, WYOMING

80 **Stringer, G., King, L.** PALEONTOLOGICAL AND HISTORICAL SIGNIFICANCE OF THE LATE EOCENE EXPOSURES NEAR COPENHAGEN, CALDWELL PARISH, LOUISIANA

81 **Al-Mufarreh, Y., Gunnell, G., Al-Massari, A., Al-Sobhi, S., Zalmout, I.** AGE OF THE VERTEBRATE-BEARING SHUMAYSI FORMATION, WESTERN SAUDI ARABIA

82 **Ayoub, M., Mihlbachler, M., Solounias, N.** PALEODIET AND RESOURCE PARTITIONING IN EARLY EOCENE HERBIVOROUS MAMMALS FROM THE BIGHORN BASIN, WYOMING: EVIDENCE FROM DENTAL MICROWEAR

83 **Anemone, R., Watkins, R., Nachman, B., Dirks, W.** AN EARLY WASATCHIAN MAMMALIAN FAUNA FROM AN EXTRAORDINARILY RICH NEW LOCALITY IN THE GREAT DIVIDE BASIN, SW WYOMING

84 **Boardman, G., Secord, R.** PALEOENVIRONMENTAL INTERPRETATION OF THREE CHADRONIAN (LATE EOCENE) MAMMALIAN FAUNAS FROM THE MID-CONTINENTAL U.S., BASED ON BODY SIZE DISTRIBUTIONS

85 **Burger, B., Murphey, P.** IS THERE A MAMMALIAN FAUNAL TURNOVER ASSOCIATED WITH THE MECO GLOBAL WARMING EVENT IN THE DUCHESNE RIVER FORMATION IN UTAH? PRELIMINARY EVALUATION OF NEW FOSSIL DISCOVERIES FROM THE BRENNAN BASIN MEMBER

86 **Grohé, C., Morlo, M., Salem, M., Salem, M., Jaeger, J.** THE OLDEST APTERODONTINAE (HYAENODONTIDAE, "CREODONTA") FROM THE MIDDLE EOCENE OF DOR EL TALHA (LIBYA)

87 **Tomiya, S.** NEW CARNIVORAMORPHANS (MAMMALIA) FROM THE MIDDLE-EOCENE SANTIAGO FORMATION OF CALIFORNIA, U.S.A., AND PHYLOGENETIC IMPLICATIONS FOR THE ORIGIN OF CROWN-ORDER CARNIVORA

88 **Billian, J., Anemone, R.** MODELING THE MANDIBULAR MORPHOLOGY AND MASTICATORY MECHANICS OF EOCENE MAMMALS: A 3D LASER SCANNING APPROACH

89 **Hoganson, J., Person, J.** TOOTH PUNCTURE MARKS ON A SKULL OF *DINICTIS* (NIMRAVIDAE) FROM THE OLIGOCENE BRULE FORMATION OF NORTH DAKOTA ATTRIBUTED TO PREDATION BY *HYAENODON* (HYAENODONTIDAE)

90 **Naples, V., Martin, L.** HOW A SABER-TOOTHED "CAT" GOT ITS SMALL BRAIN

91 **Egi, N., Sein, C., Maung-Thein, Z., Htike, T., Takai, M.** NEW AMPHICYONID (MAMMALIA: CARNIVORA) FROM THE LOWER IRRAWADDY SEDIMENTS (MYANMAR) WITH COMMENTS ON *AMPHICYON* SPECIES FROM THE MIOCENE OF ASIA

92 **Ogino, S., Egi, N., Takai, M., Maung-Thein, Z., Htike, T.** A NEW SPECIMEN OF *AGRIOTHERIUM* (MAMMALIA, CARNIVORA) FROM THE LATE MIOCENE-EARLY PLIOCENE IRRAWADDY SEDIMENTS, MYANMAR

93 **Wallace, S., Schubert, B.** PHYLOGENETIC IMPLICATIONS OF *ARCTOMELES DIMOLODONTUS* USING CRANIAL MORPHOLOGY

94 **Tucker, S., Farlow, J.** CARNIVORES FROM THE PIPE CREEK SINKHOLE (LATEST HEMPHILLIAN), GRANT COUNTY, INDIANA

95 **Tanaka, Y., Kohno, N.** RAPID DIVERSIFICATION OF THE ODOBENIDS (CARNIVORA: PINNIPEDIA) IN THE LATE MIDDLE MIOCENE OF THE NORTH PACIFIC: IMPLICATIONS OF A NEW FOSSIL FROM HOKKAIDO, JAPAN

96 **Valenzuela-Toro, A., Gutstein, C., Cozzuol, M.** A NEW TRUE SEAL MORPHOTYPE (PHOCIDAE, CARNIVORA) FROM BAHIA INGLESA FORMATION, CHILE

97 **Churchill, M., Boessenecker, R., Clementz, M.** PRELIMINARY RESULTS OF A COMPREHENSIVE MORPHOLOGICAL PHYLOGENY OF THE PINNIPEDIA (MAMMALIA: CARNIVORA)

MONDAY AFTERNOON, OCTOBER 11, 2010
POSTER SESSION II (continued)

98 **Boessenecker, R.** BARNACLE COLONIZATION OF MIDDLE PLEISTOCENE SEA LION (CARNIVORA: PINNIPEDIA) BONES ELUCIDATE THE BIOSTRATINOMY OF A FOSSIL MARINE MAMMAL

99 **Sakamoto, M., Lloyd, G., Benton, M.** PHYLOGENETICALLY STRUCTURED VARIANCE IN FELID BITE FORCE: THE ROLE OF PHYLOGENY IN THE EVOLUTION OF BITING PERFORMANCE

100 **Madan, M., Prothero, D., Sutyagina, A.** STASIS IN LATE PLEISTOCENE FELIDS (SABERTOOTH CATS AND ICE AGE LIONS) FROM LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

101 **Hodnett, J., Mead, J., White, R., Carpenter, M.** *MIRACINONYX TRUMANI* (CARNIVORA: FELIDAE) FROM THE RANCHOLABREAN OF GRAND CANYON, ARIZONA AND ITS IMPLICATIONS FOR THE ECOLOGY OF THE "AMERICAN CHEETAH"

102 **Spigelmyer, L., Bovard, B., Hartstone-Rose, A.** ASSOCIATED CRANIODENTAL AND POSTCRANIAL HYENA FOSSILS FROM THE TYPE LOCALITY OF *PACHYCROCUTA BELLAX*, KROMDRAAI, STERKFONTEIN VALLEY, SOUTH AFRICA

103 **Hartstone-Rose, A., Bovard, B., Hartstone-Rose, L.** A REEVALUATION OF THE FOSSIL JACKALS OF THE STERKFONTEIN VALLEY, SOUTH AFRICA

104 **Kuhn, B., Werdelin, L., Hartstone-Rose, A., Lacruz, R., Berger, L.** CARNIVORA ASSOCIATED WITH *AUSTRALOPITHECUS SEDIBA,* MALAPA, GAUTENG, SOUTH AFRICA

105 **Ferrusquía-Villafranca, I., Aja-Guardiola, S., Ruiz-González, J., Martínez-Hernández, E., Alvarez-Reyes, G.** THE FIRST TERTIARY POSTCRANIAL CARNIVORE SKELETON FROM SOUTH CENTRAL MEXICO: DESCRIPTION AND PALEOBIOLOGICAL SIGNIFICANCE

106 **Collins, K., Carlson, K., Kuhn, B., Berger, L.** MORPHOLOGICAL EXAMINATION OF AN ARTICULATED CARNIVORE ANKLE USING VIRTUAL PREPARATION AND DISARTICULATION OF THE SPECIMEN

107 **Northover, J., Rybczynski, N., Schröder-Adams, C.** EVIDENCE FOR CORRELATED EVOLUTION BETWEEN LONG BONE COMPACTNESS, SWIMMING BEHAVIOR AND BODY MASS IN ARCTOIDEA (MAMMALIA: CARNIVORA)

108 **Voss, M.** SIRENIAN DIVERSITY IN THE OLIGOCENE OF GERMANY

109 **Jiang, D., Rieppel, O., Hao, W., Motani, R., Tintori, A.** COMPARISON BETWEEN THE CHINESE MIDDLE TRIASSIC MARINE REPTILE FAUNAS AT THE EAST END AND THE MONTE SAN GIORGIO FAUNA AT THE WEST END OF TETHYS

TUESDAY MORNING, OCTOBER 12, 2010
SYMPOSIUM: MAKING CONNECTIONS: THE EVOLUTION AND FUNCTION OF JOINTS IN VERTEBRATES

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Casey Holliday, Matthew Vickaryous

8:00 **Holliday, C., Gardner, N.** STRUCTURE AND FUNCTION OF THE REPTILIAN MANDIBULAR SYMPHYSIS: INSIGHTS FROM SQUAMATES

8:15 **Osi, A.** JAW MECHANISM, DENTAL OCCLUSION AND EFFECTIVE ORAL FOOD PROCESSING IN HETERODONT CROCODYLIFORMS: AN UNEXPECTED VARIABILITY

8:30 **Gill, P., Rayfield, E., Robson-Brown, K., Gostling, N.** A FUNCTIONAL INVESTIGATION INTO THE JAW JOINTS OF TWO OF THE EARLIEST STEM MAMMALS; *MORGANUCODON WATSONI* AND *KUEHNEOTHERIUM PRAECURSORIS*

8:45 **Ravosa, M., Ning, J., Stock, S., Stack, M.** JAW-JOINT FUNCTION AND PLASTICITY IN MAMMALS

9:00 **Luo, Z.** MORPHOLOGICAL EVOLUTION OF THE DOUBLE CRANIOMANDIBULAR JOINT IN THE CYNODONT-MAMMALIAFORM TRANSITION

9:15 **Curtis, N., Jones, M., Evans, S., O'Higgins, P., Fagan, M.** THE ROLE AND FUNCTION FOR CRANIAL SUTURES IN REPTILES: A FINITE ELEMENT ANALYSIS OF THE SKULL OF *SPHENODON* (DIAPSIDA: LEPIDOSAURIA: RHYNCHOCEPHALIA)

9:30 **Bright, J., Gröning, F., Rayfield, E.** MAMMALIAN SKULL CONSTRUCTION AND THE IMPORTANCE OF CRANIAL SUTURES IN BIOMECHANICAL FINITE ELEMENT ANALYSIS

9:45 **Maddin, H., Wake, M.** EXPLORING THE INFLUENCE OF FOSSORIALITY ON TETRAPOD CRANIAL ARCHITECTURE, A FOCUS ON CRANIAL JOINTS

10:00 **BREAK**

10:15 **Vickaryous, M., Reisz, R., Modesto, S., Head, J.** TAIL AUTOTOMY IN THE FOSSIL RECORD: NEW INFORMATION ABOUT VOLUNTARY TAIL LOSS IN CAPTORHINID REPTILES

10:30 **Pierce, S., Molnar, J., Hutchinson, J., Clack, J.** REGIONAL VARIATION OF INTERVERTEBRAL JOINT STIFFNESS IN EXTANT AND EXTINCT TETRAPODS AND ITS IMPORTANCE FOR THE WATER-LAND TRANSITION

10:45 **Claessens, L., Hirasawa, T.** RIBCAGE ANATOMY, SKELETAL CONSTRAINT AND KINEMATICS IN EXTANT AND EXTINCT ARCHOSAURS

11:00 **Ward, C., Hammond, A., Plavcan, J., Begun, D., Kordos, L.** HIP JOINT MORPHOLOGY AND HOMINOID EVOLUTION: FROM QUADRUPEDAL TO SUSPENSORY TO BIPEDAL LOCOMOTION

11:15 **Gatesy, S., Kambic, R., Roberts, T.** BEYOND HINGES: 3-D JOINT FUNCTION IN ERECT BIPEDS

11:30 **Su, A., Patel, B., Carlson, K.** SUBCHONDRAL AND TRABECULAR BONE MORPHOLOGICAL CORRELATES OF LOCOMOTOR BEHAVIOR

11:45 **Sullivan, C., Xu, X., Zhang, F., Drake, A., Cooper, M.** FUNCTION AND EVOLUTION OF THE ANKLE JOINT IN THEROPOD DINOSAURS

12:00 **Bonnan, M., Sandrik, J., Nishiwaki, T., Wilhite, R., Elsey, R.** NON-AVIAN DINOSAUR AND EXTANT ARCHOSAUR LIMB JOINTS: WHAT'S MISSING, WHAT'S NOT, AND WHERE DO WE GO FROM HERE?

TUESDAY MORNING, OCTOBER 12, 2010
TECHNICAL SESSION IX

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Aaron Wood, Anthony Barnosky

8:00 **Evans, A., Jones, D., IMPPS RCN: Integrating Macroecological Pattern and Processes across Scales** RAPID EVOLUTIONARY RATES OVER GEOLOGICAL TIMESCALES IN MAMMALS

8:15 **Wilson, G.** MAMMALIAN EXTINCTION, SURVIVAL AND RECOVERY DYNAMICS ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY IN NORTHEASTERN MONTANA

8:30 **Wood, A., Gingerich, P.** COORDINATED SHIFTS IN EARLY EOCENE EVOLUTIONARY AND PALEOENVIRONMENTAL RECORDS IN THE CLARKS FORK BASIN, WYOMING

8:45 **Smith, F., Research Coordination Network, I.** MAMMALIAN BODY MASS EVOLUTION OVER SPACE AND TIME

9:00 **Rose, P., Fox, D.** BERGMANN'S RULE IN DEEP TIME: DOES THE RELATIONSHIP BETWEEN MAMMALIAN BODY SIZE AND TEMPERATURE APPLY TO PALEOCENE MAMMALS?

9:15 **Orcutt, J., Hopkins, S.** BODY SIZE, CLIMATE AND TIME: A PALEONTOLOGICAL TEST OF BERGMANN'S RULE

9:30 **Marcot, J., Fox, D.** LATITUDINAL DIVERSITY GRADIENT OF NORTH AMERICAN MAMMALS WAS NOT CONSTANT OVER THE CENOZOIC

9:45 **Kingston, J., Hill, A., Goble, E., Deino, A., Wilson, K.** OSCILLATING ENVIRONMENTS, ORBITALLY-FORCED CLIMATE CHANGE AND PLIOCENE MAMMALIAN EVOLUTION IN THE BARINGO BASIN, KENYAN RIFT VALLEY

10:00 **BREAK**

TUESDAY MORNING, OCTOBER 12, 2010
TECHNICAL SESSION IX (continued)

10:15 **Terry, R., Li, C., Hadly, E.** PREDICTING SPECIES RESPONSES TO CLIMATIC WARMING: HINDCASTING THE PAST USING THE MODERN GEOGRAPHIC RANGE

10:30 **Pardi, M., Graham, R.** LOSS OF HABITAT AND BIODIVERSITY DURING TERMINAL PLEISTOCENE WARMING: WHAT SMALL MAMMAL FOSSILS TELL US ABOUT THE EFFECTS OF CLIMATE CHANGE

10:45 **Muldoon, K., Rasoamiaramanana, A., Aronson, A., Simons, E., Wright, P.** EARLY HOLOCENE FAUNA FROM A NEW SUBFOSSIL SITE: CHRISTMAS RIVER, SOUTHCENTRAL MADAGASCAR

11:00 **Tryon, C., Faith, J., Peppe, D.** LATE QUATERNARY MAMMALS FROM RUSINGA ISLAND, KENYA: IMPLICATIONS FOR ENVIRONMENTAL CHANGE AND MEGAFAUNAL EXTINCTIONS

11:15 **Miller, J., Bahn, V.** SPATIAL DYNAMICS AND STRUCTURE OF THE NORTH AMERICAN PLEISTOCENE MEGAFAUNAL EXTINCTION

11:30 **MacPhee, R., Willerslev, E., Froese, D., Roberts, R., Haile, J.** AMERICAN MEGAFAUNAL EXTINCTIONS, ENVIRONMENTAL DNA AND THE CONTINUING SEARCH FOR A CAUSE

11:45 **Fisher, D., Beld, S.** IMPACT FRACTURING OF MAMMOTH LIMB BONE DIAPHYSES (LATE PLEISTOCENE, MICHIGAN, USA)

12:00 **Barnosky, A., Matzke, N., Tomiya, S., Lindsey, E., Wogan, G.** HOW PRESENT EXTINCTION RATES COMPARE WITH MASS EXTINCTION RATES: INSIGHTS FROM MAMMALS

TUESDAY MORNING, OCTOBER 12, 2010
TECHNICAL SESSION X

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Thomas Stidham, Nathan Smith

8:00 **Kellner, A., Wang, X., Jiang, S., Meng, X.** PRELIMINARY NOTE ON LONG-TAILED PTEROSAURS FROM WESTERN LIAONING OF CHINA

8:15 **Unwin, D., Lü, J., Liu, Y., Jin, X.** SEX IN PTEROSAURS

8:30 **Zhou, Z., Wang, Y.** VERTEBRATE DIVERSITY OF THE EARLY CRETACEOUS JEHOL BIOTA

8:45 **Zhou, S., Zhou, Z., O'Connor, J.** A NEW TOOTHLESS ORNITHURINE BIRD FROM THE LOWER CRETACEOUS OF CHINA

9:00 **Atterholt, J., O'Connor, J., Harris, J., Li, D., You, H.** AVIAN TAXONOMIC DIVERSITY AND ANATOMICAL DISPARITY IN THE LOWER CRETACEOUS XIAGOU FORMATION OF THE CHANGMA BASIN, GANSU PROVINCE, PEOPLE'S REPUBLIC OF CHINA

9:15 **Liu, D., Campbell, K., Sullivan, C.** MASS PREDICTION IN CHINESE MESOZOIC FOSSIL BIRDS

9:30 **Vinther, J., D'Alba, L., Li, Q., Clarke, J., Gao, K.** FOSSILIZED COLORS OF BIRDS AND OTHER DINOSAURS: IMPLICATIONS FOR UNDERSTANDING THE EVOLUTION OF FEATHERS

9:45 **Heers, A., Dial, K.** FROM BABY BIRDS TO FEATHERED DINOSAURS: INCIPIENT WINGS AND THE EVOLUTION OF FLIGHT

10:00 **BREAK**

10:15 **David, B., Dial, K.** 3-D SKELETAL KINEMATICS OF WING-ASSISTED INCLINE RUNNING (WAIR) IN ADULT CHUKAR PARTRIDGES (*ALECTORIS CHUKAR*): LINKING SKELETAL MORPHOLOGY AND THE WING STROKE

10:30 **Nesbitt, S., Ksepka, D., Clarke, J.** A STEM FROGMOUTH (AVES: PODARGIFORMES) FROM THE EARLY EOCENE GREEN RIVER FORMATION AND THE EARLY DIVERSIFICATION OF STRISORES

10:45 **Smith, N.** PHYLOGENETIC ANALYSIS OF PELECANIFORMES (AVES) BASED ON OSTEOLOGICAL DATA: IMPLICATIONS FOR WATERBIRD PHYLOGENY AND FOSSIL CALIBRATION STUDIES

TUESDAY MORNING, OCTOBER 12, 2010
TECHNICAL SESSION X (continued)

11:00 **Smith, A.** COMBINED PHYLOGENETIC ANALYSIS OF PAN-ALCIDAE (AVES, CHARADRIIFORMES): THE CONTRIBUTION OF FOSSILS TO THE RESOLUTION OF AVIAN SYSTEMATIC RELATIONSHIPS AND DIVERGENCE ESTIMATION

11:15 **Ksepka, D., Fordyce, R., Ando, T., Jones, C.** NEW SPECIES FROM THE LATE OLIGOCENE OF NEW ZEALAND REVEAL THE SKELETAL PLAN OF STEM PENGUINS (AVES: SPHENISCIFORMES)

11:30 **Stidham, T.** FOSSIL LOVEBIRDS (PSITTACIFORMES: *AGAPORNIS*) FROM SOUTH AFRICA: CONSTRAINING THE ORIGIN AND INITIAL RADIATION OF THE CLADE

11:45 **Witmer, L., Ridgely, R., James, H., Olson, S., Iwaniuk, A.** NEUROANATOMY, SKULL MORPHOLOGY AND THEIR BEHAVIORAL IMPLICATIONS FOR THE REMARKABLE, RECENTLY EXTINCT "PLATYPUS-DUCK" *TALPANAS LIPPA* (AVES: ANSERIFORMES) FROM KAUAI, HAWAII

12:00 **Boyer, A., James, H., Olson, S., Grant-Mackie, J.** ECOLOGICAL CHANGE IN A CONSERVATION HOTSPOT: THE FOSSIL AVIFAUNA OF ME AURE CAVE, NEW CALEDONIA

TUESDAY AFTERNOON, OCTOBER 12, 2010
TECHNICAL SESSION XI
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Doug Boyer, Andres Giallombardo

1:45 **Carter, K.** A CONSTRAINT-BASED MODEL FOR PHYLOGENY RECONSTRUCTION

2:00 **Lamm, K.** TREE BALANCE AND MISSING DATA COMPLICATE BAYESIAN PHYLOGENETIC ANALYSIS OF FOSSIL TAXA

2:15 **Peterson, K., Lyson, T., Sperling, E., Alysha, H., Donoghue, P.** MICRORNAS AND VERTEBRATE PHYLOGENETICS

2:30 **Boyer, D., Lipman, Y., St. Clair, E., Puente, J., Jernvall, J.** AN ALGORITHM USING INTRINSIC GEOMETRY OF ANATOMICAL STRUCTURES FOR AUTOMATIC IDENTIFICATION OF HOMOLOGOUS FEATURES

2:45 **Joshi, S., Prieto-Marquez, A.** A NEW METHOD FOR THE QUANTITATIVE ANALYSIS OF MORPHOLOGICAL VARIATION IN VERTEBRATE PALEONTOLOGY

3:00 **Schweitzer, M., Cleland, T., Zheng, W., San Antonio, J.** MOLECULAR MECHANISMS FOR THE PRESERVATION OF SOFT TISSUES AND ORIGINAL BIOMOLECULES IN FOSSILS

3:15 **Moses, R.** EXPERIMENTAL DIAGENESIS OF BONE: IMPLICATIONS FOR RARE EARTH ELEMENT UPTAKE AND STABILITY

3:30 **Longrich, N.** SURVIVAL AND EXTINCTION AT THE K-T BOUNDARY: NEW EVIDENCE AND NEW PERSPECTIVES FROM THE VERTEBRATE FAUNA OF CONTINENTAL NORTH AMERICA

3:45 **Alroy, J., Carrano, M., Uhen, M.** HAS GLOBAL TETRAPOD BIODIVERSITY INCREASED SINCE THE CRETACEOUS?

4:00 **Weinstein, D., Heim, N., Peters, S.** WHAT ARE WE MISSING?: GEOLOGICAL COMPLETENESS OF PALEONTOLOGICAL SAMPLING IN THE TERRESTRIAL CENOZOIC OF NORTH AMERICA

TUESDAY AFTERNOON, OCTOBER 12, 2010
TECHNICAL SESSION XII
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Alan Turner, Laura Porro

1:45 **Allen, E.** PHYLOGENETIC ANALYSIS OF GONIOPHOLIDID CROCODYLIFORMS OF THE MORRISON FORMATION

TUESDAY AFTERNOON, OCTOBER 12, 2010
TECHNICAL SESSION XII (continued)

2:00 **Sertich, J., O'Connor, P.** THE EVOLUTION OF TREMATOCHAMPSID CROCODYLIFORMS IN AFRICA: NEW EVIDENCE FROM THE MIDDLE CRETACEOUS GALULA FORMATION, SOUTHWESTERN TANZANIA

2:15 **Montefeltro, F., Langer, M.** A NEW BAURUSCHID (CROCODYLIFORMES, SEBECOSUCHIA) FROM THE BAURU GROUP, LATE CRETACEOUS OF MINAS GERAIS, BRAZIL

2:30 **Turner, A., Brochu, C.** A REEVALUATION OF THE CROCODYLIFORM *ACYNODON* FROM THE LATE CRETACEOUS OF EUROPE

2:45 **Hastings, A., Bloch, J., Jaramillo, C.** NEW LARGE BLUNT-SNOUTED DYROSAURID (MESOEUCROCODYLIA) FROM THE PALEOCENE OF COLOMBIA

3:00 **Brochu, C., Snyder, D.** CROCODYLIANS FROM THE UINTA FORMATION (MIDDLE EOCENE, UINTAN) OF WESTERN NORTH AMERICA, RESPONSE TO CLIMATE CHANGE AND THE ORIGINS OF *ALLIGATOR*

3:15 **Salisbury, S., Holt, T., Worthy, T., Sand, C., Anderson, A.** NEW MATERIAL OF *MEKOSUCHUS INEXPECTATUS* (CROCODYLIA: MEKOSUCHINAE) FROM THE LATE QUATERNARY OF NEW CALEDONIA, AND THE PHYLOGENETIC RELATIONSHIPS OF AUSTRALASIAN CENOZOIC CROCODYLIANS

3:30 **Owerkowicz, T., Andrade, F., Elsey, R., Middleton, K., Hicks, J.** ATMOSPHERIC HYPOXIA INCREASES BONE ROBUSTICITY IN THE AMERICAN ALLIGATOR

3:45 **Woodward, H., Horner, J.** OSTEOHISTOLOGICAL ANALYSIS OF *ALLIGATOR MISSISSIPPIENSIS* INDICATES ABSENCE OF FIBROLAMELLAR BONE IN CROCODYLIANS AND CONFIRMS DETERMINATE GROWTH WITH FIRST REPORT OF EXTERNAL FUNDAMENTAL SYSTEMS: IMPLICATIONS FOR TETRAPOD OSTEOHISTOLOGY

4:00 **Porro, L., Reed, D., Lemberg, J., Zapata, U., Ross, C.** MANDIBULAR MECHANICS OF *ALLIGATOR MISSISSIPPIENSIS:* FROM BEAM MODELS TO FINITE ELEMENT ANALYSIS

TUESDAY AFTERNOON, OCTOBER 12, 2010
TECHNICAL SESSION XIII
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Elizabeth Hadley, Tim Gaudin

1:45 **Croft, D., Dolgushina, T., Wesley-Hunt, G.** MORPHOLOGICAL DIVERSITY IN EXTINCT SOUTH AMERICAN SPARASSODONTS (MAMMALIA: METATHERIA)

2:00 **Solé, F.** EARLIEST EUROPEAN CARNIVOROUS MAMMALS ("CREODONTA", CARNIVORA): SYSTEMATICS, PHYLOGENY, EVOLUTION AND PALEOBIOGEOGRAPHY; FAUNAS FROM THE EARLY EOCENE OF THE PARIS BASIN

2:15 **Friscia, A., Kyongo, B., Macharwas, M., Rasmussen, D.** THE EARLIEST CARNIVORANS FROM AFRICA

2:30 **Tseng, Z., Wang, X.** EVOLUTION OF STRESS CHANNELING MECHANISM IN THE SKULLS OF HYENAS: FINITE ELEMENT ANALYSIS OF KEY ECOMORPHOLOGIES

2:45 **Polly, P., Lawing, A., Head, J.** COMPARATIVE EVOLUTIONARY ECOLOGICAL MORPHOLOGY OF LOCOMOTION IN TERRESTRIAL VERTEBRATE CARNIVORES

3:00 **Meachen-Samuels, J.** CHANGES WITHIN CARNIVORE GUILDS FROM THE PLEISTOCENE AND HOLOCENE OF NORTH AMERICA

3:15 **O'Keefe, F., Van Valkenburgh, B., Binder, W.** CRANIODENTAL MEASURES OF DIRE WOLF POPULATION HEALTH IMPLY RAPID EXTINCTION IN THE LOS ANGELES BASIN

3:30 **Hadly, E., Pinsky, M.** PANMIXIA, PLASTICITY AND PLACE: INSIGHTS INTO PERSISTENCE OF THE NORTHERN FUR SEAL (*CALLORHINUS URSINUS*)

TUESDAY AFTERNOON, OCTOBER 12, 2010
TECHNICAL SESSION XIII (continued)

3:45 **Jones, K., Goswami, A.** DISCORDANT CRANIAL MORPHOLOGICAL DISPARITY AND TAXONOMIC DIVERSITY IN PINNIPED VERSUS FISSIPED CARNIVORANS

4:00 **Gaudin, T., Bramblett, J.** PHYLOGENETIC ANALYSIS OF EXTINCT AND EXTANT CINGULATA (XENARTHRA, MAMMALIA) BASED ON COMBINED CRANIAL AND POSTCRANIAL DATA

TUESDAY AFTERNOON, OCTOBER 12, 2010
POSTER SESSION III

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM A
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Burch, S., Smith, N., Nesbitt, S., Irmis, R., Turner, A.** FORELIMB MYOLOGY OF THE BASAL THEROPOD DINOSAUR *TAWA HALLAE* FROM THE LATE TRIASSIC HAYDEN QUARRY OF NEW MEXICO

2 **Knoll, F.** WHAT IS "HALTICOSAURUS" ORBITOANGULATUS?

3 **Senter, P., Kirkland, J., DeBlieux, D., Madsen, S.** THREE NEW THEROPODS FROM THE CEDAR MOUNTAIN FORMATION (LOWER CRETACEOUS) OF UTAH

4 **Ibrahim, N.** A UNIQUE ANCIENT ECOSYSTEM: THE THEROPOD DOMINATED LATE CRETACEOUS KEM KEM DINOSAUR ASSEMBLAGE OF SOUTH EAST MOROCCO

5 **Peecook, B., Wilson, J., Wilson, G., Hernández, R., Montellano-Ballesteros, M.** NEW TYRANNOSAUROID REMAINS FROM THE LATE CRETACEOUS 'EL GALLO' FORMATION OF BAJA DE CALIFORNIA, MEXICO

6 **Thomson, T., Irmis, R.** FIRST OCCURRENCE OF A TYRANNOSAURID (DINOSAURIA, THEROPODA) FROM THE NESLEN FORMATION (LATE CRETACEOUS), BOOK CLIFFS AREA, UTAH

7 **Lü, J., Kobayashi , Y., Xu, L., Pu, H., Wu, Y.** A NEW BASAL THERIZINOSAUROID FROM THE LOWER CRETACEOUS YIXIAN FORMATION OF LIAONING, CHINA

8 **Blumhagen, E., Drake, A., Zhang, F., Xu, X., Claessens, L.** THREE-DIMENSIONAL DIGITAL RECONSTRUCTION OF FOSSIL BIRDS AND NON-AVIAN THEROPODS PRESERVED IN SLAB AND COUNTERSLAB USING LASER SURFACE SCANNING

9 **Cullen, T., Ryan, M., Schröder-Adams, C., Kobayashi, Y., Currie, P.** DESCRIPTION OF THE FIRST ORNITHOMIMID (DINOSAURIA) BONEBED FROM NORTH AMERICA WITH IMPLICATIONS FOR THE DISCRIMINATION, ONTOGENY AND BEHAVIOR OF ORNITHOMIMIDS

10 **Scheetz, A., Britt, B., Scheetz, R., Rauhut, O., Chure, D.** AN ORNITHOMIMID-LIKE BASAL COELUROSAUR FROM THE EARLY CRETACEOUS (APTIAN) CEDAR MOUNTAIN FORMATION OF UTAH

11 **Williams, S., Brusatte, S., Mathews, J., Currie, P.** A NEW JUVENILE *TYRANNOSAURUS* AND A REASSESSMENT OF ONTOGENETIC AND PHYLOGENETIC CHANGES IN TYRANNOSAUROID FORELIMB PROPORTIONS

12 **Persons, W.** ANATOMY OF A SPEED DEMON: THE CAUDAL MUSCULATURE OF *CARNOTAURUS* AND THE IMPLICATIONS FOR ABELISAURID LOCOMOTION AND EVOLUTIONARY TRAJECTORY

13 **Snively, E., Witmer, L., Ridgely, R., Wroe, S., Ryan, M.** IMPACT AND SCYTHE-LIKE JAW FUNCTION IN LARGE CRETACEOUS THEROPODS: *MAJUNGASAURUS*, *TYRANNOSAURUS* AND *GIGANOTOSAURUS* COMPARED

14 **Lavender, Z., Drake, A., Loewen, M., Zanno, L., Claessens, L.** THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSIS AND UNIVARIANT MEASUREMENT ANALYSIS ON AN UNDESCRIBED *ORNITHOMIMUS* MANUS

15 **Hall, L., Keenan, S.** TAPHONOMY OF A NEW SPECIMEN OF *TYRANNOSAURUS REX* FROM THE HELL CREEK FORMATION, MONTANA

16 **Lim, J., Kong, D., Kim, K., Kim, T.** NEW DINOSAUR TRACKSITE AND UNUSUAL THEROPOD FOOTPRINTS FROM THE CRETACEOUS OF KOREA

17 **Cowan, J., Lockley, M., Gierlinski, G.** FIRST DROMAEOSAUR TRACKWAYS FROM NORTH AMERICA: NEW EVIDENCE FROM A LARGE SITE IN THE CEDAR MOUNTAIN FORMATION (EARLY CRETACEOUS), EASTERN UTAH

18 **Zanno, L., Makovicky, P.** QUANTITATIVE ANALYSIS OF HERBIVOROUS ECOMORPHOLOGY IN THEROPOD DINOSAURS: PATTERNS OF CHARACTER CORRELATION AND PROGRESSION

19 **Bates, K., Benson, R., Peter, F.** THE EVOLUTION OF BODY SIZE, STANCE AND GAIT IN ALLOSAUROIDEA (DINOSAURIA: THEROPODA)

20 **Shychoski, L., Snively, E., Burns, M.** MANEUVERED OUT OF A CORNER: LIGAMENT ENTHESES OF THE ARCTOMETATARSUS ENHANCED TYRANNOSAURID AGILITY

21 **Noto, C.** GEOMETRIC MORPHOMETRIC ANALYSIS OF THEROPOD MANUAL UNGUALS: EVOLUTIONARY AND ECOLOGICAL IMPLICATIONS

22 **Wilson, L., Dececchi, T.** A SURVEY OF BONE MICROSTRUCTURE IN THEROPOD FORELIMBS WITH REGARDS TO FUNCTION

23 **Hwang, S., Claire, P.** SPECIES AND GENUS-LEVEL VARIATION IN THE TOOTH ENAMEL MICROSTRUCTURE OF TYRANNOSAURID DINOSAURS

24 **Criswell, K.** BUILDING A COMPARATIVE MORPHOLOGICAL ATLAS FOR LUNGFISH: NEW INFORMATION ON THE SKELETAL ANATOMY OF *TRANODIS CASTRENSIS*

25 **Shimada, K., Kirkland, J.** A MYSTERIOUS KING-SIZED MESOZOIC LUNGFISH FROM NORTH AMERICA

26 **Ortiz, D., Lewis, P., Kennedy, A., Bhullar, B., Hancox, J.** PRELIMINARY ANALYSIS OF DIPNOI (OSTEICHTHYES: SARCOPTERYGII) FOSSILS FROM DRIEFONTEIN, SOUTH AFRICA

27 **Wendruff, A., Scott, B.** DIVERSITY OF CAUDAL FIN MORPHOLOGY IN LOWER TRIASSIC COELACANTHS FROM BRITISH COLUMBIA, CANADA

28 **Main, D., Parris, D., Grandstaff, B.** IMPLICATIONS OF A NEW LUNGFISH SPECIES (DIPNOI: CERATODONTIDAE) FROM THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION AT THE ARLINGTON ARCHOSAUR SITE, NORTH TEXAS

29 **Shirley, M., Schachner, E., Shaw, C.** ASYMMETRIC SKELETAL ADAPTATION TO A DEBILITATING PATHOLOGY IN THE HINDLIMB OF *POPOSAURUS GRACILIS* (ARCHOSAURIA: POPOSAUROIDEA)

30 **Fernández, M., Paulina Carabajal, A., Gasparini, Z., Herrera, Y., Chong, G.** A METRIORHYNCHID CROCODYLIFORM BRAINCASE FROM NORTHERN CHILE

31 **Stocker, M.** CLARIFICATION OF THE SKELETAL ANATOMY OF PHYTOSAURS BASED ON COMPARATIVE ANATOMY AND THE MOST COMPLETE SPECIMEN OF *ANGISTORHINUS*

32 **Lecuona, A.** THE AXIAL SKELETON OF *GRACILISUCHUS STIPANICICORUM*: AUTAPOMORPHIC CHARACTERS AND ITS PHYLOGENETIC INFORMATION WITHIN THE CONTEXT OF CRUROTARSI

33 **Mancini, M., Hungerbuehler, A.** TOWARDS A STABLE PHYTOSAUR TAXONOMY: DISTINGUISHING CHARACTERISTICS BETWEEN *PSEUDOPALATUS* AND *REDONDASAURUS* (PHYTOSAURIDAE: PSEUDOPALATINAE)

34 **Hatcher, J., Janzic, A.** FIRST OCCURRENCE OF THE MARINE CROCODYLIFORM *TERMINONARIS* FROM THE UPPER CRETACEOUS (TURONIAN) OF MANITOBA

35 **Adams, T., Polcyn, M., Mateus, O., Winkler, D., Jacobs, L.** NEW OCCURRENCE OF THE LONG-SNOUTED CROCODYLIFORM, *TERMINONARIS* CF. *T. ROBUSTA*, FROM THE WOODBINE FORMATION (CENOMANIAN) OF TEXAS

36 **Schwimmer, D.** ONE OR TWO SPECIES OF THE GIANT CROCODYLIAN *DEINOSUCHUS*?

37 **Manning, P., Milan, J., Falkingham, P.** DINOSAURS WALK TALL: A CROCODILIAN TRACE FROM THE LANCE FORMATION (UPPER CRETACEOUS) OF WYOMING

38 **Masters, S., Sandau, S., Burk, D., Krumenacker, L.** A UNIQUE EOCENE CROCODYLIAN FROM THE UINTA BASIN, UTAH

39 **Jímenez Vázquez, O., Brochu, C.** CROCODYLIFORMS FROM THE EARLY MIOCENE DOMO DE ZAZA LOCALITY OF CUBA

40 **Sanders, R., Farmer, C.** THE PULMONARY ANATOMY OF *ALLIGATOR MISSISSIPPIENSIS*: A UNIDIRECTIONAL AIR FLOW SYSTEM THAT FORESHADOWS THE AVIAN RESPIRATORY SYSTEM

41 **Tsai, H., Owerkowicz, T., Felbinger, K., Andrade, F., Hicks, J.** CHRONIC EXERCISE DOES NOT ALTER LIMB BONE MORPHOLOGY OR MICROSTRUCTURE IN THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*)

42 **Bourke, J., Witmer, L.** THE NOSE KNOWS: THE EFFECTS OF NASAL CAVITY ANATOMY ON AIRFLOW IN ALLIGATORS

43 **Hurlburt, G.** ESTIMATION OF CROCODILIAN BODY FORM FROM SNOUT-VENT LENGTH AND TAIL GIRTH

44 **Silcox, M., Dalmyn, C., Hrenchuk, A., Bloch, J., Boyer, D.** ENDOCRANIAL ANATOMY OF *LABIDOLEMUR KAYI* AND ITS RELEVANCE TO THE EVOLUTION OF THE BRAIN IN EUARCHONTOGLIRES

45 **Dirks, W., Anemone, R., Beard, K., Nachman, B., Tafforeau, P.** DENTAL EMERGENCE SEQUENCES IN THE EUARCHONTA AND A POTENTIAL SYNAPOMORPHY OF EUPRIMATES

46 **Bomberger, C., Sandau, S.** PRELIMINARY REPORT ON THE DISCOVERY OF A LARGE EOCENE PRIMATE FROM THE UINTA FORMATION OF NORTHEASTERN UTAH

47 **Tsukui, K., Meng, J.** HIGH-RESOLUTION TEMPORAL VARIATIONS IN SIZE AND SHAPE OF MOLAR DENTITION AMONG *NOTHARCTUS* FROM THE MIDDLE EOCENE BRIDGER FORMATION, BRIDGER BASIN, SW WYOMING

48 **Westgate, J., Cope, D., Beard, K.** FIRST OCCURRENCE AND SIGNIFICANCE OF *MAHGARITA STEVENSI* IN A LATE MIDDLE EOCENE (LATE UINTAN) TETHYAN-INFLUENCED GULF COAST COMMUNITY

49 **Ramdarshan, A., Marivaux, L., Merceron, G.** DENTAL MICROWEAR ANALYSIS REVEALS SPATIAL AND TEMPORAL VARIABILITY IN THE DIET OF TWO EOCENE PRIMATES FROM FRANCE

50 **Kirk, E., Daghighi, P., Macrini, T., Bhullar, B., Rowe, T.** VIRTUAL ENDOCAST OF *ROONEYIA VIEJAENSIS* (MAMMALIA, PRIMATES)

51 **Miyata, K., Beard, K., Gunnell, G., Tomida, Y.** FIRST DISCOVERY OF EOCENE PRIMATES FROM JAPAN: THE EARLIEST RECORD OF SIVALADAPIDAE

52 **Eastham, L., Begun, D., Kordos, L.** PALEOECOLOGY OF A LATE MIOCENE HOMINID LOCALITY IN NORTHERN CENTRAL HUNGARY: PRELIMINARY STABLE ISOTOPE ANALYSIS OF THE RUDABANYA FAUNA

53 **Knigge, R., McNulty, K.** RE-EVALUATION OF HOMINOID FACIAL SYNAPOMORPHIES WITH IMPLICATIONS FOR THE TAXONOMIC STATUS OF *AFROPITHECUS TURKANENSIS*

54 **Jenkins, K.** PREDATION ON EARLY MIOCENE PRIMATES, *PROCONSUL*, *DENDROPITHECUS* AND *LIMNOPITHECUS* FROM RUSINGA ISLAND

55 **Bennett, V., Goswami, A.** MORPHOMETRIC ANALYSIS OF CRANIAL SHAPE IN FOSSIL AND RECENT EUPRIMATES

56 **Chester, S., Beard, K.** LATE PALEOCENE MICROMOMYID PLESIADAPIFORMS (MAMMALIA, EUARCHONTA) FROM BIG MULTI QUARRY, WASHAKIE BASIN, WYOMING

TUESDAY AFTERNOON, OCTOBER 12, 2010
POSTER SESSION III (continued)

57 **Kibii, J., Berger, L., de Klerk, B.** *AUSTRALOPITHECUS SEDIBA*: A TAPHONOMIC PERSPECTIVE

58 **Halenar, L.** FORELIMB MORPHOLOGY AND LOCOMOTOR PROFILE OF *PROTOPITHECUS* AND *CAIPORA*, THE "GIANT" PLEISTOCENE NEW WORLD MONKEYS

59 **Bobe, R.** ESTIMATING TIME RANGES IN PLIO-PLEISTOCENE HOMINIDS

60 **Massey, J., McNulty, K., Baab, K.** SEXUAL DIMORPHISM IN THE HOMININE SUPRAORBITAL TORUS: IMPLICATIONS FOR IDENTIFYING SEX IN FOSSIL HUMANS

61 **Gilbert, C.** PLIO-PLEISTOCENE AFRICAN PAPIONIN PHYLOGENETIC HISTORY AND BIOGEOGRAPHY

62 **Hammond, A., Koscielniak, N., Plavcan, J., Ward, C.** 3D ANALYSIS OF PRIMATE HINDLIMB JOINTS: RECONSTRUCTING POSITIONAL ABILITIES IN EXTINCT PRIMATES

63 **Velez-Juarbe, J., Domning, D.** THE OLIGOCENE AND MIOCENE SIRENIAN FAUNA OF PUERTO RICO: REVIEW AND NEW ADDITIONS

64 **Barrow, E., Seiffert, E., Simons, E.** CRANIAL MORPHOLOGY OF *THYROHYRAX DOMORICTUS* (HYRACOIDEA: MAMMALIA) FROM THE EARLY OLIGOCENE OF EGYPT

65 **Santana-Grace, D., Lai, R., Lofgren, D., Gluckstein, L., Ugolick, D.** TAPHONOMY OF PIPESTONE SPRINGS MAIN POCKET, A MIDDLE CHADRONIAN MICROVERTEBRATE ASSEMBLAGE FROM SW MONTANA

66 **Anaya Daza, F., Shockey, B., Croft, D.** SPARASSODONTS OF SALLA: SPECIES RICHNESS AND NEW TAXA OF CARNIVOROUS MARSUPIALS FROM THE LATE OLIGOCENE OF BOLIVIA

67 **Weiler, M., Schumaker, K., Pearson, D.** MARSUPIALS AND INSECTIVORES FROM THE OLIGOCENE OF SOUTHWESTERN NORTH DAKOTA FROM A PREVIOUSLY UNDESCRIBED COLLECTION FROM THE PIONEER TRAILS REGIONAL MUSEUM

68 **Furió, M., Ruiz-Sánchez, F., Crespo-Roures, V., Freudenthal, M., Montoya, P.** NEW DIDELPHIMORPH (MARSUPIALIA, MAMMALIA) AND DIMYLID (EULIPOTYPHLA, MAMMALIA) REMAINS FROM THE LATE EARLY MIOCENE OF SPAIN

69 **Carranza-Castañeda, O., Aranda-Gómez , J., Wang, , X.** ADVANCES IN LATE TERTIARY MEXICAN PALEONTOLOGY: THE EARLY-LATE HEMPHILLIAN FAUNA FROM THE JUCHIPILA BASIN, STATE OF ZACATECAS MEXICO

70 **Browne, I., Smith, K., Czaplewski, N.** NEW COLLECTIONS OF LATE HEMINGFORDIAN AND EARLY BARSTOVIAN SMALL MAMMALS FROM THE BARSTOW FORMATION, MOJAVE DESERT, CALIFORNIA

71 **Martin, J.** THE YOUNGEST VERTEBRATE ASSEMBLAGE FROM THE ELLENSBURG GROUP, WILBUR LOCALITY (HEMPHILLIAN), CENTRAL WASHINGTON

72 **Rincón, A., Solórzano, Á., McDonald, H.** NEW MAMMAL RECORDS FROM THE EARLY MIOCENE CASTILLO FORMATION OF VENEZUELA

73 **Domingo , L., García Merino, M., Hernández Fernández, M., Grimes, S., López-Martínez, N.** RECORD OF THE EARLY AND MIDDLE MIOCENE CLIMATIC EVENTS ON MAMMALIAN TOOTH ENAMEL δ13C VALUES FROM EUROPE

74 **Maguire, K.** MAMMALIAN RANGE DYNAMICS ACROSS THE MID-MIOCENE CLIMATIC OPTIMUM IN THE JOHN DAY BASIN, OREGON

75 **Hoffman, J., Clementz, M.** UNDERSTANDING GRASSLAND EXPANSION, CLIMATIC FACTORS AND HYPSODONTY EVOLUTION THROUGHOUT THE MIOCENE IN THE JOHN DAY BASIN, OREGON

76 **Miller, E., Wood, A.** PALEOENVIRONMENTAL RECONSTRUCTION OF BULUK, EARLY MIOCENE, KENYA

77 **Garcia Yelo, B., Gomez Cano, A., Sanisidro, O., Domingo, L., Hernández Fernández, M.** APPROXIMATION OF THE DIMENSIONS OF THE MIDDLE MIOCENE IBERIAN SAVANNAS

78 **Gomez Cano, A., Hernández Fernández, M., Garcia Yelo, B.** SAMPLING BIAS AND REDUNDANCY IN MAMMALIAN COMMUNITIES: DO THEY AFFECT TO PALAEOENVIRONMENTAL APPROACHES?

79 **Hopkins, S., Calede, J., Gusey, A.** RECONSTRUCTING HABITAT DIVERSITY FROM FAUNAS OF THE MIDDLE AND LATE MIOCENE OF EASTERN OREGON

80 **Sameh, M., Croft, D.** ECOLOGICAL STRUCTURE AND HABITAT OF TWO MIDDLE MIOCENE SOUTH AMERICAN MAMMAL PALEOCOMMUNITIES

81 **Gusey, A., Davis, E.** DIVERSITY BIASES OF THE PUBLISHED RECORD OF FOSSILS AT NINE MIOCENE MAMMALIAN FAUNAS OF NEVADA AND OREGON

82 **Finarelli, J., Badgley, C.** DIVERSIFICATION OF MIOCENE MAMMALS IN NORTH AMERICA, WITH RESPECT TO TECTONIC AND CLIMATIC HISTORY

83 **Nargolwalla, M.** A REAPPRAISAL OF BIOPROVINCIALITY IN MIDDLE AND LATE MIOCENE EURASIAN MAMMALS

84 **Thasod, Y., Saegusa, H., Ratanasthien, B., Jintasakul, P., Hanta, R.** STEGODONTID (PROBOSCIDEA, MAMMALIA) FOSSILS FROM THA CHANG SAND PITS, NAKHON RATCHASIMA PROVINCE, THAILAND

85 **Schwartz, L.** THE SEDIMENTOLOGY AND STRATIGRAPHY OF BULLOCK CREEK, AUSTRALIA - AN IMPORTANT BIOCHRONOLOGIC MARKER FOR AUSTRALIA'S MID-CENOZOIC

86 **Yann, L., Schiebout, J.** RARE EARTH ELEMENTS AS AN INVESTIGATIVE TOOL INTO THE SOURCE, AGE AND ECOLOGY OF LATE MIOCENE TO LATE PLEISTOCENE FOSSILS FROM THE TUNICA HILLS, LOUISIANA

87 **Hulbert Jr., R., MacFadden, B., Sanborn, S., West, C.** SPATIAL-TEMPORAL LIMITATIONS OF AGE DETERMINATION USING RARE EARTH ELEMENTS WITH NEOGENE FAUNAS FROM FLORIDA

88 **McAfee, R.** DISCOVERY OF THE JUGAL BONE IN THE HAITIAN GROUND SLOTH *NEOCNUS* (MAMMALIA. PILOSA. MEGALONYCHIDAE) AND THE IMPLICATIONS FOR DIETARY RECONSTRUCTION

89 **Shaw, B.** SLOTHS UP A TREE: ELUCIDATING SEMI-ABOREAL LOCOMOTION OF SMALL GROUND SLOTHS (SUPERORDER XENARTHRA, ORDER PILOSA)

90 **Holte, S., Schubert, B., Wallace, S.** AN ANALYSIS OF THE *MEGALONYX JEFFERSONII* MATERIAL FROM ACB-3 CAVE, COLBERT COUNTY, ALABAMA AND AN EXAMINATION OF MEASURING TECHNIQUES FOR GROUND SLOTHS

91 **Bryk, A., Feranec, R., Semken, H.** STABLE ISOTOPE ANALYSIS OF AN EXTINCT PLEISTOCENE GROUND SLOTH, *MEGALONYX JEFFERSONII,* FROM THE TARKIO VALLEY OF SOUTHWESTERN IOWA: IMPLICATIONS FOR BIOAPATITE DIAGENESIS

92 **Zurita, A., Carlini, A., Gillette, D.** A NEW GLYPTODONTINAE (XENARTHRA, GLYPTODONTIDAE) FROM NORTHERN SOUTH AMERICA: ITS IMPLICATIONS IN THE GREAT AMERICAN BIOTIC INTERCHANGE

93 **Kalthoff, D.** GIANTS AND THEIR LITTLE SECRETS: TOOTH MICROSTRUCTURES IN MYLODONTID SLOTHS (MAMMALIA, FOLIVORA)

94 **Rountrey, A., Fisher, D.** AN EVALUATION OF PRETREATMENT METHODS FOR STABLE ISOTOPE ANALYSIS OF DENTIN CARBONATE

95 **Broska, J., Tütken, T., Alt, K.** ASSESSING CALCIUM ISOTOPES AS DIETARY PROXY FOR TERRESTRIAL VERTEBRATES

TUESDAY AFTERNOON, OCTOBER 12, 2010
POSTER SESSION III (continued)

96 **Higgins, P., MacFadden, B., Bershaw, J., Garzione, C.** MODELING COMPLEX PAST ENVIRONMENTS WITH BULK ISOTOPIC DATA

97 **Boyd, C.** FOSSILS, MOLECULES AND THE HISTORICAL RECORD: NEW APPLICATIONS FOR STRATIGRAPHIC CONSISTENCY METRICS

98 **Malenda, H., Simpson, E., Szajna, M., Fillmore, D., Hartline, B.** DEPOSITIONAL SETTING OF FISH-PART SANDSTONES AND CONGLOMERATES: A TAPHONOMIC INTERPRETATION OF A RARE LACUSTRINE STRAND LINE

99 **Moore, J., Krumenacker, L., Varricchio, D.** ASSESSING THE CHARACTERISTICS DEFINING THE TAPHONOMIC MODE OF VERTEBRATE FOSSIL ASSEMBLAGES USING ORDINATION ANALYSIS

100 **Sundell, K., Rothschild, B.** PATHOLOGY AND LIFE EXPECTANCY: RECOGNITION OF AN ANCIENT TUMOR

101 **Bennett, III, G.** QUANTIFYING COLLECTION BIAS AND ASSESSING PALEOECOLOGICAL UTILITY OF MICROVERTEBRATE FOSSILS FROM ANTHILLS

102 **Breithaupt, B., Matthews, N.** AN EARLY JURASSIC DESERT ICHNOFAUNA: PALEONTOLOGICAL RESOURCES IN THE VERMILION CLIFFS NATIONAL MONUMENT AND PARIA CANYON-VERMILION CLIFFS WILDERNESS

103 **Van Orden, E., Behrensmeyer, A.** BONE ABRASION AND TRANSPORT DISTANCE: TAPHONOMIC EXPERIMENTS IN THE EAST FORK RIVER, WYOMING

WEDNESDAY MORNING, OCTOBER 13, 2010
SYMPOSIUM: EVOLUTION OF THE MODERN AFRICAN FAUNA

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Nancy Stevens, Lars Werdelin, William Sanders

8:00 **Gheerbrant, E., Amaghzaz , M., Bouya, B.** NEW DATA ON THE PRIMITIVE UNGULATE (CONDYLARTH-LIKE) MAMMALS FROM THE PALEOCENE OF THE OULED ABDOUN BASIN, MOROCCO

8:15 **Borths, M., Seiffert, E., Goodenberger, K., Simons, E.** THE OLDEST FAYUM CREODONT: DENTAL AND HUMERAL MORPHOLOGY OF A NEW PROVIVERRINE HYAENODONTID FROM THE EARLIEST LATE EOCENE OF EGYPT

8:30 **Stevens, N.** EVOLUTION OF THE AFRICAN FAUNA: PALEOGENE TO NEOGENE FAUNAL TRANSITIONS RECORDED IN THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

8:45 **Sanders, W.** AFRO-ARABIA AS THE CRUCIBLE OF PROBOSCIDEAN EVOLUTION

9:00 **Domning, D., Gingerich, P., Zalmout, I.** A REVIEW OF THE AFRICAN FOSSIL SIRENIA

9:15 **Lehmann, T.** EVOLUTIONARY HISTORY OF TUBULIDENTATA (MAMMALIA, AFROTHERIA) AND THE ORIGIN OF THE LIVING AARDVARK

9:30 **Tabuce, R., Adaci, M., Hautier, L., Mennecart, B., Mahboubi, M.** SOLVING THE MYSTERY OF THE ENIGMATIC MAMMAL *HELIOSEUS INSOLITUS*: A HIGHLY DERIVED HYRAX FROM THE EOCENE OF GOUR LAZIB, ALGERIA

9:45 **Gunnell, G.** CENOZOIC AFRICAN BAT COMMUNITIES

10:00 **BREAK**

10:15 **Peigné, S., Werdelin, L.** A REVIEW OF THE FOSSIL RECORD OF CARNIVORA (MAMMALIA) IN AFRICA

10:30 **Lewis, M., Werdelin, L.** PATTERNS OF EVOLUTION IN EASTERN AND SOUTHERN AFRICAN CARNIVORA

10:45 **Seiffert, E., MacLatchy, L., Cote, S.** A CRANIUM OF THE EARLY MIOCENE TENREC *ERYTHROZOOTES* FROM NAPAK, NORTHEASTERN UGANDA

WEDNESDAY MORNING, OCTOBER 13, 2010
SYMPOSIUM: EVOLUTION OF THE MODERN AFRICAN FAUNA (continued)

11:00 **Andanje, S., Critz, K., Cerling, T.** COMPARISON OF THE LIFETIME HISTORIES OF HIPPOS FROM DIFFERENT ENVIRONMENTS USING STABLE ISOTOPES

11:15 **Uno, K., Cerling, T., Harris, J., Leakey, M., Nakaya, H.** DIFFERENTIAL DIET CHANGE AMONG EAST AFRICAN HERBIVORES FROM THE LATE MIOCENE TO PLIOCENE BASED ON CARBON ISOTOPE DATA FROM FOSSIL ENAMEL

11:30 **Bernor, R., Gilbert, W., Wolf, D.** EVOLUTIONARY HISTORY OF THE AFRICAN EQUIDAE

11:45 **Werdelin, L., Peigné, S.** HOW ADEQUATE IS THE NEOGENE FOSSIL RECORD OF AFRICA? AN ANALYSIS BASED ON CARNIVORA

12:00 **Harrison, T.** NEW ESTIMATES OF HOMINOID TAXONOMIC DIVERSITY IN AFRICA DURING THE NEOGENE AND ITS IMPLICATIONS FOR UNDERSTANDING CATARRHINE COMMUNITY STRUCTURE

WEDNESDAY MORNING, OCTOBER 13, 2010
TECHNICAL SESSION XIV

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Stephen Brusatte, Randall Irmis

8:00 **Brusatte, S., Niedzwiedzki, G., Butler, R.** NEW POLISH FOOTPRINTS PULL ORIGIN AND DIVERSIFICATION OF DINOSAUR STEM-LINEAGE INTO EARLY TRIASSIC

8:15 **Upchurch, P., Barrett, P., Xu, X., Li, K.** NEW INFORMATION ON THE TAXONOMY AND PHYLOGENETIC RELATIONSHIPS OF MIDDLE AND LATE JURASSIC SAUROPODS FROM CHINA

8:30 **Whitlock, J., D'Emic, M., Fisher, D., Smith, K., Wilson, J.** TRENDS IN SAUROPOD TOOTH SIZE, SHAPE AND REPLACEMENT RATE

8:45 **Pittman, M., Upchurch, P., Hutchinson, J.** THE EVOLUTION OF TAIL VARIATION IN SAUROPOD DINOSAURS

9:00 **Wilson, J., D'Emic, M., Ikejiri, T., Moacdieh, E., Whitlock, J.** A NOMENCLATURE FOR VERTEBRAL FOSSAE IN SAUROPODS AND OTHER SAURISCHIAN DINOSAURS

9:15 **Sues, H., Nesbitt, S., Berman, D., Henrici, A., Sullivan, R.** A NEW BASAL THEROPOD DINOSAUR FROM THE *COELOPHYSIS* QUARRY (UPPER TRIASSIC) OF GHOST RANCH, NEW MEXICO

9:30 **Irmis, R., Nesbitt, S., Smith, N., Turner, A., Downs, A.** ANATOMY OF THE BASAL THEROPOD *TAWA HALLAE* AND ITS IMPLICATIONS FOR EARLY DINOSAUR PHYLOGENY

9:45 **Britt, B., Chure, D., Engelemann, G., Scheetz, R., Hansen, R.** MULTI-TAXIC THEROPOD BONEBEDS IN AN INTERDUNAL SETTING OF THE EARLY JURASSIC EOLIAN NUGGET SANDSTONE, UTAH

10:00 **BREAK**

10:15 **Sereno, P.** NOASAURID (THEROPODA: ABELISAUROIDEA) SKELETON FROM AFRICA SHOWS DERIVED SKELETAL PROPORTIONS AND FUNCTION

10:30 **Barrett, P., Benson, R., Rich, T., Vickers-Rich, P.** A DEFINITIVE SPINOSAURID THEROPOD FROM THE LOWER CRETACEOUS OF AUSTRALIA AND ITS IMPLICATIONS FOR GONDWANAN PALEOBIOGEOGRAPHY

10:45 **Carr, T.** ONTOGENETIC VARIATION IN *TYRANNOSAURUS REX*: RESULTS FROM A NUMERICAL CLADISTIC ANALYSIS

11:00 **Loewen, M., Sertich, J., Irmis, R., Sampson, S.** TYRANNOSAURID EVOLUTION AND INTRACONTINENTAL ENDEMISM IN LARAMIDIA: NEW EVIDENCE FROM THE CAMPANIAN WAHWEAP FORMATION OF UTAH

11:15 **Kobayashi, Y., Lee, Y., Lü, J., Ryan, M., Currie, P.** A NEARLY COMPLETE SKELETON OF A NEW ORNITHOMIMID FROM THE NEMEGT FORMATION OF MONGOLIA

WEDNESDAY MORNING, OCTOBER 13, 2010
TECHNICAL SESSION XIV (continued)

11:30 **Dececchi, T., Hone, D., Larsson, H., Sullivan, C., Xu, X.** A RE-ANALYSIS OF THE "COELUROSAURIAN PIT-BULL" *YIXIANOSAURUS LONGIMANUS* WITH IMPLICATIONS FOR THE THEROPOD DINOSAUR DIVERSITY OF THE JEHOL BIOTA

11:45 **Tsuihiji, T., Watabe, M., Tsogtbaatar, K., Suzuki, S., Barsbold, R.** A NEW TROODONTID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS OF THE GOBI DESERT IN MONGOLIA

12:00 **Jackson, F., Jackson, R., Varricchio, D., Zelenitsky, D.** UNCOVERING THEROPOD EGGS: WATER VAPOR CONDUCTANCE AND NESTING STRATEGY OF *TROODON*

WEDNESDAY MORNING, OCTOBER 13, 2010
TECHNICAL SESSION XV

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Kerin Claeson, Brian Swartz

8:00 **Qiao, T., Zhu, M.** A *URANOLOPHUS*-LIKE LUNGFISH FROM THE PRAGIAN (EARLY DEVONIAN) OF YUNNAN, SOUTH CHINA

8:15 **Lu, J., Zhu, M.** NEUROCRANIAL MORPHOLOGY OF A BASAL ONYCHODONT *QINGMENODUS* REVEALED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY

8:30 **Swartz, B.** THE FIRST TRISTICHOPTERID (STEM-TETRAPOD) FROM THE MIDDLE DEVONIAN OF WESTERN NORTH AMERICA: FURTHER EVIDENCE OF PARALLELISM IN THE TETRAPOD STEM-GROUP

8:45 **Lund, R., Emily, G., Grogan, E.** DIVERSITY AND DISTRIBUTION OF FISH IN A MISSISSIPPIAN BAY: THE BEAR GULCH FISH FAUNA

9:00 **Greenfest-Allen, E., Lund, R., Grogan, E.** COMMUNITY STRUCTURE OF THE MISSISSIPPIAN BEAR GULCH BAY FISHES

9:15 **Menasco-Davis, L., Stidham, T.** HIGH RESOLUTION EXAMINATION OF THE ECOLOGY, EVOLUTION AND BIOGEOGRAPHY OF MARINE VERTEBRATES IN THE POST KT-EXTINCTION INTERVAL IN EASTERN TEXAS

9:30 **Ciampaglio, C., Clayton, A.** ANALYSIS OF CHONDRICHTHYAN FAMILIAL AND GENERIC RICHNESS, DIVERSIFICATION OF DENTAL MORPHOLOGIES, AND ECOSPACE DIVERSITY ACROSS THE PERMIAN-TRIASSIC AND CRETACEOUS-PALEOGENE BOUNDARIES

9:45 **Claeson, K.** THE FIRST PHYLOGENY OF RAJIDAE TO INCLUDE EXTINCT AND EXTANT TAXA SIMULTANEOUSLY

10:00 **BREAK**

10:15 **Lane, J.** THE ORIGINS AND EVOLUTIONARY RELATIONSHIPS OF HYBODONT SHARKS: NEW INFERENCES BASED ON SKELETAL MORPHOLOGY

10:30 **Ehret, D.** MACROEVOLUTION OF LARGE BODY SIZE IN MEGATOOTHED (LAMNIFORMES: OTODONTIDAE) SHARKS

10:45 **Sallan, L.** FUNCTIONAL MORPHOLOGY AND MODULAR LAGS IN THE EARLY DIVERSIFICATION OF RAY-FINNED FISHES (ACTINOPTERYGII)

11:00 **Schultze, H., Arratia, G., González Rodríguez, K.** THE EARLY APPEARANCE OF ADVANCED EUTELEOSTS AND THE CONTROVERSY BETWEEN MOLECULAR CLOCK AND GEOLOGICAL APPEARANCE OF ACTINOPTERYGIANS

11:15 **Chang, M., Miao, D., Wang, N.** ASCENT WITH MODIFICATION: FOSSIL FISHES WITNESSED THEIR OWN GROUP'S ADAPTATION TO THE UPLIFT OF THE TIBETAN PLATEAU DURING THE LATE CENOZOIC

WEDNESDAY MORNING, OCTOBER 13, 2010
TECHNICAL SESSION XV (continued)

11:30 **Liu, J., Chang, M., Wilson, M.** THE FOSSIL CATOSTOMID *JIANGHANICHTHYS* FROM CHINA AND IMPLICATIONS FOR THE EVOLUTION OF BASAL CATOSTOMIDS (CYPRINIFORMES, ACTINOPTERYGII)

11:45 **Miyashita, T., Snively, E., Murray, A.** MICRO-CT SCANNING TECHNOLOGY REVEALS DEVELOPMENT OF DIPLOSPONDYLY IN *AMIA CALVA*

12:00 **Darras, L., Purnell, M., Hart, P., Turingan, R.** INVESTIGATING THE DIET OF EXTANT AND FOSSIL FISHES THROUGH MICROTEXTURAL ANALYSIS OF TEETH

WEDNESDAY AFTERNOON, OCTOBER 13, 2010
TECHNICAL SESSION XVI

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 301
MODERATORS: Tobin Hieronymus, Karen Sears

1:45 **Baermann, E., Sánchez, I., Andrés Rodrigo, M., Alcalde, G., Morales, J.** TOTAL EVIDENCE ANALYSIS OF THE ANTILOPINAE WITH IMPLICATIONS FOR THE EARLY HISTORY OF AFRICAN ANTELOPES

2:00 **Faith, J.** THE FOSSIL RECORD OF EXTINCTION: THE DEMISE OF THE BLUE ANTELOPE (*HIPPOTRAGUS LEUCOPHAEUS*) IN SOUTHERN AFRICA

2:15 **Theodor, J.** MORPHOLOGY OF THE AUDITORY REGION OF *HYPISODUS MINIMUS*: IMPLICATIONS FOR THE EVOLUTION OF THE MASTOID FOSSA OF ARTIODACTYLS

2:30 **Bormet, A., Marcot, J., Sears, K.** EVOLUTIONARY RATES AND PATTERNS OF ARTIODACTYL LIMB REDUCTION

2:45 **Sears, K., Bormet, A., Rockwell, A., Powers, L., Grobis, M.** DEVELOPMENTAL MECHANISMS UNDERLYING TRENDS IN ARTIODACTYL LIMB REDUCTION: A CASE STUDY IN THE DOMESTICATED PIG, *SUS SCROFA*

3:00 **Cuddahee, R., Madden, R., Churchill, S., Bobe, R.** NON-DIETARY ABRASIVES AND THE DENTAL EVOLUTION OF PLIO-PLEISTOCENE SUIDAE (ARTIODACTYLA: MAMMALIA)

3:15 **Hieronymus, T., Cooper, L., Vinyard, C., Thewissen, J.** INFERRING DIET FROM MORPHOLOGY IN EARLY WHALES: MORPHOMETRIC ANALYSIS OF FEEDING STRATEGY IN *REMINGTONOCETUS*

3:30 **Uhen, M., Clementz, M.** LIFE HISTORY AND ECOLOGICAL INFORMATION INFERRED FROM STABLE ISOTOPE ANALYSIS OF THE DENTITION OF *ZYGORHIZA KOCHII* (CETACEA: BASILOSAURIDAE)

3:45 **Moran, M., Thewissen, J., Bajpai, S.** SACRAL FUSION IN MODERN AND FOSSIL CETACEA

4:00 **Ekdale, E., Berta, A., Deméré, T.** PHYLOGENETIC IMPLICATIONS OF THE PETROTYMPANIC COMPLEX OF BALEEN WHALES (CETACEA, MYSTICETI)

WEDNESDAY AFTERNOON, OCTOBER 13, 2010
TECHNICAL SESSION XVII

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM B
MODERATORS: Hans Larsson, Matthew Lamanna

1:45 **Csiki, Z., Brusatte, S., Vremir, M., Norell, M.** BEING A THEROPOD ON AN ISLAND: A PECULIAR DROMAEOSAURID FROM THE MAASTRICHTIAN OF THE TRANSYLVANIAN BASIN, ROMANIA

2:00 **Larsson, H., Hone, D., Dececchi, T., Sullivan, C., Xu, X.** THE WINGED NON-AVIAN DINOSAUR *MICRORAPTOR* FED ON MAMMALS: IMPLICATIONS FOR THE JEHOL BIOTA ECOSYSTEM

2:15 **Lamanna, M., Li, D., Harris, J., Atterholt, J., You, H.** FIRST NON-AVIAN DINOSAUR FROM THE LOWER CRETACEOUS (APTIAN) XIAGOU FORMATION OF THE CHANGMA BASIN, NORTHWESTERN CHINA

WEDNESDAY AFTERNOON, OCTOBER 13, 2010
TECHNICAL SESSION XVII (continued)

2:30 **Watanabe, A., Sereno, P.** A LARGE SHORT-SNOUTED DROMAEOSAURID (THEROPODA: MANIRAPTORA) FROM INNER MONGOLIA

2:45 **Pei, R.** ASSESSING MORPHOLOGICAL RATES OF CHANGE: AN EXAMPLE USING COELUROSAURIAN DINOSAURS

3:00 **Hone, D., Jonah, C., Sullivan, C., Currie, P.** ELONGATION AND REDUCTION OF THE ARM IN THEROPOD DINOSAURS

3:15 **Choiniere, J., Dimitrov, D., Anton-Fernandez, C., Xing, X., Clark, J.** ANALYSIS OF HOMOLOGY IN SERIALLY REPETITIVE MORPHOLOGICAL STRUCTURES: THE THEROPOD DIGIT PROBLEM

3:30 **Mori, H., Britt, B.** PRELIMINARY DETRITAL ZIRCON AGES FOR THREE STRATIGRAPHIC UNITS OF THE CEDAR MOUNTAIN FORMATION AND STATISTICAL ANALYSES OF ITS FAUNAS

3:45 **Suarez, C., Gonzalez, L., Ludvigson, G., Kirkland, J., Cifelli, R.** OXYGEN ISOTOPIC COMPOSITION OF VERTEBRATE PHOSPHATE FROM THE CEDAR MOUNTAIN FORMATION, UT: A TOOL FOR DECIPHERING BOTH GLOBAL AND SMALL-SCALE CLIMATE CHANGE AND ECOLOGIC PARTITIONING

4:00 **Montanari, S., Norell, M.** LATE CRETACEOUS PALEOENVIRONMENTS OF THE GOBI DESERT: RECONSTRUCTIONS FROM STABLE ISOTOPES OF DINOSAUR FOSSILS

WEDNESDAY AFTERNOON, OCTOBER 13, 2010
TECHNICAL SESSION XVIII

DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, ROOM 304
MODERATORS: Sergio Dias-da-Silva, Kenneth Angielczyk

1:45 **Dias-da-Silva, S., Sengupta, D., Cabreira, S., da Silva, L.** FIRST RECORD OF CHIGUTISAURIDS (STEREOSPONDYLI, TREMATOSAURIA) IN THE SANTA MARIA FORMATION (UPPER TRIASSIC OF SOUTHERN BRAZIL)

2:00 **McHugh, J.** A SPECIES-LEVEL PHYLOGENETIC ANALYSIS OF TEMNOSPONDYLI (VERTEBRATA: CHOANATA)

2:15 **Angielczyk, K., Ruta, M.** GEOMETRIC MORPHOMETRIC ANALYSIS OF SKULL SHAPE IN CARBONIFEORUS AND PERMIAN TEMNOSPONDYL AMPHIBIANS

2:30 **Sidor, C., Steyer, J., Angielczyk, K., Smith, R., Tolan, S.** NEW INFORMATION ON THE PERMIAN AND TRIASSIC VERTEBRATE FAUNAS OF THE LUANGWA BASIN, ZAMBIA

2:45 **Báez, A.** ANURAN ASSEMBLAGE FROM THE LOWER CRETACEOUS OF SPAIN: NOVEL INSIGHTS ON THE BASAL RADIATION OF CROWN-CLADE ANURA

3:00 **Dong, L., Wang, Y.** A STEM-GROUP ANURAN FROM THE LOWER CRETACEOUS OF WESTERN LIAONING, CHINA

3:15 **Wang, Y., Dong, L., Evans, S.** POLYDACTYLY IN A MESOZOIC SALAMANDER FROM CHINA

3:30 **Redelstorff, R., Orr, P., McNamara, M.** DIE AND ROT: EXPERIMENTAL TAPHONOMY OF TADPOLES

3:45 **Meyer, T., Anderson, J.** WHEN IS AN ASTRAGALUS NOT AN ASTRAGALUS? TARSAL FUSION IN *HYLONOMUS*, THE EARLIEST KNOWN AMNIOTE

4:00 **Tsuji, L., Reisz, R., Müller, J.** THE LATE PERMIAN REPTILE *EMEROLETER LEVIS* FROM RUSSIA AND THE PHYLOGENY OF THE NYCTEROLETER PARAREPTILES

WEDNESDAY AFTERNOON, OCTOBER 13, 2010
POSTER SESSION IV
DAVID L. LAWRENCE CONVENTION CENTER, EAST LOBBY, SPIRIT OF PITTSBURGH BALLROOM A
Authors must be present from 4:15 – 6:15 p.m.
Posters must be removed by 6:30 p.m.

1 **Escaso, F., Silva, B., Ortega, F., Malafaia, E., Sanz, J.** A PORTUGUESE SPECIMEN OF *CAMPTOSAURUS APHANOECETES* (ORNITHOPODA: CAMPTOSAURIDAE) INCREASES THE DINOSAURIAN SIMILARITY AMONG THE UPPER JURASSIC ALCOBACA AND MORRISON FORMATIONS

2 **Thomas, D.** A DESCRIPTION OF THE CRANIAL ANATOMY OF AN EXCEPTIONALLY WELL-PRESERVED SPECIMEN OF *TENONTOSAURUS TILLETTI* (ORNITHOPODA, DINOSAURIA) FROM THE ANTLERS FORMATION OF OKLAHOMA

3 **Iibiricu, L., Lamanna, M., Martinez, R., Casal, G., Lacovara, K.** A NEW ORNITHOPOD (DINOSAURIA: ORNITHISCHIA) SPECIMEN FROM THE UPPER CRETACEOUS BAJO BARREAL FORMATION OF PATAGONIA, ARGENTINA

4 **Herrero, L., Farke, A.** MORPHOLOGICAL VARIATION IN THE HADROSAUR DINOSAUR *GRYPOSAURUS* FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH

5 **Scheetz, R., Britt, B., Higgerson, J.** A LARGE, TALL-SPINED IGUANODONTID DINOSAUR FROM THE EARLY CRETACEOUS (EARLY ALBIAN) BASAL CEDAR MOUNTAIN FORMATION OF UTAH

6 **Krauss, D., Salame, I.** EVIDENCE FOR SPECIALIST FEEDING IN *HYPSILOPHODON FOXII*

7 **Krumenacker, L., Britt, B., Scheetz, R., Evans, B.** A NEW BASAL ORNITHOPOD FROM THE MID-CRETACEOUS WAYAN FORMATION OF IDAHO

8 **Cleland, T., Zheng, W., Schweitzer, M.** PRESERVATION OF BLOOD VESSELS IN A NEW SPECIMEN OF *BRACHYLOPHOSAURUS CANADENSIS*

9 **Brown, C., Druckenmiller, P.** BASAL ORNITHOPOD (DINOSAURIA: ORNITHISCHIA) TEETH FROM THE PRINCE CREEK FORMATION (CAMPANIAN-PALEOCENE), NORTH SLOPE, ALASKA: TAXONOMY AND FAUNAL COMPARISON

10 **Levitt, C., Irmis, R.** AN ARTICULATED SMALL JUVENILE HADROSAURID DINOSAUR (ORNITHISCHIA; ORNITHOPODA) FROM THE CAMPANIAN KAIPAROWITS FORMATION, UTAH

11 **King, L., Yacobucci, M., Farver, J.** USE OF FINITE ELEMENT ANALYSIS TO DETERMINE THE OPTIMUM ANGLE OF THESCELOSAUR (*DINOSAURIA*) METATARSALS

12 **Freedman, E., Fowler, D.** STRATIGRAPHIC CORRELATION OF JUDITH RIVER FORMATION (CAMPANIAN, UPPER CRETACEOUS) EXPOSURES IN KENNEDY COULEE (NORTHCENTRAL MONTANA) TO THE FOREMOST FORMATION (ALBERTA): IMPLICATIONS FOR ANAGENESIS IN HADROSAURID DINOSAURS

13 **Van Dongen, B., Wogelius, R., Buckley, M., Lyson, T., Manning, P.** PRESERVATION OF ORGANIC MOLECULES IN A HADROSAUR DINOSAUR FROM THE HELL CREEK FORMATION, NORTH DAKOTA (USA)

14 **Norman, D.** IGUANODONTIAN DINOSAURS FROM THE WEALDEN GROUP OF ENGLAND: TAXONOMIC CONUNDRUMS

15 **Brink, K., Zelenitsky, D., Evans, D., Therrien, F.** AFFINITIES OF LAMBEOSAURINE (ORNITHISCHIA: HADROSAURIDAE) EMBRYOS FROM DEVIL'S COULEE (CAMPANIAN), ALBERTA

16 **Lucas, S., Sullivan, R., Jasinski, S.** GIANT HADROSAUR FOOTPRINTS FROM THE UPPER CRETACEOUS FRUITLAND FORMATION, SAN JUAN BASIN, NEW MEXICO

17 **Nabavizadeh, A.** NEW FUNCTIONAL SIGNIFICANCE OF THE PREDENTARY BONE IN HADROSAUROID MASTICATION

18 **Marugán-Lobón, J., Chiappe, L.** TESTING THE CONSISTENCY OF THE LATERAL SEMICIRCULAR CANAL AS A COMPARATIVE COORDINATE SYSTEM FOR CRANIOFACIAL DESCRIPTIONS IN SAURISCHIAN DINOSAURS

19 **Boehmer, C., Rauhut, O.** 3D MORPHOMETRIC ANALYSIS OF THE PRESACRAL VERTEBRAE OF *PLATEOSAURUS*: IMPLICATIONS FOR VERTEBRAL EVOLUTION IN SAUROPODOMORPH DINOSAURS

20 **Yates, A., Bonnan, M., Neveling, J.** A NEW, POSSIBLY RELICTUAL, BASAL SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC OF SOUTH AFRICA

21 **D'Emic, M., Wilson, J.** AUGMENTATION OF THE HOLOTYPE OF *NEUQUENSAURUS AUSTRALIS*: IMPLICATIONS FOR THE TAXONOMY OF SALTASAURINE SAUROPOD DINOSAURS

22 **Curry Rogers, K., D'Emic, M., Cagan, A.** TITANOSAUR OSTEODERM ONTOGENY, ANATOMY AND FUNCTION: NEW DATA FROM *RAPETOSAURUS KRAUSEI* (MAEVARANO FORMATION, MADAGASCAR)

23 **Carballido, J., Schwarz-Wings, D., Marpmann, S., Sander, M., Pabst, B.** SYSTEMATIC REEVALUATION OF "TONI", THE JUVENILE SAUROPOD FROM THE MORRISON FORMATION

24 **Turner, L., Neufeld, B., Chadwick, A., Spencer, L.** TEN YEARS EXCAVATION AT AN EXTENSIVE LANCIAN *EDMONTOSAURUS* BONEBED IN NORTHEASTERN WYOMING

25 **Santos-Cubedo, A., Poza, B., Suñer, M., de Santisteban, C.** NEW REMAINS OF A TITANOSAUR (DINOSAURIA: SAUROPODA) FROM THE EARLY CRETACEOUS OF SPAIN

26 **McNulty, K., Curry Rogers, K., Rudloff, O.** MORPHOMETRIC ANALYSES OF TITANOSAUR CAUDAL VERTEBRAE: IMPLICATIONS FOR NAMING "MALAGASY TAXON B"

27 **Wilhite, R., Bonnan, M., Sanders, R.** APPENDICULAR JOINT RECONSTRUCTION IN SAUROPOD DINOSAURS BASED ON COMPUTED TOMOGRAPHY OF A MAMMAL, A BIRD AND A CROCODILIAN

28 **Woodruff, D., Fowler, D.** ONTOGENETIC INFLUENCE ON NEURAL SPINE BIFURCATION IN DIPLODOCOIDEA (DINOSAURIA: SAUROPODA): A CRITICAL PHYLOGENETIC CHARACTER

29 **Barnes, R., Upchurch, P., Barrett, P.** INVESTIGATING TITANOSAUR EVOLUTION USING PHYLOGENETIC ANALYSIS

30 **Ludtke, J.** THE OREODONT RECORD OF THE UINTAN NALMA AND ITS IMPLICATIONS FOR THE BIOCHRONOLOGY OF THE MIDDLE EOCENE

31 **Meehan, T.** MASS DEATH ASSEMBLAGES OF *HYPERTRAGULUS CALCARATUS* (ARTIODACTYLA: RUMINANTIA)

32 **Tsubamoto, T., Kohno, N.** REAPPRAISAL OF "*BRACHYODUS*" *JAPONICUS*, AN OLIGOCENE ANTHRACOTHERIID ARTIODACTYL (MAMMALIA) FROM JAPAN

33 **Miller, M.** SAMPLE ANALYSIS OF *ARCHAEOTHERIUM* (ARTIODACTYLA: ENTELODONTIDAE) FROM THE CONATA PICNIC GROUND "BIG PIG DIG", BADLANDS NATIONAL PARK, SOUTH DAKOTA

34 **Rincon, A., Bloch, J., MacFadden, B., Suarez, S., Carlos, J.** NEW EARLY MIOCENE CAMELID FROM THE LAS CASCADAS FORMATION, PANAMA CANAL, CENTRAL AMERICA

35 **Hanta, R., Kunimatsu, Y., Jintasakul, P.** NEOGENE SUIDAE OF THAILAND AND THEIR BIOSTRATIGRAPHY

36 **Raymond, K., Prothero, D.** STASIS IN LATE PLEISTOCENE *BISON* FROM LA BREA TAR PITS OVER THE LAST GLACIAL-INTERGLACIAL CYCLE

37 **Jiménez-Hidalgo, E., Cabrera-Pérez, L., Guerrero-Arenas , R., MacFadden, B.** *BISON ANTIQUUS* FROM NORTHWESTERN OAXACA, SOUTHERN MEXICO

38 **Robinson, C., Belmaker, M.** THE TAXONOMY AND BIOGEOGRAPHY OF *GIRAFFA* SPP. IN THE PLIO-PLEISTOCENE: EVIDENCE FOR MULTIPLE DISPERSALS OUT OF AFRICA

39 **Villasenor, A., Behrensmeyer, A.** GEOGRAPHIC VARIATION IN HORN SIZE IN THE IMPALA, *AEPYCEROS MELAMPUS*, WITH APPLICATIONS TO THE AFRICAN FOSSIL RECORD

40 **Antar, M., Zalmout, I., Gingerich, P.** SEXUAL DIMORPHISM IN HIND LIMBS OF LATE EOCENE *BASILOSAURUS ISIS* (MAMMALIA, CETACEA), WADI AL HITAN WORLD HERITAGE SITE, EGYPT

41 **van Vliet, H., Abu el Khair, G.** A NEW SITE OF EOCENE WHALES AND SIRENIANS IN EGYPT

42 **Fahlke, J., Wood, A., Gingerich, P.** CHEWING MOVEMENT AND TOOTH FUNCTION IN *BASILOSAURUS ISIS* (MAMMALIA, CETACEA) BASED ON DIGITAL ANALYSIS OF WEAR FACETS

43 **Nance, J., Godfrey, S.** AN ANKYLOSED MIOCENE MYSTICETE UPPER LIMB FROM THE CALVERT FORMATION OF CALVERT CLIFFS, MARYLAND

44 **Buchholtz, E.** AXIAL PATTERNING IN THE PYGMY RIGHT WHALE *CAPEREA MARGINATA*: IS IT A FOURTH EXCEPTION TO THE RULE OF SEVEN?

45 **Sánchez, I., Quiralte, V., Morales, J., Pickford, M.** MORPHOLOGICAL DIVERSITY OF THE EARLY MIOCENE TRAGULIDAE (CETARTIODACTYLA, RUMINANTIA)

46 **Missiaen, P., Gunnell, G., Gingerich, P.** NEW EARLY EOCENE PERISSODACTYL FAUNAS FROM THE CONTINENTAL UPPER GHAZIJ FORMATION OF BALOCHISTAN, PAKISTAN

47 **Homchaudhuri, A., Mihlbachler, M., Solounias, N.** DENTAL MICROWEAR ANALYSIS OF EOCENE BRONTOTHERIOIDEA AND IMPLICATIONS FOR PALEODIETARY INTERPRETATIONS OF LONG EXTINCT SPECIES

48 **McLaughlin, B., Mihlbachler, M., Ellison, M.** THE POSTCRANIAL SKELETON OF *EMBOLOTHERIUM* (BRONTOTHERIIDAE) FROM THE MIDDLE AND LATE EOCENE OF CENTRAL ASIA

49 **Drewicz, A., Terry Jr., D., Grandstaff, D., Ash, R.** THE INFLUENCE OF BONE HISTOLOGY ON FOSSILIZATION: INSIGHTS FROM LASER ABLATION ANALYSES OF LATE EOCENE BRONTOTHERES

50 **Bai, B., Wang, Y.** EARLY EOCENE CHALICOTHERE *LITOLOPHUS* (PERISSODACTYLA, MAMMALIA) POSSESSES HOOFLIKE UNGUALS RATHER THAN CLAWS

51 **Temme IV, T., Sroka, S., Finlayson, H.** PRELIMINARY REPORT OF A WELL PRESERVED PERISSODACTYL TRACK SET FROM CENTRAL UINTAH BASIN, UT

52 **Holbrook, L.** CRANIAL AND POSTCRANIAL ANATOMY OF *OROHIPPUS* (MAMMALIA, PERISSODACTYLA)

53 **Rounds, C., Coombs, M.** A NEW SPECIES OF *MOROPUS* IN THE BATESLAND FORMATION AND A REVIEW OF CHALICOTHERE MATERIAL FROM THE RUNNINGWATER FORMATION, GREAT PLAINS MIOCENE OF NORTH AMERICA

54 **Famoso, N., Pagnac, D.** A COMPARISON OF THE TAXONOMIC COMPOSITON OF MEDIAL MIOCENE EQUIDS (MAMMALIA: PERISSODACTYLA) FROM THE MISSION PIT, SOUTH DAKOTA AND ASHFALL FOSSIL BEDS, NEBRASKA

55 **Pagnac, D., Reynolds, R.** DISPARITY IN ABUNDANCE OF THE DWARFED EQUID *ARCHEOHIPPUS* IN MIDDLE MIOCENE DEPOSITS OF SOUTHERN CALIFORNIA

56 **Olvera-Badillo, P., Cacho-Alfaro, N., Bravo-Cuevas, V.** DIETARY BEHAVIOR OF *ASTROHIPPUS STOCKII* FROM THE LATE HEMPHILLIAN OF CENTRAL MEXICO USING THE MESOWEAR METHOD

57 **Watabe, M., Nakaya, H., Ataabadi, M., Maschenko, E.** TAXONOMIC REVISION OF LATE MIOCENE HIPPARIONS (EQUIDAE, PERISSODACTYLA) FROM THE EX-USSR REGION - THEIR WIDE GEOGRAPHIC DISTRIBUTION

58 **Gibson, M., Wallace, S.** POPULATION STRUCTURE OF *TAPIRUS POLKENSIS* BASED ON DENTAL ERUPTION AND WEAR

59 **Aurell Garrido, J., Madurell-Malapeira, J., Alba, D., Moyà-Solà, S.** EQUIDS FROM THE PLEISTOCENE SECTIONS OF VALLPARADIS (TERRASSA, VALLES-PENEDES BASIN, NORTHEASTERN IBERIAN PENINSULA)

60 **Sanisidro, O., Alberdi, M., Morales, J.** HEAD SHAPE EVOLUTION IN RHINOCEROTIDAE (PERISSODACTYLA): AN OVERVIEW OF ITS ECOLOGICAL IMPLICATIONS

61 **Bykowski, R., Green, R., O'Donnell, K., Smith, M., Polly, P.** DISCRIMINATING FOSSILS ARE NOT STATIC: AN ASSESSMENT OF THE DISCRIMINANT FUNCTION ANALYSIS METHOD FOR TESTING STASIS

62 **Anders, U., von Koenigswald, W.** FUNCTIONAL SHIFT IN THE DENTITION OF EXTANT AND FOSSIL MAMMALS

63 **Hawkins, P., Wallace, S.** SIMPLE FEMORAL INDICATORS OF LOCOMOTION DERIVED FROM ANATOMICAL STUDIES

64 **Margetts, L., Phillip, M., Mustansar, Z., Johnson, M.** RELIABILITY OF IMAGE BASED FINITE ELEMENT MODELLING IN VERTEBRATE PALEONTOLOGY

65 **Janis, C., Shoshitaishvili, B., Kambic, R.** ON THEIR KNEES: DISTAL FEMUR ASYMMETRY IN UNGULATES AND ITS RELATIONSHIP TO BODY SIZE AND LOCOMOTION

66 **Haiar Wilborn, B.** AMOUNT OF MORPHOLOGICAL VARIATION IN LIMB ELEMENTS FROM SELECT EXTANT AND EXTINCT QUADRUPEDS

67 **Thompson, R., Asher, R.** HIDDEN SUPPORT IN INSECTIVORAN-GRADE MAMMAL PHYLOGENY

68 **Crumpton, N.** EIMER'S ORGANS IN MOLES AND THE RESOLUTION OF OSTEOLOGICAL EVIDENCE FOR SOMATOSENSATION

69 **Asher, R., Hautier, L.** NOVEL CHARACTERS FOR HIGH LEVEL PHYLOGENY OF PLACENTAL MAMMALS

70 **Springer, K., Scott, E., Manker, C., Lake, Q.** PALEONTOLOGIC SITE STEWARDSHIP ON FEDERAL LAND IN NEVADA; A MODEL FOR PROMOTING CITIZEN SCIENCE

71 **Evans, T.** THE USE OF SEARCH AND RESCUE AND TECHNICAL (ROPE) RESCUE TECHNIQUES IN THE AID OF PALEONTOLOGICAL FIELDWORK

72 **Shin, J., Motani, R.** HIGH SHELL-CRUSHING PERFORMANCE OF TEETH FACILITATED BY UNIQUE FRACTURE PATTERNS

73 **Turrin, D., Beatty, B.** A NOVEL APPROACH TO SERIAL SECTIONING AND THREE-DIMENSIONAL VISUALIZATION OF ENAMEL MICROSTRUCTURE

74 **Marivaux, L., Adaci, M., Mebrouk, F., Tabuce, R., Mahboubi, M.** THE ZEGDOUMYIDAE (RODENTIA, MAMMALIA) FROM THE EARLY PALEOGENE OF ALGERIA: NEW DENTAL EVIDENCE ON STEM ANOMALUROID RODENTS

75 **Wood, D., Hunter, J.** BODY MASS, DIET PREFERENCE AND NICHE PARTITIONING IN THE MULTITUBERCULATES AND RODENTS OF NORTH AMERICA, EUROPE AND ASIA

76 **Anderson, D., Keil, K., Holt, B.** NEW SPECIMENS OF *THISBEMYS BREVICRISTA* (RODENTIA) FROM THE MIDDLE EOCENE BRIDGER FORMATION, GREEN RIVER BASIN, WYOMING

77 **Bertrand, O., Flynn, J., Croft, D., Wyss, A.** DESCRIPTION OF THE OLDEST CAVIOMORPHS AND A PHYLOGENY OF THE GROUP'S INITIAL RADIATION

78 **Schwarz, C., Ruf, I., Martin, T.** MICRO-CT ANALYSIS OF THE EAR REGION IN *HETEROXERUS COSTATUS* (RODENTIA, MAMMALIA)

79 **López-Antoñanzas, R., Knoll, F.** A CLADISTIC ANALYSIS OF CTENODACTYLINE INTRARELATIONSHIPS

80 **Czaplewski, N., Smith, K., Browne, I.** A MESODONT DIPODID RODENT FROM THE MIDDLE MIOCENE OF THE GREAT BASIN OF NORTH AMERICA

81 **Chick, J., Croft, D., Dodson, H., Flynn, J., Wyss, A.** THE EARLY MIOCENE RODENT FAUNA OF PAMPA CASTILLO, CHILE

82 **Tomida, Y.** NEW SPECIES OF *ALLOPTOX* (OCHOTONIDAE; LAGOMORPHA), FIRST RECORD OF THE GENUS FROM JAPAN, AND SUBGENERIC DISTINCTION

83 **Martin, R., Peláez-Campomanes, P.** PATTERNS OF SIZE CHANGE IN LATE NEOGENE POCKET GOPHERS (MAMMALIA: GEOMYIDAE) FROM THE MEADE BASIN OF SOUTHWESTERN KANSAS

84 **Nishioka, Y., Maung-Thein, Z., Htike, T., Egi, N., Takai, M.** EVOLUTIONARY CHANGE IN PORCUPINES IN THE LATE MIOCENE TO PLEISTOCENE OF CENTRAL MYANMAR

85 **Rinaldi, C., Martin, L., Timm, R., Cole III, T., Kumar, V.** EVIDENCE OF A PREDATION ATTEMPT ON A GIANT BEAVER BY A TERRESTRIAL CARNIVORE

86 **Whiteman, S., Smith, F.** WHO'S TRASH STASH? USING GEOMETRIC MORPHOMETRICS TO DIFFERENTIATE BETWEEN *NEOTOMA* MOLARS FOUND IN PALEOMIDDENS

87 **Hautier, L., Saksiri, S.** A NEW ASSESSMENT OF THE ENIGMATIC MANDIBLE OF THE LIVING FOSSIL LAONASTES AENIGMAMUS (RODENTIA, MAMMALIA)

88 **Mehling, C.** TURDS OF A FEATHER

89 **Stegner, A., Hadly, E.** USING THE PAST TO PREDICT THE FUTURE: BLUE GROUSE AS A MODEL FOR CLIMATE CHANGE

90 **Ridgely, R., Witmer, L., James, H., Olson, S., Iwaniuk, A.** WHATEVER FITS THE BILL: NOVEL DIGITAL TECHNIQUES FOR RECONSTRUCTING SKULL AND EYEBALL ANATOMY IN THE UNUSUAL EXTINCT HAWAIIAN DUCK, *TALPANAS LIPPA*

91 **Doyle, J., Johnson, E., Moretti, J., Lewis, P.** PRELIMINARY BIOGEOGRAPHICAL AND SYSTEMATIC ANALYSIS OF AN EARLY PLEISTOCENE AVIFAUNA IN THE ROLLING PLAINS REGION OF WEST TEXAS

92 **Felice, R., O'Connor, P., Fleagle, J.** NEW FOSSIL BIRDS FROM THE DESEADAN (LATE OLIGOCENE) OF ARGENTINA

93 **Yury-Yáñez, R., Gutstein, C., Rubilar-Rogers, D.** FOSSIL PROCELARIDS (AVES: PROCELLARIIFORMES) FROM THE BAHIA INGLESA FORMATION BONEBED (LATE MIOCENE), ATACAMA DESERT, NORTHERN CHILE

94 **Boles, Z., Ksepka, D.** QUANTIFYING SHIFTS IN OSTEOSCLEROSIS IN THE HUMERUS OF FOSSIL PENGUINS (AVES: SPHENISCIFORMES)

95 **Leggitt, V.** AVIAN EGGSHELL FRAGMENTS FROM A FRESHWATER FACIES OF THE SALINE WILKINS PEAK MEMBER OF THE EOCENE GREEN RIVER FORMATION

96 **O'Connor, J., Zhou, Z., Zhang, F.** A NEW LOOK AT 'OLD' BIRDS FROM THE JEHOL FAUNA

97 **DeBee, A., Lawver, D., Clarke, J., Guillermo, R.** A NEW ENANTIORNITHINE (THEROPODA, AVIALAE) FROM THE UPPER CRETACEOUS LA COLONIA FORMATION OF PATAGONIA, ARGENTINA

98 **Wang, X., Dyke, G., Nudds, R.** INFERRING THE FLIGHT STYLES OF EARLY BIRDS AND FLIGHT EVOLUTION FROM PRIMARY FEATHER LENGTH

99 **Wogelius, R., Bergmann, U., Sellers, W., Larson, P., Manning, P.** *ARCHAEOPTERYX* CHEMISTRY REVEALED VIA SYNCHROTRON RAPID SCANNING X-RAY FLUORESCENCE

100 **Abernethy, A., Wallace, S.** EXTREME VARIATION IN THE SAGITTAL CREST OF *TAPIRUS POLKENSIS* FROM THE GRAY FOSSIL SITE, TN

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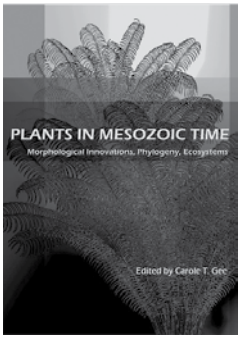

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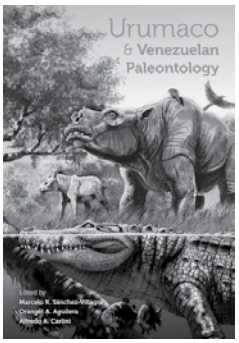

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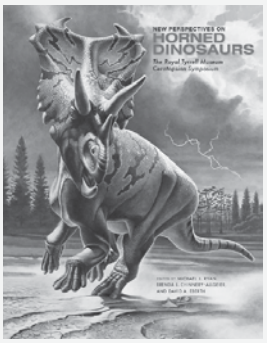

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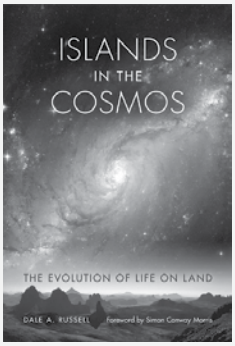

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Poster Session IV (Wednesday)

EXTREME VARIATION IN THE SAGITTAL CREST OF *TAPIRUS POLKENSIS* FROM THE GRAY FOSSIL SITE, TN

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The excellent preservation and quantity of fossil tapirs from the Gray Fossil Site in northeastern Tennessee provides a great opportunity for comparison and analysis of several skeletal characteristics. Intraspecifically, modern tapirs show little to no variation in the morphology of the sagittal crest. Specifically, a small percentage of the specimens at Gray display a well defined sagittal crest composed of two thin temporal ridges on the parietals that merge and extend vertically from the braincase; crests that form large flattened parietal tables, which can also extend vertically; crests where the temporal ridges merge briefly; while other specimens exhibit little or no sagittal crest. Several hypotheses may explain the observed variation and are addressed here: 1) more than one species is present at Gray, 2) sexual dimorphism, 3) ontogeny, 4) feeding behaviors and dietary choice, 5) pathogenic responses, or 6) the sagittal crest is simply a highly variable character in *Tapirus polkensis*. Previous work has determined coefficients of variation are consistent with a single species. Four separate crest states within the Gray sample would also suggest up to four species when compared to modern analogues, which is unlikely considering the tapir's ecological niche as a large low level browser. To date, no osteological evidence of sexual dimorphism exists for tapirs, and no correlation between crest morphology and sex was observed here. Several juveniles identified by having unerupted cheek teeth display well defined sagittal crests, while some adults with heavily worn teeth have minor thickening of the temporal ridges with no true crest, therefore no distinct correlation between age and crest state could be established. Concerning hypothesis 4, three different patterns of wear exist within the sample, and there is some correlation between these and crest morphology. No cranial pathologies were found to be associated with a crest type. Despite some correlations evident in the sample the sagittal crest could simply be a variable character due to intraspecific variation.

Poster Session III, (Tuesday)

NEW OCCURRENCE OF THE LONG-SNOUTED CROCODYLIFORM, *TERMINONARIS* CF. *T. ROBUSTA*, FROM THE WOODBINE FORMATION (CENOMANIAN) OF TEXAS

ADAMS, Thomas, Huffington Dept. of Earth Sci., SMU, Dallas, TX, USA; POLCYN, Michael, Huffington Dept. of Earth Sci., SMU, Dallas, TX, USA; MATEUS, Octávio, CICEGe, Faculdade de Ciências e Tecnologia, FCT, Universidade Nova de Lisboa, 2829-516 Caparica, Portugal and Museu da Lourinhã, Portugal, Lourinhã, Portugal; WINKLER, Dale, Huffington Dept. of Earth Sci., SMU, Dallas, TX, USA; JACOBS, Louis, Huffington Dept. of Earth Sci., SMU, Dallas, TX, USA

A specimen of the longirostrine crocodyliform *Terminonaris* was recovered in 2006 from the northeast shore of Lewisville Lake, Denton County, Texas. It is represented by a nearly complete rostrum consisting of fused premaxillae and maxillae, nasals, partial jugal and lacrimal, dentaries, and partial splenials. The anterior ends of the premaxillae are transversely broad and ventrally directed. The jugal, lacrimal and the position of the frontals extend anteriorly to the same level. These characters diagnose the Lewisville Lake specimen to the genus *Terminonaris*. The nasals contact with the premaxilla at the level between the ninth and tenth maxillary tooth, indicating a stronger affinity with *T. robusta* than that of *T. browni*. However, because the posterior portion of the skull is missing, the Lewisville Lake specimen is conservatively referred to as *Terminonaris* cf. *T. robusta*. A second specimen, also collected from Lewisville Lake, consists of a fragment of maxilla and an osteoderm. The fossils derive from the Arlington Member in the uppermost part Woodbine Formation, which represents an age no younger than early Middle Cenomanian (approximately 96 Ma). *Terminonaris* is known from the Early to Middle Turonian of North America (Saskatchewan, Montana, Minnesota, and Kansas), and the Late Cenomanian of Germany. The Lewisville Lake specimens are not only significant for being the first record of *Terminonaris* in Texas; they are also the earliest and the southernmost occurrence of this crocodyliform globally.

Poster Session II, (Monday)

AGE OF THE VERTEBRATE-BEARING SHUMAYSI FORMATION, WESTERN SAUDI ARABIA

AL-MUFARREH, Yahya, Saudi Geological Survey, Jeddah, Saudi Arabia; GUNNELL, Gregg , University of Michigan, Museum of Paleontology, Ann Arbor, MI, USA; AL-MASSARI, Abdu, Saudi Geological Survey, Jeddah, Saudi Arabia; AL-SOBHI, Saleh, Saudi Geological Survey, Jeddah, Saudi Arabia; ZALMOUT, Iyad, University of Michigan, Museum of Paleontology, Ann Arbor, MI, USA

The Shumaysi Formation is part of an early Tertiary sedimentary package that occupies two major NNW-SSE trending troughs in the Al Hijz Province of Western Saudi Arabia. The 400 meter thick formation is composed of three distinctive clastic units: lower, middle, and upper. The middle unit is characterized by the presence of several oolitic ironstone beds and bands separated from each other by alternating ocher and deep red muds, shales, silts, and fine-grained sandstones. The oolitic ironstone beds are truncated by channels and wedges of sandstones with pebbles and cobbles of quartz. Radioisotopic dating of intrusive volcanic dykes and the basalts overlying the top of the Shumaysi Formation indicate that the age of the middle unit is older than the Miocene. Recently a Saudi Geological Survey-University of Michigan expedition has recovered terrestrial mammals from the middle unit of the Shumaysi Formation. The faunal assemblage includes embrithopods, anthracotheriid artiodactyls, proboscideans, hyraxes, and a catarrhine primate. These forms are similar to, but more advanced than, counterparts from the early Oligocene Jebel Qatrani Formation, Fayum, Egypt. However, they are less advanced than comparable forms from the late Oligocene sites of Chilga in Ethiopia and Lothidok in Kenya. Primitive gomphotheres and mammutids are unknown from early Oligocene Afro-Arabian sites and the co-occurrence of elephantoids with more archaic palaeomastodonts has only been documented previously from Chilga which is dated to 28-27 Ma. Although *Megalohyrax eocaneus* is a Fayumian species, the elephantoid proboscideans indicate that the middle Shumaysi Formation is slightly younger than Jebel Qatrani Formation deposits. Conversely, while the anthracotheres and embrithopods are suggestive of an age older than the Chilga Formation both are more advanced than similar taxa from the Fayum. Temporally, the Shumaysi Formation assemblage is best interpolated as falling between the Jebel Qatrani and Chilga faunas. Based on this and the radioisotopic results, the Shumaysi Formation can be dated between 29 and 28 Ma.

Technical Session XII, Tuesday 1:45

PHYLOGENETIC ANALYSIS OF GONIOPHOLIDID CROCODYLIFORMS OF THE MORRISON FORMATION

ALLEN, Eric, University of Iowa, Iowa City, IA, USA

Goniopholididae includes some of the most common, widespread, and distinctive crocodyliforms of the Late Jurassic and Early Cretaceous, and includes some of the first crocodyliforms to superficially resemble extant crocodiles. Putative goniopholidids from Europe and North America have historically been referred to the genus *Goniopholis*. Recently, the affinity of North American forms with the nominally European *Goniopholis* has come under question, but has not been tested. A novel phylogenetic analysis increasing taxon sampling to the most comprehensive treatment of putative goniopholidids to date, including all specimens currently referred to *Goniopholis* from the Morrison Formation (Upper Jurassic) of the American West, *Goniopholis gilmorei*, *G. lucasii*, and *G. stovalli*, reveals that *Goniopholis* is not monophyletic. Instead, the Morrison Formation members are distinct from European *Goniopholis* and share several characters in common with other North American goniopholidids such as *Eutretauranosuchus* also from the Morrison Formation and *Calsoyasuchus* from the Early Jurassic, particularly in regard to the palatal expression of the nasal passages. This suggests a monophyletic North American clade within Goniopholididae. In addition to taxonomic revision, these results have profound implications for the stratigraphic and biogeographic history of Goniopholididae as well as the evolution of Neosuchia as a whole.

Technical Session XI, Tuesday 3:45

HAS GLOBAL TETRAPOD BIODIVERSITY INCREASED SINCE THE CRETACEOUS?

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Analyses of global tetrapod diversity in the fossil record have long relied upon family-level age ranges instead of using sampling-standardized estimates that derive from taxonomically resolved faunal occurrences. The Paleobiology Database now includes enough faunal data to examine both mammalian and non-mammalian diversification patterns in Europe, Asia, and North America at the genus level. Counts derived from age ranges create the appearance of a massive tetrapod radiation throughout the Cretaceous and Cenozoic, while conventional sampling standardization methods such as rarefaction create the appearance of very little change. However, rarefaction is biased towards finding flat trends because it imposes uniform sampling levels that put rich intervals at a disadvantage. The new shareholder quorum subsampling (SQ) method avoids this problem by seeking to sample in proportion to the size of the preservable taxon pool. If, say, the pool's true richness doubles from one time to the next, SQ should draw a subsample that reflects the doubling regardless of what the raw taxon counts might be. SQ curves for non-volant, non-marine mammals and for other tetrapods show a large mammalian radiation at the Cretaceous-Paleogene boundary, but no later increase and no change in non-mammalian diversity. Throughout the Cenozoic, mammalian genus counts in each continent are typically three to four times as great as non-mammalian counts. However, mammals comprise less than 30% of modern terrestrial tetrapod diversity. Because most preservational biases have been controlled for by excluding doubtful identifications, ichnofossils, compression fossils, and sieved collections, the only obvious explanation for the disparity is the greater identifiability of mammalian fossils. Data on type specimens show that most tetrapods are named on the basis of skulls and skeletons, but most mammal names are tied to mandibles or isolated teeth. Indeed, most mammalian identifications are based only on teeth, but in other groups teeth are generally unidentifiable at the genus or even family level. Thus, there is no clear evidence that tetrapods ever experienced a large, steady radiation: instead, all that can be shown is that there was an isolated radiation of mammals leading to a new equilibrium diversity level.

Poster Session III, (Tuesday)

SPARASSODONTS OF SALLA: SPECIES RICHNESS AND NEW TAXA OF CARNIVOROUS MARSUPIALS FROM THE LATE OLIGOCENE OF BOLIVIA

ANAYA DAZA, Federico, Universidad Autónoma Tomás Frías, Potosí, Bolivia; SHOCKEY, Bruce, Manhattan College & AMNH, New York, NY, USA; CROFT, Darin , Case School of Medicine, Cleveland, OH, USA

Sparassodont marsupials are uncommon in the late Oligocene Salla Beds of Bolivia, as in most faunas. However, this group shows considerable species richness and morphological diversity at Salla. We recognize a minimum of 7 species. Five of these have been formally described: *Fredszalay hunteri*; *Pharsophorus lacerans*; *Notogale mitis*; *Sallacyon hoffstetteri*; and *Paraborhyaena boliviana*. We also have recently recovered partial crania of two small, apparently new, borhyaenids. The new short-faced species from Unit 3 is distinctive in having: only 2 upper premolars; reduced upper molar stylar shelves; very well developed postmetacristae, with that of M3 strongly oblique and nearly perpendicular to the jaw axis; very large orbits; and a large infraorbital canal. It has 4 upper incisors followed by a gap for the large lower canine. The upper canine is large and long-rooted, as evidenced by the long, palpable bulge extending nearly 2 cm into the skull. The distinctive shearing blades of the molars in this taxon, as well as the two blade-like premolars, leave little doubt that animal material was an important food for this small, dog-like marsupial. A second small, dog-like specimen comes from higher in the section, Unit 5 of the Tapial Pampa region of Salla. The tooth crowns are badly damaged, but it is clear that it had 3 premolars and 4 molars. The snout is much longer than the previous specimen and its tip is wide, slightly flared, and blunt. We also have encountered a jaw of a very large proborhyaenid, cf. *Paraborhyaena*, at the base of Unit 3. It is distinguished by its large size, hypercarnassial m4, and the presence of a single pair of large, blunt incisors. The proborhyaenid(s) of Salla appear to represent the youngest record of the giant, carnivorous marsupials. The 7+ species of sparassodont marsupials at Salla are one of the most diverse communities known, potentially exceeded only by that of Santa Cruz, Argentina. These faunas illustrate the need for increased faunal sampling to accurately assess diversities of rare groups such as sparassodonts.

Evolution of the Modern African Fauna, Wednesday 11:00

COMPARISON OF THE LIFETIME HISTORIES OF HIPPOS FROM DIFFERENT ENVIRONMENTS USING STABLE ISOTOPES

ANDANJE, Samuel, Biodiversity Research and Monitoring, Kenya Wildlife Service, Nairobi, Kenya; CHRITZ, Kendra, Department of Biology, University of Utah, Salt Lake City, UT, USA; CERLING, Thure, Department of Geology and Geophysics, University of Utah, Salt Lake City, UT, USA

Stable isotope analysis (SIA) has the potential to elucidate aspects of ecology in fossil organisms that are not easily observable using traditional paleontological techniques, such as diet and migration. Before SIA can be applied to ancient specimens with confidence, more work must be done on modern analogues living in a variety of environments in order to understand how environmental parameters are recorded in the isotopic signature of diagenetically resistant tissues, such as tooth enamel. We present data from isotope measurements taken at 10mm intervals along the profiles of *Hippopotamus amphibius* (hippo) canine (tusk) enamel from a collection of 25 hippos living in a variety of environments across Kenya. These tusks present a wealth of information about isotopic variation across the lifetime histories of modern hippos. Tusk profiles indicate that hippo feeding behavior varies across environments and can deviate considerably from the traditionally assumed pure grazer (C_4) diet depending on their habitat and changes occurring therein. These data suggest that observations taken from isolated populations in time or space do not accurately reflect the ecology of a species, and care must be taken when using SIA in the fossil record without proper modern analogues for comparison.

Poster Session I, (Sunday)

PECTORAL GIRDLE AND FIN SEXUAL DIMORPHISM IN THE HOLOCEPHALAN *HARPAGOFUTUTOR VOLSELLORHINUS* FROM THE BEAR GULCH LIMESTONE OF MONTANA (HEATH FORMATION, BIG SNOWY GROUP, SERPUKHOVIAN) WITH COMMENTS ON *CHONDRENCHELYS PROBLEMATICA*

ANDERMANN Jr., Roy, Saint Joseph's University, Philadelphia, PA, USA; GROGAN, Eileen, Saint Joseph's University, Philadelphia, PA, USA; LUND, Richard, Carnegie Museum of Natural History, Mount Holly, PA, USA

Recently excavated specimens of the holocephalan chondrenchelyid *Harpagofututor volsellorhinus* reveal sexual dimorphism in the pectoral fin and girdle between these male specimens and the previously described females. The pectoral fin of the female *Harpagofututor* is paddle-like, characterized by a single series of axials from which thin radials radiate both dorsally and ventrally. This is distinct from the male pectoral fin in that the elements of the latter are appreciably more robust. The male fin axials are very broad and support jointed radials which are also considerably broader than in the female. These larger radials in the male *Harpagofututor* are positioned closer together in series than in females. To support the more robust paddle, the pectoral girdle of male *Harpagofututor* is correspondingly more developed than that of females. This sex based variation in anatomy suggests distinction in how these structures are used, possibly for display purposes. Such a correlation has been reported in extant fish with comparable sex-based pectoral dimorphism. In addition to pectoral fin and girdle dimorphism, the male *Harpagofututor* also possessed denticulated ethmoid claspers and pelvic fins, augmenting the already large body of evidence for pervasive sexual selection in Bear Gulch chondrichthyans. We also find the sexually dimorphic pectoral design reported here is comparable to that of the Scottish relative, *Chondrenchelys problematica*. Otherwise, the male *Chondrenchelys* pectoral fin is distinct from the male *Harpagofututor* in exhibiting denticulation on its leading edge. Ultimately, and in addition to other morphological features of the cranium, dentition and body, the similarity in pectoral fin structure of the American *Harpagofututor* and Scottish *Chondrenchelys* accentuates the close relationship between these fish.

Poster Session IV, (Wednesday)

FUNCTIONAL SHIFT IN THE DENTITION OF EXTANT AND FOSSIL MAMMALS

ANDERS, Ulrike, Universität Bonn, Bonn, Germany; VON KOENIGSWALD, Wighart, Universität Bonn, Bonn, Germany

Bunodont teeth are generally regarded as being used for crushing food. However, in some suids (e.g., *Sus scrofa*) and fossil proboscideans (e.g., *Gomphotherium*) the degradation of the cheek teeth opens up the possibility of functional changes. During ontogeny wear causes the flattening of the surface and enamel margins of the exposed dentine fields in the cusps may function as shearing edges. Crushing elements in the cheek teeth are present on the bunodont dentition with the eruption of the deciduous fourth premolar shortly after birth. Whether the first molar comes in function the crushing area shifts distally and the deciduous fourth premolar with exposed dentine bordered by enamel margins modifies to functional shearing. Measurements in *Sus scrofa* show that the relationship between crushing surfaces and shearing edges remains almost constant in the dentition throughout a long period of individual age. In older individuals badly worn teeth give the impression of functional disability but the loss of crushing surfaces and afterwards shearing edges in the anterior region is compensated by the late eruption of the posterior second and third molars. Thus, the functional shift can be recognized from the anterior to the posterior region. To increase the efficiency *Sus scrofa* has enlarged third molars with an exceeded number of cusps. Accompanied with an elongation of the tooth exchange crushing and shearing surfaces are functional over a longer period. The functional shift might give advantage to large or even hypsodont third molars as in *Phacochoerus* while anterior teeth may be expelled. Furthermore, the elongation of the tooth eruption phase and the posterior shift of the main functional area favour the evolution of a horizontal tooth exchange as seen in some fossil and extant proboscideans.

Preparators' Session, Monday 10:30

HOW TO MOLD AND CAST A MUMMY DINOSAUR

ANDERSEN, Arthur, Virtual surfaces Inc., Mt Prospect, IL, USA; LICHKO, Joseph, Cubic Vision Inc., Deerfield, IL, USA; JONES, Martin, Ford Motor Co., Livonia, MI, USA; LARSON, Peter, Black Hills Inst of Geological Research, Hill City, SD, USA

Traditional molding and casting of fossil bones is a time-honored process going back to the first preparators. The result is a very accurate cast of the original fossil specimen.However, some specimens are so unique and delicate that traditional molding and casting would destroy the specimen. We found this to be the case with Leonardo, a mummy dinosaur. The molding process involves the usual cleaning of excess matrix, gluing broken pieces and filling in any cracks. Mold release agents may be applied. To accurately record the surface geometry, latex and/or silicon rubber is applied to the fossil surface, which is then backed with foam or fiberglass to maintain the shape. Once the rubber and backing elements have cured, they are removed. Of course, a fossil would require several separate mold jackets to enclose the entire specimen. The mold jackets can now be filled with a casting compound such as a polyester acrylic resin or polyurethane. Leonardo has skin impressions, exposed fossilized bone, and a myriad of small and large surface cracks. He is a very unique specimen. But filling the cracks along with extensive application of chemical release agents, compromises the chemical signature of the surface. After some discussion we opted to employ the use of a non-contact 3-D scanner. Once the scanning is complete, it is followed-up with data editing and rapid prototyping. The scanning itself took 7 days complete, which included the main specimens' body, a separate tail section and his right arm. Over 300 scans were made to insure that as much detail was included. And since the scans are line-of-sight, every feature required multiple scan views. Total resolution: 0.10 mm, at 10 microns accuracy. Data editing required 4 months, which resulted in a series of 32 blocks suitable for rapid prototyping. The rapid prototyped blocks were sent to the Black Hills Institute for assembly, molding and casting. Also rapid prototyped were ¼ and 1/10 scaled models. Thus a valuable specimen remains in pristine condition, saved for future studies.

Poster Session IV, (Wednesday)

NEW SPECIMENS OF *THISBEMYS BREVICRISTA* (RODENTIA) FROM THE MIDDLE EOCENE BRIDGER FORMATION, GREEN RIVER BASIN, WYOMING

ANDERSON, Deborah, St. Norbert College, De Pere, WI, USA; KEIL, Kim, St. Norbert College, De Pere, WI, USA; HOLT, Beth, St. Norbert College, De Pere, WI, USA

New specimens from the Green River Basin allow for the lower dentition of the middle Eocene rodent *Thisbemys brevicrista* to be described and compared with other species of the genus for the first time. Previously, only the upper dentition and a partial maxilla were known from Bridgerian (Br) 3. Included in the new sample are the first specimens of lower molars, additional upper molars, and maxillary fragments including a partial zygomatic arch

that preserves the relationship of the arch to the first upper molar. The specimens are from Br1-2, documenting the co-existence of *T. brevicrista* with *T. perditus, T. nini, T. plicatus,* and *T. corrugatus*. *Thisbemys brevicrista* is intermediate in size between *T. plicatus* and *T. corrugatus* and can be distinguished from these species based on several crown pattern characters: posterior width of p4 significantly greater than the anterior width; metaconid displaced buccally; ectolophid straight with two enamel extensions into the talonid basin; deep lingual gorge extending one third the distance across the talonid basin; presence of distinct hypoconulids; protoconid arms connected to deeply incised crenulations on m1-2; m3 having anterior width exceeding posterior width and enamel blocking the posterior aspect of the talonid basin. In *T. brevicrista* the posterior aspect of the anterior part of the zygomatic arch has a narrow angle and more posterior position when compared to *T. plicatus*. Patterns of dental evolution in *Thisbemys* and other ischyromyids provide additional documentation of the early Bridgerian expansion in mammalian diversity. Discovery and description of the lower molars clarifies the alpha taxonomy for *Thisbemys*, which is one of several ischyromyid genera to show increased species diversity coincident with the late early Eocene Climatic Optimum (EECO, 53-50 MA).

Physical Drivers and Marine Tetrapod Evolution, Monday 10:15

FLIGHTLESS WING-PROPELLED DIVERS: SOUTHERN PROSPERITY VS. NORTHERN EXTINCTIONS

ANDO, Tatsuro, Ashoro Museum of Paleontology, Ashoro, Japan

Flightless wing-propelled divers have evolved 4 times in 3 lineages of modern birds (Neornithes). Many superficial similarities result from the morpho-functional constraints of a flightless wing-propelled diving lifestyle, in turn reflecting similar ecological habit. Though wing-propelled divers are often referenced as a good example of convergence, their evolutionary histories show a drastic contrast between the North and South. While penguins (Sphenisciformes) in the Southern Hemisphere seem to have been thriving throughout the Cenozoic, their Northern Hemisphere counterparts, the plotopterids (Pelecaniformes) and the flightless auks (Great Auk and Lucas auks: Charadriiformes), had undergone extinctions without exception. Were the evolutionary histories of those flightless wing-propelled divers driven by common phenomena? Comparative approaches to assessing their diversity should help to interpret their evolutionary 'drivers'.

In general, fluctuations in the diversity of wing-propelled divers seem to be correlated with the sea level changes through the Cenozoic. The different timings and locations of marine invasions by those birds suggest that invasions need not have been triggered by large-scale global events, such as the mass extinction at the end of the Cretaceous - although about this time penguins did become flightless and probably obligate marine birds. The demise of giant diving birds at the end of the Oligocene, and the incoming of newer groups in the Middle Miocene, are seen in both hemispheres and thus imply that there were common 'drivers' for them. "Biotic" factors have been suggested to explain the demise of giant forms, but it is unlikely that direct competition or predation by smaller marine mammals such as pinnipeds and porpoises drove giant diving birds to extinction concurrently in both hemispheres. It may be possible that larger-sized marine mammals have affected those birds through the trophic cascade. Rather complicated interpretations are needed since they are not 'true' final consumer in the trophic chains.

Poster Session II, (Monday)

AN EARLY WASATCHIAN MAMMALIAN FAUNA FROM AN EXTRAORDINARILY RICH NEW LOCALITY IN THE GREAT DIVIDE BASIN, SW WYOMING

ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA; WATKINS, Ronald, Curtin University, Perth, Australia; NACHMAN, Brett, University of Texas, Austin, TX, USA; DIRKS, Wendy, University of Newcastle, Newcastle, United Kingdom

Early Eocene deposits from the Great Divide Basin (GDB) in Sweetwater County, Wyoming have been the subject of vertebrate paleontological investigations episodically since the 1950s, and intensively since the middle 1990s. During Western Michigan University's summer 2009 field season, we located a new fossil mammal locality (WMU-VP 2009-01) of unprecedented faunal richness and diversity. The new locality occurs in a massive (10 m thick) fluvial sandstone whose microstratigraphy and sedimentology suggest deposition by large-scale sheet floods. These would have been high-energy but ephemeral floods that would have carried, and quickly deposited, a great deal of sediment along with skeletal remains of mammals that had died on the river's floodplain. Twelve previous field seasons in the GDB yielded 7500 mammals, including 250 jaws with teeth from 100 localities, for an average of 75 mammals and 2.5 jaws per locality. Six days of surface collecting and dry screening at this new locality yielded 400 jaws with teeth, more than 2000 teeth, and more than 1000 postcranial fossils of Wasatchian mammals. The fauna includes at least 20 taxa and is dominated by small to tiny mammals, including rodents, small hyopsodontid and meniscotheriid condylarths, and omomyid primates. Larger mammals are rare but include perissodactyls (both equids and isectolophids), carnivores and hyaenodontid creodonts, and adapid primates. The faunal composition of this new locality is unique in the Wasatchian of the GDB, where rodents and omomyids are typically very rare, adapids and equids are common, and mammals of medium to large body size tend to predominate. Preliminary taxonomic study of this assemblage suggests the presence of at least three new taxa: one cylindrodontid rodent and two omomyid primates. Biostratigraphic indicators suggest a Graybullian or middle Wasatchian (Wa3-Wa5) age for this assemblage. While the Great Divide Basin has never been considered one of the premier sources of Wasatchian mammals in the American West, this new locality suggests a reevaluation of the significance of the GDB for our understanding of the evolution of Eocene mammals.

Technical Session XVIII, Wednesday 2:15

GEOMETRIC MORPHOMETRIC ANALYSIS OF SKULL SHAPE IN CARBONIFEORUS AND PERMIAN TEMNOSPONDYL AMPHIBIANS

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Temnospondyls - a major component of Permian and Carboniferous terrestrial ecosystems - display great diversity in skull shapes and proportions. To quantify and interpret this diversity, we conducted a geometric morphometric analysis using 45 landmarks on the dorsal surface of the skull in 91 species with well represented cranial material. Results show a correlation between morphospace occupation and phylogenetic proximity of taxa only for trees in which dvinosaurs and dissorophoids are sister taxa. Nevertheless, most large clades occupy specific areas of morphospace and nearest neighbor analyses reveal significantly greater taxon clumping than expected under uniform or Gaussian null models. Size correlates strongly with shape across the whole data set, highlighting the association of some traits (short, broad snout; large orbits) with small size. A significant relationship between size and shape is not seen in subclades such as branchiosaurids, dvinosaurs, trematopids, suggesting that evolutionary allometry patterns vary across temnospondyls. In the case of branchiosaurids, the pattern may be explained by their similar sizes and relatively conservative morphologies. Distance-based disparity measures indicate that archegosauriforms, eryopids, and edopoids make the largest contributions to total disparity (reflecting their peripheral locations in morphospace), whereas amphibamids, dissorophids, and trematopids make the smallest contributions. Disparity correlates strongly with diversity within clades, suggesting that skull shape was not subject to character state exhaustion. The Kasimovian, Roadian, Wordian, and Changhsingian are times of high disparity despite their low diversity. We hypothesize that this pattern stems from the fact that times of high diversity sample more areas of morphospace, resulting in mean shapes that are located relatively close to the grand mean, whereas mean shapes for low diversity stages are based on incomplete morphospace samples. Many of these patterns are similar to those observed in previous analyses of stereospondyls, suggesting that similar controls on skull shape may have been present throughout temnospondyl history.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

USING GEOLOGY TO INFER BIOLOGY: GEOCHEMICAL TECHNIQUES FOR ASSESSING DIFFERENCES BETWEEN PATHOLOGICAL AND NORMAL BONE

ANNE, Jennifer, Temple University, Philadelphia, PA, USA

One of the main influences on fossilization is the original crystallinity of bone apatite. In this study, petrographic, x-ray diffraction (XRD), and Raman spectroscopy analyses were used to examine fracture pathologies and their effects on crystallinity and fossilization in pedal phalanges of the theropod dinosaur *Allosaurus fragilis*, from the Jurassic Morrison Formation, Cleveland-Lloyd Dinosaur Quarry, and the modern birds *Branta canadensis* (Canada goose) and *Cathartes aura* (turkey vulture). It was hypothesized that both fossil and modern normal (mature) bone tissue would have a lower crystallinity than pathological (immature) bone tissue due to the higher degree of mineralization and rates of osteogenesis seen in pathologic bone growth versus normal bone remodeling. Carbon and oxygen isotopes in the carbonate fraction of fossil bones were analyzed to determine if pathological bone tissue was isotopically different from normal bone tissue.

XRD peak widths are greater in normal bone tissue in both modern avian and *Allosaurus* specimens, supporting the hypothesis that pathologic bone tissue is more crystalline than mature normal bone tissue. XRD spectra in the *Allosaurus* fossils differ between well remodeled and poorly remodeled pathologic bone tissue, with the latter more closely resembling normal bone tissue. Raman spectra of modern avian bones from the same individual exhibit both peak shifts and the presence and/or absence of different peaks between different bone tissue types including cancellous versus cortical and pathologic versus normal bone. Values of $\delta^{13}C$ and $\delta^{18}O$ differed significantly within individual *Allosaurus* bones.

Geochemical techniques prove to be useful tools in determining differences in bone crystallinity in different bone tissues. Pathologic and normal bone tissues differed in both modern avian and fossil *Allosaurus* specimens. Future work on other theropod and non-theropod dinosaurs as well as other archosaurs is necessary to determine if similarities observed between modern birds and *Allosaurus* have a broader phylogenetic distribution.

Poster Session IV, (Wednesday)

SEXUAL DIMORPHISM IN HIND LIMBS OF LATE EOCENE *BASILOSAURUS ISIS* (MAMMALIA, CETACEA), WADI AL HITAN WORLD HERITAGE SITE, EGYPT

ANTAR, Mohammed, Wadi Hitan World Heritage Site, Fayum, Egypt; ZALMOUT, Iyad, Museum of Paleontology, University of Michigan, Ann Arbor, MI, USA; GINGERICH, Philip, Museum of Paleontology, University of Michigan, Ann Arbor, MI, USA

Wadi Al Hitan is a UNESCO World Heritage Site in Egypt established to preserve and exhibit an exceptionally rich and accessible record of late Eocene fossil whales. The archaeo-

cetes *Basilosaurus isis* and *Dorudon atrox* dominate the early Priabonian interval that has yielded the most whales to date, but several additional species are present. We have mapped literally hundreds of well preserved specimens of *Basilosaurus* and *Dorudon*. Subadult specimens of *Dorudon atrox* are common, providing a basis for growth studies but obscuring achievement of recognizable differences in adult specimens. All *Basilosaurus isis* specimens found to date are adult, and these sort into subtly larger and smaller specimens. Discovery that the protocetid *Maiacetus inuus* is dimorphic raises the question of sexual dimorphism in *Basilosaurus* and other basilosaurids.In *Maiacetus* the male specimen averages about 12% larger in linear dimensions than the known female, and has a larger canine thatcorroborates interpretation as a male. A 12% difference in linear measurements corresponds to an expected mean difference of a little more than two standard deviation units between the sexes (2 x 0.05 = 10% or 0.10 on a natural log scale). Normally we expect to find 95% of specimens within two standard deviations of the mean, for an expected range of four standard deviation units. With two-standard-deviation dimorphism, we expect to find 95% of specimens, males and females, in a range of six standard deviation units. This also raises the possibility that dimorphism can be recognized by sample bimodality even in small samples.To test this idea we studied femur diaphysis length for femora representing seven different individuals of *Basilosaurus isis*. The resulting distribution spans seven standard deviation units, and is clearly bimodal, with modes even more separated than expected. Four specimens have shorter diaphyses and cluster together, and three specimens have longer diaphyses and cluster together. Each small sample spans about three standard deviation units, but the separation between modes is five standard deviation units. For comparison, two femora of later North American *Basilosaurus cetoides* differ by four standard deviation units. We interpret *Basilosaurus isis* and *B. cetoides* with smaller femora as females, and those with larger femora as males. By this criterion, the complete skeleton of *B. isis* under study at present, WH-74 collected in 1989 and 2005, is a female. The posterior half of the Smithsonian skeleton, USNM 12261, is a male.

Poster Session II, (Monday)

PLESIOSAURS FROM THE MAASTRICHTIAN OF BENTIABA, NAMIBE PROVINCE, ANGOLA

ARAÚJO, Ricardo, Southern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; MATEUS, Octávio, Museu da Lourinhã & Universidade Nova de Lisboa, Lourinhã, Portugal; SCHULP, Anne, Maastricht Museum of Natural History, Maastricht , Netherlands

Recent excavations at the Maastrichtian locality of Bentiaba, Namibe Province, in the southern part of Angola, have yielded high quality and partially articulated plesiosaur specimens that indicate at least three taxa were present. A new elasmosaurid is the most abundant and well-preserved plesiosaur taxon at Bentiaba. It is known from a complete articulated paddle and other elements of the skeleton, many of which remain to be collected. The most diagnostic elements so far recovered are the complete pelvic and pectoral girdles, which indicate that the Bentiaba elasmosaurid is probably a new genus because it bears an asymmetrical ventral process of the coracoids, a complete cordiform posterior coracoid vacuity, and pronounced excavation of the anterior border of the coracoids, among other characters. A polycotylid is identified on the basis of confluent basioccipital tubers. *Tourangisaurus*, a genus initially named from the Late Cretaceous of New Zealand, is identified by short but massive propodials with no distal facets for epipodials and by the nearly symmetrical anterior and posterior borders of the ischium. The presence of *Tourangisaurus* in Angola extends the geographic range of this genus and suggests austral affinities for the Angolan plesiosaur fauna, as opposed to the early mosasaur and turtle records in Angola, which indicate northern affinity. Because the South Atlantic Ocean opened at its southern extent prior to the completion of the tropical Atlantic Gateway, plesiosaurs with southern affinities could have entered the coastal waters of Angola multiple times both prior to and after the evolution of mosasaurs, leading to the biogeogeographic pattern reflected in marine tetrapods from the Maastrichtian of Angola. Thus, the high quality specimens from Bentiaba are critical for a phylogenetic understanding of southern hemisphere plesiosaur biogeography specifically and Cretaceous marine tetrapod biogeography generally.

Technical Session I, Sunday 11:00

A CRETACEOUS ARMOURY: MULTIPLE ANKYLOSAURID TAXA IN THE LATE CRETACEOUS OF ALBERTA, CANADA AND MONTANA, USA

ARBOUR, Victoria, University of Alberta, Edmonton, AB, Canada

Several taxa of ankylosaurid dinosaurs from the Late Cretaceous of North America have been reassigned to the genus *Euoplocephalus*. Unlike any other dinosaur known from numerous skeletons, *Euoplocephalus* is thought to be present in both the Dinosaur Park, Horseshoe Canyon, and Two MedicineFormations, and possibly the Oldman Formation. This suggests that further examination of specimens referred to *Euoplocephalus* is required in order to verify whether thisgenus transcends formational boundaries, or should be split into several taxa. *Euoplocephalus* has been considered highly morphologically variable, especially in terms of cranial morphology. However, examination of more than 60 specimens, including 13 skulls, shows that these variations are stratigraphically segregated. Ankylosaurids from the Horseshoe Canyon Formation are found to be distinct from *Euoplocephalus*, which is restricted to the Dinosaur Park Formation. *Anodontosaurus*, the holotype of which is from the Horseshoe Canyon Formation, is therefore distinct from *Euoplocephalus*, and is a valid taxon. *Euoplocephalus* specimens from Montana appear to be similar to those from the Dinosaur Park Formation. When compared with *Euoplocephalus,Anodontosaurus* possesses distinctive skull and cervical half ring ornamentation. Although previously thought to represent variation within *Euoplocephalus*, differences in tail club morphology are also correlated with stratigraphy. *Anodontosaurus* tail clubs typically have a greater width:length ratio than *Euoplocephalus* and are characterized by pointed, triangular knob osteoderms in dorsal view. *Dyoplosaurus*, from the Dinosaur Park Formation, was recently suggested to be distinct from *Euoplocephalus* based on pelvic morphology. The taxonomic assignment of Natural History Museum specimen R5161 ("*Scolosaurus*") is still uncertain, butthis specimen does not appear to be referable to *Euoplocephalus* based on cervical half ring morphology. Royal Ontario Museum specimen 813 includes armour not found inNatural History Museum specimenR5161 and represents a distinct but as yet indeterminate taxon. Ankylosaurid diversity in the Late Cretaceous of Alberta and Montanais greater than previously recognized.

Poster Session I, (Sunday)

THE UTILITY OF POSTCRANIAL ELEMENTS IN DIAGNOSING SOUTHERN AFRICAN MICROFAUNA

ARNEY, Irisa, Sam Houston State University, Huntsville, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsiville, TX, USA; THIES, Monte, Sam Houston State University, Huntsville, TX, USA

Micromammals are informative environmental indicators due to their ecological specificity, sensitivity to environmental change, and small habitat ranges. As such, small mammal assemblages are often useful in paleoenvironmental reconstructions, particularly in cave localities which frequently preserve large samples. While species composition and relative abundance of these fossil assemblages are needed to reliably reconstruct paleoenvironments, lower-level taxonomic identification using mandibles, maxilla and teeth can be ambiguous due to overlapping morphologies. Data from postcranial elements is often overlooked as a source of apomorphies. In order to test the value of micromammal postcrania in identifying taxa from a Pleistocene fossil assemblage from northwestern Botswana, an examination of 13 known modern species trapped at the Koanaka Hills locality of Ngamiland Province was undertaken. Results from this analysis indicate that the femur displays genus-specific morphological features. Femoral characteristics that are most diagnostic include proximal to distal length, features of the neck (width, length, and angle), head size, greater trochanter size, lesser trochanter size, inter-trochanteric angle, and third trochanter size and position. While individual features tend to overlap between genera, the suite of these characteristics allowed confident diagnosis of the genera examined. Our analysis also proved useful in differentiating between two species of *Gerbilliscus* (*G. brantsii* and *G. leucogaster*). An examination of the fossil small mammal femora (early to middle Pleistocene in age) collected from the Koanaka South Bone Cave locality yielded distinctions consistent with the morphology of the modern taxa, indicating that the postcranial elements may allow for more confident micromammal identification. Many of the taxa studied in this analysis are widespread in southern Africa and are known to occur at many fossil localities in the region.

Poster Session IV, (Wednesday)

NOVEL CHARACTERS FOR HIGH LEVEL PHYLOGENY OF PLACENTAL MAMMALS

ASHER, Robert, Department of Zoology, Cambridge, United Kingdom; HAUTIER, Lionel, Department of Zoology, Cambridge, United Kingdom

The recently established phylogenetic framework for living placental mammals enables a sophisticated level of character analysis. Phenotypes previously thought to be without much significance for high-level nodes (e.g., vertebral variation, timing of dental eruption) may prove to be key apomorphies in distinguishing major clades within placental mammals. For example, vertebral variation has been shown to be relatively low due in part to stabilizing selection. Among humans, departures from a neck skeleton with seven ribless vertebrae has already been associated with high frequency of fetal and/or childhood pathology and infrequent survival to reproductive age. The extent to which other mammals also exhibit this pattern has not yet been adequately quantified. Here, we present data from the axial skeleton of embryonic, fetal, and near-term non-human mammals, focusing on afrotherians and xenarthrans, and quantify their vertebral counts and incidence of axial skeleton anomalies (e.g., asymmetries, non-thoracic ribs). Our data show that most mammals have at least some variability in the axial skeleton, but with a few exceptions this variability tends to be greater in afrotherians (e.g., hyracoids, tenrecids) and xenarthrans (e.g., pilosans) than in other mammals (e.g., carnivorans, rodents, talpids). Investigating this character complex in certain extinct groups is difficult, because sample sizes of enigmatic taxa such as the Malagasy "aardvark" or endemic South American ungulates are small. We seek to test the extent to which such extinct clades exhibit features differentially present in "northern" vs. "southern" placental mammals.

Technical Session X, Tuesday 9:00

AVIAN TAXONOMIC DIVERSITY AND ANATOMICAL DISPARITY IN THE LOWER CRETACEOUS XIAGOU FORMATION OF THE CHANGMA BASIN, GANSU PROVINCE, PEOPLE'S REPUBLIC OF CHINA

ATTERHOLT, Jessie, University of California, Berkeley, Berkeley, CA, USA; O'CONNOR, Jingmai, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; HARRIS, Jerald, Physical Sciences Department, Dixie State College of Utah, St. George, UT, USA; LI, Da-Qing, Fossil Research and Development Center, Third Geology and

Mineral Resources Exploration Academy, Gansu Provincial Bureau of Geo-Exploration and Mineral Development, Lanzhou, China; YOU, Hai-Lu, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China

In recent years, Lower Cretaceous deposits in northern China have yielded spectacular fossil discoveries that provide critical insight into early avian evolution and diversification. The majority of these fossils pertain to Enantiornithes, a group widely recognized as the dominant avian clade of the Cretaceous. The Aptian Xiagou Formation of the Changma Basin in Gansu Province has yielded approximately 100 three-dimensionally preserved, largely articulated avian fossils, among other vertebrate remains. However, most of these specimens are either definitively or probably referable to the ornithuromorph *Gansus yumenensis*. Several others are referable to a new enantiornithine taxon, and still others likely belong to at least one additional species within this latter clade.

We report on a new avian specimen from the Changma Basin that consists of a complete sternum, several sternal ribs, and a furcula. The fossil exhibits morphologies that differ from those of previously-known Xiagou Formation birds, including *Gansus* (i.e., the sternum has uniquely deep incisions between the medial, intermediate, and lateral trabeculae, and an unusually short body). Phylogenetic analysis indicates that the specimen pertains to a derived, non-ornithuran member of Ornithuromorpha. It therefore represents a second ornithuromorph taxon from the Xiagou Formation.

The discovery of this second Changma ornithuromorph increases the known morphological disparity of basal members of this clade, as well as the taxonomic diversity of the Xiagou Formation avifauna. Two taxa each of Enantiornithes and Ornithuromorpha are now known from this avifauna, suggesting that these clades may have been comparably diverse in the Xiagou paleoecosystem. This situation contrasts with that in the Jehol Group, where enantiornithines appear both numerically and taxonomically more abundant than ornithuromorphs. The occurrence of the new specimen and *Gansus* in the Xiagou Formation emphasize the importance of its avifauna for deciphering the early evolution and radiation of Ornithuromorpha, and, ultimately, of the extant avian clade Neornithes.

Poster Session I, (Sunday)

TOPOGRAPHIC CHANGE AND PLIO-PLEISTOCENE BETA DIVERSITY OF THE NORTH AMERICAN GREAT BASIN AND GREAT PLAINS

ATWATER, Amy, University of Oregon Dept. Geological Sci., Eugene, OR, USA; DAVIS, Edward, University of Oregon Dept. Geological Sci. and MNCH, Eugene, OR, USA

Beta diversity measures the difference between average local and overall diversity within a region and can be expressed in either richness or evenness. Previous studies have suggested that beta diversity can be driven by external factors such as changing climate or changing topography. We are investigating the effects of climatic and topographic change on beta diversity through time by exploring the Pliocene and Pleistocene of the Great Basin and Great Plains faunal provinces of North America. We expected beta diversity in the Great Basin to have become elevated relative to the Great Plains at the beginning of the Pliocene when the Great Basin reached its current topographic complexity. We analyzed records from the FAUNMAP database for beta diversity in terms of both richness and evenness. Preliminary results for richness beta diversity support the hypothesis of a topographic control of Great Basin beta diversity and reject the hypothesis of a primary climatic control; however, there is some suggestion that Pleistocene climate cycling caused a secondary increase in beta diversity. Additionally, Holocene values from fossil sites are greater than measured values from modern mammalogy collections, suggesting a strong, potentially significant, decrease in beta diversity between fossil sites and the modern landscape. Our preliminary evenness results are equivocal in relation to the hypothesis of tectonic control and suggest that evenness may be responding in a more complex way than richness. Previous work suggested that evenness metrics are more sensitive and so may better illuminate the transition from Miocene to Plio-Pleistocene beta diversity in the Great Basin.

Poster Session IV, (Wednesday)

EQUIDS FROM THE PLEISTOCENE SECTIONS OF VALLPARADIS (TERRASSA, VALLES-PENEDES BASIN, NORTHEASTERN IBERIAN PENINSULA)

AURELL GARRIDO, Josep, Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain; MADURELL-MALAPEIRA, Joan, Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain; ALBA, David, Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain; MOYÀ-SOLÀ, Salvador, ICREA at Unitat d'Antropologia Biològica (Dept. BABVE) and Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain

During the last fifteen years, palaeontological excavations have been carried out in two localities (Cal Guardiola and Estacio de Vallparadís) from the Pleistocene section of Torrent de Vallparadís (Terrassa, Northeastern Iberian Peninsula), which geologically corresponds to the Terrassa alluvial fan system (Vallès-Penedès Basin). About thirty mammalian fossil taxa have been identified from these localities, constituting a typical late Early Pleistocene to Middle Pleistocene mammalian assemblage. We report the presence of three distinct equid species from the Pleistocene section of the Torrent de Vallparadís, which spans from the late Early Pleistocene to the Middle Pleistocene: Equus altidens (from Early Pleistocene levels); and Equus cf. hydruntinus and E. cf. ferus (from Middle Pleistocene levels). The age of the several levels has been inferred from the associated fauna as well as magnetostratigraphic data.Equus altidens is a middle-sized stenonian equid from the late Villafranchian. It is characterized by a typical stenonian dentintion, coupled with slender postcranial bones indicative of cursorial habits. This species is considered to be ancestral to Equus hydruntinus, a small-sized equid from the Middle Pleistocene to the Recent. This species shares the postcranial slenderness and the stenonian dentition with the former, but it is considered to be a hemionine on the basis of DNA analysis and cranial morphology. The third species tentatively recorded from Vallparadís, Equus ferus, is a middle-sized equid from the Middle Pleistocene, which combines of a typically caballine dentition with robust postcranial bones. This species, ancestral to the extant wild horse, Equus ferus przewalskii, as well as the domestic horse, might be either a descendant of the European E. major-E. suessenbornensis lineage or an American incomer. The significance of Vallparadís for understanding the replacement of stenonian equids by caballines and hemionines in southern Europe is discussed.

Poster Session II, (Monday)

PALEODIET AND RESOURCE PARTITIONING IN EARLY EOCENE HERBIVOROUS MAMMALS FROM THE BIGHORN BASIN, WYOMING: EVIDENCE FROM DENTAL MICROWEAR

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The hothouse climate of the early Eocene suggests that geographically northern ecosystems of the time, such as the North American interior, may have ecologically resembled recent rainforests with herbivore faunas that fed on lush understory vegetation with high amounts of frugivory. We investigated the dental microwear patterns of five early Eocene herbivores from the Bighorn Basin, Wyoming, during the WA3 interval (54.4-54.1 MA) of the Wasatchian age, including two phenacodontids (*Ectocion osbornianus*, *Phenacodus* sp.), two perissodactyls (*Arenahippus aemulor*, *Homogalax protapirinus*), and a large pantodont (*Coryphodon* sp.). Using digital photographs of molar wear surfaces taken at 100x, pits and scratches were partitioned into discrete size categories and counted in a 2.25×10^4 μm^2 area. For each specimen, images were taken on a buccal cusp, a lingual cusp, and in a bucco-lingually intermediate position. No significant difference was found in the numbers of microwear features counted in different positions of the tooth so the microwear data of the three areas were averaged. The microwear patterns of all five taxa examined included dense concentrations of scratches <20µm wide and pits <50µm diameter. Earlier analyses of stable isotopes suggest that early Eocene ungulates of the Bighorn Basin occupied open canopy forests with larger species adopting more folivorous diets and smaller species more frugivorous diets. Microwear data are consistent with this interpretation, although strictly folivorous browsing diets may not have been present. Likewise, pits >50µm diameter, such as those seen in peccary and other rooters and seed predators, are absent. *Coryphodon*, the largest of the species examined, shows fewer wide scratches (5-20µm width) and large pits (20-50µm diameter), suggesting smaller-grained abrasives, whereas the slightly "coarser" nature of the microwear of the smaller species may indicate hard object feeding and/or a greater amount of grit contamination. However, the interspecific differences in these microwear data are minor and seem to indicate generalized diets with a high degree of similarity in dietary texture and possibly feeding preferences.

Technical Session XVI, Wednesday 1:45

TOTAL EVIDENCE ANALYSIS OF THE ANTILOPINAE WITH IMPLICATIONS FOR THE EARLY HISTORY OF AFRICAN ANTELOPES

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Antilopinae are one of the least understood groups of bovids. They include the Antilopini and the Neotragini tribes, i.e. gazelles and other species living in open habitats and feeding predominantly on grass, specialized browsers such as the gerenuk, and some of the dwarf antelopes like the dik-diks that live in pair territories and occupy more closed habitats. Neither molecular nor morphological analyses agree on a phylogeny of this group. Antilopinae are important for understanding the early evolutionary history of African antelopes (i.e. Aegodontia, which include Antilopinae and all other non-bovine bovids), as the dwarf antelopes are assumed to show many of the primitive characters of this large group of bovids. Some fossil groups have been included in Antilopinae (e.g. *Homoiodorcas*, and many extinct species assigned to the largest and most wide-spread genus Gazella) but their relationship to other species in Antilopinae was never tested in a phylogenetic analysis.

Here we present a phylogenetic analysis of Antilopinae, sampling every genus of living species and some fossil specimens. The tree was built using molecular sequences of eight genes, morphological characters from skulls, and data on chromosome rearrangements and behavior. It shows a high resolution for the living species and allows first hypotheses on the placement of fossils like *Homoiodorcas*. We found convincing evidence for the monophyly of the dwarf species, which implies that some of their shared characters (e.g., small body size, pair territories, short horns) are not primitive but derived characters within Antilopinae.

Technical Session XVIII, Wednesday 2:45

ANURAN ASSEMBLAGE FROM THE LOWER CRETACEOUS OF SPAIN: NOVEL INSIGHTS ON THE BASAL RADIATION OF CROWN-CLADE ANURA

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The Cretaceous Konservat-Lagerstätte of Las Hoyas is world-known for the innumerable well-preserved remains of plants, invertebrates, and aquatic, as well as terrestrial, vertebrates that it has produced. The fossils are contained in laminated fine-grained carbonates of the Barremian La Huérguina Limestones Formation, which outcrops in the Serranía de Cuenca, east-central Spain. A total of fifteen mostly articulated anuran specimens from this fossiliferous site, some of which belong to either tadpoles at advanced stages of metamorphosis or to recently metamorphosed individuals, were studied. Some of these specimens minimally represent a taxon that is either a stem group pipoid or a member of Xenoanura (= Pipoidea); this placement is based on the fusion of the frontoparietals into an azygous element and a parasphenoid that lacks alae underlying the otic capsules. However, the presence of plesiomorphic features, such as ectochordal vertebrae and five pairs of ribs during development, suggests that this taxon is basal to crown Pipidae. Other specimens represent two taxa that belong to the costatan lineage based on the postmetamorphic retention of two or three pairs of ribs, and the presence of eight presacrals and urostylar transverse processes. Three of these specimens, which belong to adult individuals, are characterized by a distinctive skull that is longer than wide, relatively narrow neurocranium, toothed maxilla bearing a conspicuous palatine process, maxillary-squamosal contact, transverse processes of posterior postsacral vertebrae slightly anteriorly directed, moderately expanded sacral diapopyses, and separate tibiale and fibulare. This suite of characters distinguishes these specimens from all described Cretaceous taxa. Other specimens with ectochordal presacral vertebrae, which are not ´present in extant costatans, have an overall resemblance to the nearly coetaneous *Eodiscoglossus santonjae* from northeastern Spain, although there are conflicting interpretations of several features of the latter taxon. The Las Hoyas material thus provides new evidence on the evolution of some of the most basal lineages of crown-anurans.

Poster Session IV, (Wednesday)

EARLY EOCENE CHALICOTHERE *LITOLOPHUS* (PERISSODACTYLA, MAMMALIA) POSSESSES HOOFLIKE UNGUALS RATHER THAN CLAWS

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The advanced forms of chalicotheres are characterized by bearing claws instead of hoofs. However, the question of whether early chalicotheres possess claws as the advanced forms did has puzzled paleontologists for a long time. Fortunately, new materials of Early Eocene chalicothere *Litolophus gobiensis*, including ungual phalanges, were unearthed recently from basal Arshanto Formation, Erlian Basin, Nei Mongol, China. The unguals of *Litolophus* are characterized by being wider than high, proximo-distally compressed with two foramina placed laterally, and by having relatively deep and wide sagittal notches, pointed distal angles, and the distal ends as thick as proximal ones. Preliminary comparisons of *Litolophus* unguals with those of some perissodactyls, including brontotheres, amynodontids, tapiroids and advanced chalicotheres, show that the unguals of *Litolophus* display a combination of features present in other perissodactyl groups even including advanced chalicotheres. The combined features of *Litolophus* unguals include: (1) truncate contours, distal ends as thick as proximal ones and two laterally placed foramina, which are shared with some hoof-reduced brontotheres and amynodontids; (2) pronounced sagittal notches and distal angles, which are the traits of most tapiroids with relatively well-developed hoofs; (3) two laterally placed foramina and relatively deep sagittal notches, which represent characters of claws of advanced chalicotheres. In general, the unguals of *Litolophus* are morphologically more similar to hoofs than to claws, however, the combination of characters make them differ from any other perissodactyl hoofs and/or claws.With respect tolocomotion, *Litolophus* probably has a semidigitigrade stance, in which the disto-ventral portions of the ungual phalanx contact the ground and the basal phalanx hyperextends to some extent, resulting inthe middle phalanx being free of the ground. This pattern of locomotion is similar to that of some advanced chalicotheres, and implies the trend towards claws in advanced chalicotheres.

Poster Session IV, (Wednesday)

INVESTIGATING TITANOSAUR EVOLUTION USING PHYLOGENETIC ANALYSIS

BARNES, Rosie, University College London, London, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom; BARRETT, Paul, Natural History Museum, London, United Kingdom

Titanosaurian dinosaurs appeared in the Middle Jurassic, persisting until the end-Cretaceous mass extinction. Whilst other sauropod groups were in decline, titanosaurs underwent a mid-Late Cretaceous radiation. They were a highly diverse clade, known from all continents except Antarctica, making them an excellent group for testing biogeographic hypotheses; however their intra-relationships are poorly understood. A data matrix comprising 365 characters for 38 taxa (33 ingroup titanosaur genera) was constructed in Mesquite. This included revised character scores for *Jainosaurus* and *Euhelopus*, and two ingroup taxa (*Maxakalisaurus* and *Amargatitanis*) that have not appeared previously in cladistic analyses. Analysis of this matrix using TNT yielded 41,565 most parsimonious trees of length 1,068. The resulting strict consensus shows notable differences in topology to previous analyses, and provides further resolution of titanosaur relationships. *Euhelopus* is basal to *Jainosaurus* as indicated in recent redescriptions. In the more derived part of the strict consensus, *Nemegtosaurus, Rapetosaurus* and Saltasaurinae form a polytomy with 6 other genera. However, the presence of *Andesaurus* in this polytomy is anomalous, as all previous analyses have placed it in a basal position within Titanosauria. *Maxakalisaurus* is basal to the Saltasaurinae, but the expected relationship with *Isisaurus* is ambiguous as these taxa are in a polytomy. Previous work has suggested that *Gondwanatitan* lies outside the Saltasaurinae, but in a more derived position than *Andesaurus* and *Malawisaurus*, and is closely related to *Aeolosaurus*: however, here *Gondwanatitan* is recovered near the base of Titanosauria. *Amargatitanis* is found to be an early derived titanosaur, which is consistent with previous interpretations. This analysis produces a substantial improvement in resolution relative to previous work, but inclusion of additional taxa and new characters, and revision of existing characters are required in order to resolve the fine details of titanosaur phylogeny.

Technical Session IX, Tuesday 12:00

HOW PRESENT EXTINCTION RATES COMPARE WITH MASS EXTINCTION RATES: INSIGHTS FROM MAMMALS

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There is little doubt that present-day species are going extinct at an alarming rate, but it has been difficult to assess how current rates compare with those that are measured over geological time. The problem in comparing modern rates with fossil ones – either those characterizing mass extinctions or normal background extinction rates – is twofold. First, the paleontological record in most cases is not resolved enough to discern details of extinction rates that operate on time-scales less than a few tens of thousands of years, whereas modern rates are measured over tens or hundreds of years. Second, empirical measurements of extinction rates indicate an inverse relationship between the absolute value of the maximum apparent rate and the time-interval over which the rate was calculated. Also, the variation in apparent rates is inversely correlated with measurement interval. The net effect is that rates measured over a few centuries very likely will appear much higher or much lower than rates averaged over thousands or millions of years. Only if the short-term rates rise above statistical expectations do they robustly indicate we are in an extinction crisis. Here we use the rich fossil and modern record of mammals to set modern extinction rates in the context of this statistical interval-rate effect. We find that even under this conservative approach, extinction rates of mammals today and in the very recent past appear elevated compared to normal background rates. If all currently endangered mammals go extinct within the next 500 years, then mammal extinction rates would approach or exceed those that characterized the 'Big Five' mass extinctions. This speaks to the urgency of ensuring the survival of endangered species.

Technical Session XIV, Wednesday 10:30

A DEFINITIVE SPINOSAURID THEROPOD FROM THE LOWER CRETACEOUS OF AUSTRALIA AND ITS IMPLICATIONS FOR GONDWANAN PALEOBIOGEOGRAPHY

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A cervical vertebra from the Lower Cretaceous Eumeralla Formation of southeastern Australia represents the first definitive spinosaurid dinosaur from East Gondwana. It can be identified as a spinosaurid by one synapomorphy, a fine lamina that internally divides the central pneumatic foramen, and a combination of characters unique to the clade. In overall morphology, the Australian cervical is exceptionally similar to *Baryonyx* (Barremian, UK). It is opisthocoelous, more than twice as long as broad, dorsoventrally depressed, and lacks the camellate internal architecture present in Cretaceous allosauroids. A previous report of an Australian spinosauroid (cf. *Megaraptor*) has been shown to represent a neovenatorid allosauroid. Discovery of an Early Cretaceous Australian spinosaurid significantly extends the geographic distribution of the group, which is otherwise known from South America, Europe and eastern Asia at this time. It also adds to the Otway Group theropod fauna, which minimally comprises a tyrannosauroid, oviraptorosaur, neovenatorid, and abundant indeterminate material. Similar taxa are known from coeval Laurasian sites, suggesting a longer interval for faunal exchange between Gondwana and Laurasia, and across Gondwana, than previously appreciated. For example, *Fukuiraptor* (Aptian-Albian, Japan) has been posited as the sister-taxon of *Australovenator* from Queensland. Similarly, the hitherto unexpected presence of tyrannosauroids and oviraptorosaurs in Australia demonstrates that 'Laurasian' taxa were present in Gondwana, suggesting that all of these groups had potentially cosmopolitan late Mesozoic distributions. Theropod phylogenies predict the origins of major coelurosaurian clades in the Middle Jurassic, an inference supported by new discoveries (e.g., *Proceratosaurus*). Consequently, these occurrences in the Gondwanan Early Cretaceous imply that many theropod lineages were present in areas/intervals that remain poorly sampled (e.g., Africa, India, Antarctica). Additional fieldwork, and critical reappraisal of historical material, is likely to yield additional surprises in the poorly known Middle Jurassic to Early Cretaceous sediments of Gondwana.

Technical Session V, Sunday 4:00

NORTH AMERICAN LATE PLEISTOCENE EQUIDS (MAMMALIA, PERISSODACTYLA): A GEOMETRIC MORPHOMETRIC STUDY OF THE UPPER PREMOLARS

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The taxonomy of North American late Pleistocene equids continues to be an area of contention. The latest morphological revisions point to the validity of three to as many as ten species. In contrast, molecular studies suggest that only two species should be recognized: a stout-legged caballine and a stilt-legged form. Most morphological revisions have concentrated on cranial and postcranial material, whereas the study of the cheek tooth dentition has been limited to simple observations and measurements. In this study, geometric morphometric techniques were used to analyze the occlusal pattern of upper premolars with the objective of studying the variation in shape and size, and its potential significance for equid taxonomy and systematics. Twenty-six landmarks were placed on digital photographs of the occlusal enamel pattern of third and fourth upper premolars. Procrustes superimposition and relative warp analysis were performed. Centroid size was calculated as a measure of tooth size. The specimens studied came from different North American late Pleistocene localities ranging from southern Alaska to central Mexico. To control for ontogenetic variation, only teeth at an equivalent stage of wear were analyzed. The results indicate that in terms of shape, as defined by the configuration of landmarks, only two distinct morphotypes are identified in the data set. These correspond to the caballine and stilt-legged groups that have been recognized in other studies. In contrast, there is a large variation in size within these morphotypes, particularly for the caballine group. To a large extent this size variation might be ascribed to geographical variation. However, there are some localities that present a bimodal size distribution within the caballine morphotype. This might represent sexual dimorphism, disruptive selection, or the presence of two separate caballine species. Further analyses employing more specimens and other tooth positions will clarify the size and shape patterns observed thus far. This study highlights the potential of the cheek tooth dentition to provide insights into the taxonomy and systematics of North American late Pleistocene equids.

Poster Session III, (Tuesday)

CRANIAL MORPHOLOGY OF *THYROHYRAX DOMORICTUS* (HYRACOIDEA: MAMMALIA) FROM THE EARLY OLIGOCENE OF EGYPT

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The Jebel Qatrani Formation in the Fayum Depression, Egypt, has yielded a diverse hyracoid fauna that includes both small- and large-bodied forms. *Thyrohyrax domorictus* is one of the most common hyracoids found in the upper sequence of the Formation, from sites dating to between 29-30 Ma. The dental morphology of *T. domorictus* is more similar to that of living hyraxes than other Paleogene species, but additional morphological evidence is needed to test the hypothesis of procaviid affinities. Two fairly complete crania and other cranial fragments of *T. domorictus* are now known and provide a number of additional craniofacial characters for phylogenetic analysis. The specimens are comparable in size to other small-bodied Fayum hyracoids and extant procaviids. *T. domorictus* has a relatively long rostrum that is perforated by a nasomaxillary fossa, which is also present in Miocene *Afrohyrax* and *Prohyrax* and older *Thyrohyrax pygmaeus.* The frontal bones are smooth and flat and the temporal and sagittal crests are well-developed. The orbit is positioned above the molars and is closed posteriorly by a complete post-orbital bar that bears a small parietal contribution as in extant procaviids. A complete post-orbital bar is also present in Miocene *Prohyrax*, but this species lacks a parietal contribution. Compared to other Fayum hyracoids, *T. domorictus* exhibits relatively derived, and more procaviid-like, cranial morphology. The cranium of *T. domorictus* is most similar to the extant genus *Dendrohyrax*, a form that has a relatively long rostrum compared with other procaviids, and which shares a similar morphology of the orbit and cranial roof with *T. domorictus*. Phylogenetic analysis including morphological and molecular data from a large sample of living and extinct afrotherians places *Thryohyrax domorictus* as the closest known Paleogene relative of Procaviidae, supporting the hypothesis of procaviid affinities that was originally proposed solely on the basis of dental morphology.

Poster Session III, (Tuesday)

THE EVOLUTION OF BODY SIZE, STANCE AND GAIT IN ALLOSAUROIDEA (DINOSAURIA: THEROPODA)

BATES, Karl, University of Manchester, Manchester, United Kingdom; BENSON, Roger, University of Cambridge, Cambridge, United Kingdom; PETER, Falkingham, University of Manchester, Manchester, United Kingdom

Allosauroids were a diverse group of non-avian theropods that dominated predatory niches in terrestrial ecosystems for much of the Mesozoic. Cladistic analyses have highlighted contrasts in pelvic limb osteology between basal allosauroids and the derived clade Carcharodontosauria, which have modified the iliac blade, pubic boot, femoral head and condyles. Myological reconstructions indicate that pelvic limb synapomorphies of carcharodontosaurians are not associated with restructuring of hind limb musculature. Similarity in centre of mass and muscle moment arm predictions across allosauroids suggest mass distribution and 3D muscle mechanics remained fundamentally unchanged. Most proportional changes in long bones are attributable to body size: similar allometric patterns are present in *Allosaurus* and across allosauroid taxa; although megaraptorans have elongate distal limb bones. While allosauroid femoral diameters show near-isometry, the moment arms of major hip extensors exhibit positive allometry, which likely evolved as a measure to support the limb as mass increased. Horizontally orientated femoral heads in non-carcharodontosaurians are associated with augmented mediolateral midshaft diameters relative to dorsally inclined femora in carcharodontosaurians. The same morphological correlations are present in extant bovids, where it is suggested that greater mediolateral diameter reflect higher bending loads incurred directly from the horizontal orientation of the femoral head. Dorsal inclination of the femoral head may therefore have reduced bending stress in the femoral head and shaft in carcharodontosaurians. Carcharodontosauria includes the smallest and largest allosauroids, and primitive members of its component clades had intermediate body sizes. Therefore adaptations for improved weight support appeared independent of any change in size and prior to the evolution of large bodied multi-ton taxa. Similar changes occurred independently in the evolution of tyrannosaurids suggesting that these features are important and may be related to body size, either as functional requirements or as adaptive morphologies predisposed by large size.

Edwin H. and Margaret M. Colbert Prize Competition, (Monday)

VARIATION IN SKELETAL TAPHONOMY OF MARINE REPTILES FROM THE MIDDLE TRIASSIC OF MONTE SAN GIORGIO, SWITZERLAND

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Taphonomic evaluations of fossil vertebrates are crucial to elucidate the processes that affected a carcass in the interval between death and burial. Most previous studies use the fossils' general appearance to classify its preservation as one of a series of discrete stages; the potential impact of short-term variation in environmental conditions is rarely factored in. Herein, we address these deficits by developing a comprehensive taphonomic model for the skeletal taphonomy of vertebrates using the Middle Triassic marine reptiles from Monte San Giorgio, Switzerland, as a case study. The most common taxa are the free-swimming, marine, pachypleurosaurids *Serpianosaurus* (Anisian-Ladinian: Besano Formation) and *Neusticosaurus* (Ladinian: Meride Limestone).Individuals were semi-quantitatively scored for the articulation and completeness of nine skeletal units: skull, neck, ribs, thorax, the four limbs, and tail, the scores aggregated, and a percentage for each calculated. *Serpianosaurus* and *Neusticosaurus* are almost identical in size and anatomy, therefore any taphonomic variation reflects different pathways in the interval between death and burial. In *Neusticosaurus* articulation varies (40-100%) but completeness is consistently high (>75%). Disarticulation occurred after deposition; disarticulated elements were not removed from the vicinity of the carcass. In *Serpianosaurus* disarticulation and loss of completeness are positively correlated, i.e. disarticulated elements were removed from the remainder of the carcass either while it floated in the water column or after deposition. A prolonged phase of floating is discounted as in individual skeletons paired appendages rarely show similar values for completeness and articulation. In *Serpianosaurus* many smaller skeletal elements (e.g. phalanges) remain *in situ*, but larger elements, notably ribs, are frequently disarticulated on one side of the abdominal region, and clustered adjacent to the carcass. This is attributed to rupture following build-up of decay gases. The absence of the feature in *Neusticosaurus* is due to subtle environmental differences.

Physical Drivers and Marine Tetrapod Evolution, Monday 10:30

DENTAL MICROWEAR OF MODERN AND FOSSIL SIRENIA REFLECTS CHANGES IN THE PHYSICAL ENVIRONMENT IN THE NEOGENE OF FLORIDA

BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA; MIHLBACHLER, Matthew, New York College of Osteopathic Medicine, Old Westbury, NY, USA

Manatees and dugongs are restricted to rivers and coastal habitats, feeding on plants usually bound to a substrate. Peninsular Florida has changed much over time, including a change from carbonate to siliclastic substrates during the Miocene and the emergence of a manatee-dominated ecosystem replacing a dugong-dominated one. This shift is presumably connected, reflecting the specialization of manatee horizontal tooth development as competitively advantageous in dealing with an increased source of abrasives over the primitive tooth replacement found in dugongs. To test this, we looked at dental microwear of all subspecies of modern and fossil *Trichechus* and compared them with Clarendonian and Hemphillian *Metaxytherium floridanum*, as well as *Crenatosiren* and a possible Eocene *Protosiren* for added insight. Using digital photomicrographs taken at 100x, pits and scratches were traced and partitioned into discrete size categories based on widths and diameters, and counted in a $1.6x10^5 \mu m^2$ square area, all by a single observer. Though the location on which teeth were sampled had a marginal effect on the data, ANOVA results indicate that all populations, including comparisons to modern aquarium-housed individuals, were significantly different for all features except for very wide scratches (≥20 µm width) and very wide pits (≥50 µm width). Curiously, *T. manatus* had more scratches than *T. inunguis*, suggesting that microwear features in marine herbivores are less likely a reflection of wear by phytoliths and more likely wear by siliclastic substrate exposure. Rancholabrean *T. m. bakerorum* appear to have had fewer scratches and Irvingtonian *T. manatus* even fewer, but with more pits. Clarendonian *Metaxytherium* appear to have had many pits and scratches, compared to Hemphillian *Metaxytherium* which had similar numbers of pits, but fewer scratches. More data is needed to determine what the causes of dental microwear is for aquatic herbivores, yet our data suggests that microwear reflects measurable changes in feeding ecology, whether it be substrate or dietary composition, were experienced by *Metaxytherium* from the Middle to Late Miocene and *Trichechus* throughout the Pleistocene.

Poster Session I, (Sunday)

INCONGRUENCE BETWEEN MORPHOLOGICAL DATA PARTITIONS: AN EXAMPLE FROM THE FOSSIL RECORD OF THE ARCHOSAUROMORPHA

BENNETT, S. Christopher, Fort Hays State University, Hays, KS, USA

Testing morphological and molecular data sets against one another for incongruence has become commonplace; however, testing for incongruence can also be done with partitioned morphological data sets from fossil taxa. As a demonstration a published data set of 126 morphological characters from 14 archosauromorph taxa, in which most taxa are known only from fossils, was partitioned into five partitions: one with characters associated with digitigrade bipedal cursorial locomotion, and the other four with characters from the skull and mandible, postcranial axial skeleton, forelimb, and hindlimb, respectively. Homogeneicity testing using PAUP showed that the Cursorial partition is incongruent with other partitions and with all other characters at the P=0.01 probability level. In order to identify the source of the incongruence, each taxon was deleted and the partitioned data set from the remaining 13 taxa was tested for homogeneicity. Significant incongruence remained after deletion of 13 of the taxa, whereas deletion of one taxon, the Pterosauria, removed all significant incongruence, demonstrating that the incongruence resulted from the coding of that taxon for the cursorial characters. The cause of the incongruence was interpreted as homoplasy in hindlimb morphology, and after reevaluating and revising the characters of the Cursorial partition, a revised data set was tested for homogeneicity and had no significant incongruence between partitions.

Poster Session III, (Tuesday)

MORPHOMETRIC ANALYSIS OF CRANIAL SHAPE IN FOSSIL AND RECENT EUPRIMATES

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Quantitative analysis of morphology can recognize subtle patterns in morphological evolution and identify convergences that can aid ecological interpretations of extinct taxa. Here, we use geometric morphometrics to analyse skulls from 28 modern and extinct genera of euprimates, including the Eocene adapiforms *Adapis* and *Leptadapis*, and the Quaternary lemurs *Archaeolemur, Palaeopropithecus*, and *Megaladapis,* to test if fossil primates occupy the same regions of morphospace as their extant relatives and to identify any convergence in cranial morphology across fossil and extant primates. 33 landmarks were gathered with a Microscribe 3-D digtizer from a total of 382 specimens. Data were treated with Procrustes superimposition to remove all non-shape differences and then subjected to Principal Components Analysis. PC1 (25.7% of the total variance) divided haplorhines, with wide and short skulls, at the negative end from strepsirrhines and most fossil taxa, with long and narrower skulls, at the positive end. *Megaladapis* defines the positive extreme of this axis, while howler monkeys and *Archaeolemur* overlap in the middle. PC2 (16.5%) involved a shift from a long vault and short, wide face towards a shorter vault and longer face. Haplorhines, strepsirrhines and adapiformes overlap at the negative end of PC2, whilst haplorhines such as *Gorilla* and *Pan* defined the positive end. PC3 (7.2%) chiefly showed widening and ventro-dorsal shortening of the vault with tarsiers at the positive extreme, *Archaeolemur* and *Cacajao* at the negative extreme and adapiformes overlapping with most haplorhines and strepsirrhines in the middle. On PC4 (5.2%) *Alouatta* and *Megaladapis* lie at the positive end*,* with a narrower and shorter cranial vault, while the other strepsirrhines and some haplorhines overlap at the negative end of PC4. Although strepsirrhines and haplorhines are generally distinct in morphospace, there is some overlap along the major axes of variation. Most adapiforms fall within or close to strepsirrhine space, while Quaternary lemurs deviate from extant strepsirrhines, either exploring unique regions of morphospace or converging on haplorhines.

Poster Session III, (Tuesday)

QUANTIFYING COLLECTION BIAS AND ASSESSING PALEOECOLOGICAL UTILITY OF MICROVERTEBRATE FOSSILS FROM ANTHILLS

BENNETT, III, George, Shenandoah Valley Discovery Museum & George Mason University, Winchester, VA, USA

Throughout the semiarid and arid portions of North America the harvester ant (*Pogonomyrmex*) is known to collect pebbles and debris in order to coat the surface of its mounds, and in the process can concentrate vertebrate microfossils enabling easy surface collecting or screen washing. It is intuitively apparent that collecting from such anthills will yield smaller skeletal elements than general surface collecting as a result of the limited strength of the ants. But how much collection bias results from anthill mining? Is there useful paleoecological information to be gleaned from such sites when compared to conventional screen washing and surface collecting? A series of localities in the upper Hell Creek Formation of eastern Montana have been evaluated by surface collecting, screen washing anthills, and conventional screen washing. The conical, shed teeth of fish, lizards, champsosaurs, dinosaurs, and crocodilians (n=395), were measured and used to analyze the size-class distribution and taxonomic diversity recovered by these three collection methods. Data show that conventional screen washing consistently does not sample the smallest (<5mm) skeletal elements and that anthill recovered specimens make up over 80% of specimens in that size category. Likewise, fossils over 15mm are underrepresented not only on anthills but also when using conventional screen washing. At a single site well-sampled by all three methods, anthill screen washing produced the greatest taxonomic diversity (n=10). Overall, anthill collection yielded nearly two thirds of the teeth (n=248) and the only record of the theropod dinosaur *Troodon*. Although fossils gathered by ants are out of stratigraphic context, they expose a portion of the thanatocoenose that is commonly underrepresented. Detecting the smallest taxa or assessing size-class structure by recovering the smallest individuals of a taxon is best accomplished by combining anthill screening with traditional screen washing where possible.

Preparators' Session, Monday 8:30

LONG TERM DOCUMENTATION OF THE CONATA PICNIC GROUND SITE (BIG PIG DIG) BADLANDS NATIONAL PARK, SOUTH DAKOTA

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In August of 2008, the Conata Picnic Ground Site (Big Pig Dig) was closed after itsfifteenth and final field season. All known paleontological accumulations had been mapped and excavated.Because of its scientific significance and unique occurrence, park management felt it was important to establish some type of long term documentation of the site. The goal was to choose a site and grid marker system that future research groups could easily locate and possibly use if a new quarry were to be established. Several different types of monuments were evaluated based on their composition and their position above or below ground. Issues that were considered included the highly corrosive alkaline soils, snow plow and construction activity along a nearby county road, potential flooding at the site and the ability to locate the monuments in the next 50 to100 years. A final decision was made to use stainless steel engraved survey markers with 3 inch tops and 18 inch spikes encased in a 12 inch diameter concrete cylinder. The top of each stainless steel monument was engraved with the words origin, backsite and easting respectively. The word Pig Dig was written into the surrounding concrete. A magnet was also inserted in the concrete so the monuments could be located with a metal detector. The monuments were set 2 feet below grade to ensure that they would not be disturbed by any future surface activity. Information about the monuments will be included in the final report summarizing the site, all associated publications, and in thefield notes archived in the park collections facility. Several challenges were encountered during the monument installation. An *Archaeotherium* cranium was discovered directly under the origin stake and had to be excavated before the origin stake could be replaced. A total station was needed to complete the replacement of the origin, backsite and easting rebar stakes with the stainless steel monuments.

Evolution of the Modern African Fauna, Wednesday 11:30

EVOLUTIONARY HISTORY OF THE AFRICAN EQUIDAE

BERNOR, Raymond, Howard University, Washington, DC, USA; GILBERT, William, California State University, East Bay, Hayward, CA, USA; WOLF, Dominik, Howard University, Washington, DC, USA

African Equidae are known from localities of late Miocene to Recent age. Three-toed equids of the tribe Hipparionini first appear in the earlier late Miocene and persist well into the middle Pleistocene. The first appearance of *Equus* in eastern Africa is in the Omo Shungura sequence (lower Member G) at ca. 2.36 Ma. This is somewhat later than in Eurasia, where *Equus* first appears at 2.6 Ma. We recognize a diverse assemblage of African hipparions, including the following supraspecific groups: *"Cormohipparion,"* ?*"Sivalhippus," Eurygnathohippus*, *Cremohipparion*, and possibly *Hipparion* s.s. (the last two in northern Africa only). The earliest equid in Africa, *"Cormohipparion,"* is a descendant of the North American genus *Cormohipparion* that first occurred in the Old World at 11.2 Ma and is first known to occur at 10.5 Ma in North Africa. The taxon ?*"Sivalhippus"* refers to a late Miocene (ca. 9 Ma) group of African and South Asian hipparions currently undergoing systematic revision. The Eurasian genera *Hipparion* s.s. and *Cremohipparion* apparently made a successful range extension into northern Africa during the late Turolian, ca. 7 Ma, where they are reported from Sahabi, Libya. *Eurygnathohippus* is a genus of African Hipparionini that first appears in the late Miocene Nawata Formation, Kenya, and successfully radiated throughout unforested Africa in the late Miocene-Pleistocene. The last occurrence of *Eurygnathohippus* is at circa 1.0 Ma when the most derived form, *E. cornelianus* occurred in eastern and southern Africa. Extant Old World *Equus* includes caballine horses, hemionines, and the African asses and zebras. Late Pliocene-early Pleistocene African *Equus* (*E. oldowayensis* and *E. koobiforensis*) is large and similar to Eurasian *Equus stenonis*. Smaller forms are present in Africa by the later early Pleistocene. Several African Pleistocene localities are shedding new light on the origin of African asses and zebras, but their relationships to earlier clades of Old World *Equus* have not been established. We update our understanding of later Neogene African equid systematics and biogeography including recently published genomic data on Holarctic and African *Equus.*

Poster Session IV, (Wednesday)

DESCRIPTION OF THE OLDEST CAVIOMORPHS AND A PHYLOGENY OF THE GROUP'S INITIAL RADIATION

BERTRAND, Ornella, University Montpellier II ISE-M and American Museum of Natural History, New York, NY, USA; FLYNN, John, American Museum of Natural History, Division of Paleontology, New York, NY, USA; CROFT, Darin, Case Western Reserve University, Department of Anatomy, Cleveland, OH, USA; WYSS, Andre, University of California, Department of Earth Science, Santa Barbara, CA, USA

South America was an isolated island continent during most of the Cenozoic, resulting

in highly endemic land mammal faunas. Traditionally, the beginning of G.G. Simpson's "Stratum 2", the Deseadan SALMA (late Oligocene) had marked the sudden appearance of hystricognath (caviomorph) rodents. The oldest known caviomorphs were from sequences in Patagonia and Bolivia, and arguably the recently described fauna from Santa Rosa (Perú). Since the late 1980s, the Andean Main Range of Chile has become recognized as one of the continent's best archives of Cenozoic mammal evolution. The Tinguiririca Fauna (Chile) forms the basis for the Tinguiririan SALMA (spanning ~33-31 Ma), a biochronologic interval interposed between the Mustersan and the Deseadan of the classical SALMA sequence. Including the oldest caviomorphs, this may be the most important transitional Eocene-Oligocene fauna known from South America.

The timing of the split between New and Old World hystricognaths as well as the source area and dispersal mechanisms for the arrival of caviomorphs in South America have not yet been resolved. We describe two caviomorphs recovered from the Tinguiririca Fauna, each represented by a single lower jaw with a complete tooth row. We place these taxa within a phylogenetic context via a parsimony analysis of a newly created matrix containing over 30 taxa and more than 120 dental characters. This is the first attempt to elucidate phylogenetic relationships among Deseadan and Tinguiririan caviomorph genera. This analysis confirms that the new Chilean caviomorphs each represent new species, a chinchillid and a dasyproctid. These results further demonstrate that Caviomorpha in general, and these two clades in particular, had already begun to diversify prior to the earliest Oligocene (31-33 Ma). Therefore, the initial immigration of this group to South American was older than previously documented and most likely occurred during the mid-late Eocene—i.e., probably at some point after the poorly dated Mustersan SALMA, an interval during which rodents are entirely unknown.

Technical Session V, Sunday 3:15

MIO-PLIOCENE FAUNAL EXCHANGES BETWEEN EURASIA AND AFRICA: THE RECORD OF RARE BOVID TAXA

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Three fossil bovid taxa previously known only from Eurasian deposits are newly documented from the Mio-Pliocene assemblages of the Middle Awash (Afar Region, Ethiopia). These are *Prostrepsiceros vinayaki*, *Pachyportax latidens*, and ?Caprini cf. *Protoryx/Pachytragus*. All three constitute first records for these taxa in Africa, *Pr. vinayaki* and *Pa. latidens* otherwise known only from the Siwaliks (Pakistan and India) and the Baynunah (United Arab Emirates). The probable caprin is indeterminate to genus or species but bears strong resemblance to *Protoryx* and *Pachytragus*, documented from the Greco-Iranian province. These three bovids significantly augment the record of sub-Saharan fossil taxa of Eurasian affinities, demonstrating stronger biomic connections between sub-Saharan Africa and southern Asia in the Mio-Pliocene than later in the Pliocene and Pleistocene. The three Middle Awash taxa are also very rare, being represented by only one or two specimens each from otherwise rich assemblages, highlighting the importance of an attentive specimen-based approach to fossil assemblages for elucidation of past evolutionary and biogeographic trends. The record of East and southern African fossil bovids of Eurasian affinities is reviewed, including the reduncin *Kobus porrecticornis* and species of "Boselaphini" (*Tragoportax* spp.).

Poster Session II, (Monday)

MODELING THE MANDIBULAR MORPHOLOGY AND MASTICATORY MECHANICS OF EOCENE MAMMALS: A 3D LASER SCANNING APPROACH

BILLIAN, Joseph, Western Michigan University, Kalamazoo, MI, USA; ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA

Along with their characteristic differences in dentition, modern carnivores and herbivores have evolved strikingly distinct mandibular morphologies related to their different means of acquiring and masticating food. Modern carnivores utilize a powerful, slicing bite between carnassial teeth (upper fourth premolar and lower first molar) powered by the large temporalis muscle, which inserts into a tall mandibular coronoid process. The dentary- squamosal joint of carnivores is low, essentially in line with the maxillary tooth row. In contrast, modern herbivores chew with a side-to-side grinding motion that is dominated by the masseter muscle, have little or no coronoid process, and have a dentary-squamosal joint that is placed high above the maxillary tooth row. When these functional adaptations first appeared can only be answered by a consideration of the morphology and mandibular mechanics of fossil mammals. We used a desktop laser scanner to develop three dimensional models of the mandible of two extant mammals (cat and rabbit), and compared these with a fossil carnivore (*Miacis latidens)* and perissodactyl (*Lambdotherium popoagicum)* from early Eocene deposits in Wyoming's Great Divide Basin. We used Greaves' biomechanical model for estimating bite force mechanics in order to determine whether the Eocene taxa had evolved mandibular morphology and masticatory mechanics that were comparable to modern carnivores and herbivores. Our results indicate that early Eocene *Lambdotherium* already closely resembled modern herbivores with respect to the main direction of bite force that it was able to exert during mastication. *Miacis*, on the other hand, had not yet developed a posteriorly oriented bite force similar to that seen in modern carnivores.

Technical Session VIII, Monday 2:45

TOOTH-LIKE LIP AND CHEEK SCALES IN EARLY GNATHOSTOMES FROM THE MACKENZIE MOUNTAINS, NORTHWEST TERRITORIES, CANADA

BLAIS, Stephanie, University of Alberta, Edmonton, AB, Canada; MACKENZIE, Lindsay, University of Montana, Missoula, MT, USA; WILSON, Mark, University of Alberta, Edmonton, AB, Canada

The Man On The Hill (MOTH) fossil assemblage from the Mackenzie Mountains, Northwest Territories, has yielded hundreds of specimens of Early Devonian (Lochkovian) vertebrates, including numerous species of agnathans, chondrichthyans, and acanthodians. These specimens are incredibly well preserved and may exhibit features that are not preserved in other localities to the same degree. One such feature, common in MOTH specimens of ischnacanthid acanthodians, is the presence of modified head scales in the region of the lips and cheeks, the scales becoming more tooth-like in morphology with proximity to the mouth. The specimens are laterally compressed, and the scales are preserved superimposed over the labial surfaces of the palatoquadrate and Meckel's cartilages, as well as over the labial surfaces of the tooth-bearing dermal jaw bones unique to ischnacanthids. Although there are three distinct morphological types of cheek scales, they all conform to a general pattern: beginning labial to the outer edges of the jaw cartilages, the rows of scales gradually transition from enlarged head scales to compound structures resembling small tooth whorls that have been unrolled, with the cusps all pointing toward the cleft of the mouth. The upper and lower scales converge at a point approximately halfway along the length of the jaw bones, where a tooth whorl is often preserved. Anterior to this point, the scales are modified above and below the margins of the lips, transitioning from head scales to smaller, needle-like, asymmetrical scales pointing toward the cleft of the mouth. At the front of the mouth, there are large, parasymphyseal tooth whorls. The different cheek and lip scale types vary in the morphology of their cusps. The close similarity of these cheek and lip scales to the actual tooth whorls of these ischnacanthids suggests that they share a common developmental program that is expressed in and near the mouth.

Technical Session III, Sunday 3:45

DISTAL PHALANGES OF EOCENE NORTH AMERICAN NOTHARCTINES (MAMMALIA, PRIMATES): IMPLICATIONS FOR PRIMATE AND ANTHROPOID ORIGINS

BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; RANDALL, Zachary, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; SILCOX, Mary, University of Toronto at Scarborough, Toronto, ON, Canada; CHESTER, Stephen, Yale University, New Haven, CT, USA; BOYER, Doug, Brooklyn College, New York, NY, USA

Presence of nails instead of claws on some or all digits, associated with specialized grasping behaviors, has been recognized as a diagnostic trait of Primates. Discovery of a nail-bearing distal phalanx on the hallux of Paleocene plesiadapiform *Carpolestes simpsoni* suggests that this feature originated earlier in primate evolution than previously supposed. Morphology of the *C. simpsoni* hallucal distal phalanx is not identical to that of extant primates, suggesting the possibility of convergence. When the morphology of Eocene adapoid euprimates is taken into account, this contrast is less marked. Some of the non-hallucal distal phalanges of Eocene notharctines are similar to the hallucal distal phalanx of *C. simpsoni* in being dorsoventrally deeper at the proximal end and recurved towards the tip. Lateral profiles of these phalanges are more "claw-like" than in living primates, suggesting that they may represent a transitional claw-to-nail morphology. Furthermore, partial skeletons of notharctine euprimates from the Bridger Basin, Wyoming, show that distal phalangeal morphology is more variable than previously appreciated. Some elements are short, wide, dorsoventrally compressed and easily recognizable as the hallucal distal phalanx based on their similarity to those of extant lemurs. Others are shorter and less compressed, similar to those of the non-hallucal distal phalanges of lemurs. Still others are elongate, narrow, and somewhat curved in lateral profile, similar to the distal phalanx for the grooming claw in extant strepsirhines and the non-anthropoid haplorhine, *Tarsius*. The range of variation in distal phalangeal morphology of *N. tenebrosus* is similar to that found in lemurs. This variation is consistent with previous observations of one species of European adapoid *Europolemur*, which was interpreted to have a grooming claw. In contrast, the adapoid *Darwinius masillae* was interpreted to have a nail-like structure on all digits, including the second toe. If true, this condition may have been inherited from a common ancestor with living anthropoids that excludes notharctines and *Europolemur*, or have evolved independently.

Poster Session III, (Tuesday)

THREE-DIMENSIONAL DIGITAL RECONSTRUCTION OF FOSSIL BIRDS AND NON-AVIAN THEROPODS PRESERVED IN SLAB AND COUNTERSLAB USING LASER SURFACE SCANNING

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Many vertebrate fossils preserved in thin bedding planes split with fossil bone and impressions thereof distributed irregularly between a slab and counterslab. The unequal distribution of anatomical data over two slabs often confounds straightforward interpretation. In this

study, we used non-contact laser surface scanning to capture detailed digital models of both slabs for several avian and non-avian theropods from the Late Jurassic and Early Cretaceous of China, including the holotypes of the troodontid *Anchiornis* and the basal bird *Eoconfuciusornis*. Scans were made with a Konica Minolta Range7 scanner with a maximum point cloud density of one point per 40 micrometers. Different methods for digitally extracting and reconstructing laser scan surface data were explored using the three-dimensional editing software package Rapidform. Fully three-dimensional skeletal reconstructions are possible when skeletal elements are accessible from every aspect, or when a particular bone or skeleton is preserved as a natural mold on both the slab and counterslab. More commonly, however, a bone exposed on one slab is matched by a mold on the other, so that the two slabs preserve redundant information from the same bone surface. By digitally aligning slab and counterslab scans and deleting concave molds that would otherwise overlap with positive skeletal topography from the opposite slab, data from both slabs can be merged into a single digital model that exhibits all available anatomical information in the correct three-dimensional spatial arrangement. The merged digital models enable the simultaneous inspection of countersurface anatomy of fragmented skeletal elements and facilitate both visual and quantitative examination. Although laser surface scanning cannot reveal surfaces buried in slab or counterslab in contrast to computed tomography (CT) scanning, this new methodology allows for a relatively rapid and cost efficient integration of fossil slab data that is not significantly constrained by large specimen size or radiographic contrast between bone and matrix.

Poster Session II, (Monday)

PALEOENVIRONMENTAL INTERPRETATION OF THREE CHADRONIAN (LATE EOCENE) MAMMALIAN FAUNAS FROM THE MID-CONTINENTAL U.S., BASED ON BODY SIZE DISTRIBUTIONS

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One of the richest and best preserved sequences of late Eocene and early Oligocene mammals in the world occurs in deposits of the western Great Plains and Rocky Mountain region. In spite of the richness of these faunas, paleoenvironmental interpretations for this interval are still somewhat uncertain, ranging from savanna to closed forest based on conflicting proxies. Here we use ranked body size distributions (cenograms) in three middle Chadronian mammalian faunas to infer paleohabitats and climatic conditions. We compare faunas from Flagstaff Rim (Wyoming) and northwestern Nebraska in the White River Group (or Formation), and the Renova Formation of southwestern Montana (Pipestone Springs l.f.). The distribution of body size, as calculated from the area of the lower first molar (m1), indicates that all three faunas are composed predominantly (52-62%) of taxa weighing under 0.5 kg (i.e. small-bodied mammals). This distribution is similar to that seen in modern forests and woodlands. Several parameters of ranked body weight graphs, determined from modern studies, can be used to assess the structure of local vegetation (closed vs. open habitat) and environmental moisture (rainfall, etc.). The slopes of the medium-sized (0.5 -10 kg) mammals in all three Chadronian faunas (0.42, 0.33, and 0.456, respectively) are indicative of seasonal moisture, with Nebraska being the least seasonal of the three. These slopes likely indicate a dry-season. Minimal offsets (i.e. the gap) in logged body weight between small- and medium-sized mammals are 0.11, 0.34, and 0.37 for the Flagstaff Rim, Nebraska, and Pipestone Springs faunas, respectively. Slopes below 0.5 indicate that these faunas all lived in forested habitats, but that forests in the last two were more open than at Flagstaff Rim. Analyses of trophic categories with regard to body weight indicate that each of the three faunas were dominated by small- to large-sized herbivores, with a relative abundance of small- to medium-sized frugivores. The mid-continental U.S. during the Middle Chadronian, as inferred from body size distributions, was relatively densely forested and experienced seasonal precipitation, which is in general agreement with paleofloral interpretations. Future work will include comparison of late Eocene and early Oligocene habitats based on body size distributions in conjunction with isotopic analysis of tooth enamel to test hypothesized trophic categories.

Poster Session III, (Tuesday)

ESTIMATING TIME RANGES IN PLIO-PLEISTOCENE HOMINIDS

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Estimating the relative abundance of hominids as part of larger vertebrate samples is critical in evaluating the uncertainties associated with first and last occurrences, and therefore with known hominid time ranges. Fossil hominids are notoriously rare, but estimating their abundance in the larger context of fossil vertebrates has been difficult. A key problem is that fossil hominids are consistently sought after and collected, but many of the other vertebrates that co-occur with hominids are not. Here I present data from systematic collection efforts in the Koobi Fora Formation of Kenya and use these data to estimate the relative abundance of hominids in these Pliocene and Pleistocene deposits. The fossils were collected during three field seasons and include nearly 400 specimens. The data are now included in the Turkana Paleontology Database, which is used to provide a larger context for these analyses. The database currently has about 17,000 records of fossil vertebrates collected over the last few decades. The data are used to place error bars on estimates of the time of origination of *Homo* and the extinction of *Paranthropus*. Results show large error bars associated with these events, and thus show that our knowledge of the timing of key events in human evolution remains very poorly constrained.

Poster Session IV, (Wednesday)

3D MORPHOMETRIC ANALYSIS OF THE PRESACRAL VERTEBRAE OF *PLATEOSAURUS*: IMPLICATIONS FOR VERTEBRAL EVOLUTION IN SAUROPODOMORPH DINOSAURS

BOEHMER, Christine, Ludwig Maximilans Universität, Munich, Germany; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

Sauropodomorph dinosaurs are noteworthy for their highly complex and variable vertebral morphology and vertebral count. However, the exact mode and pattern of variation of vertebral count in sauropodomorphs is largely unknown. Thus, it is often uncertain whether additional cervical vertebrae, for example, represent new elements or dorsal vertebrae that have been incorporated into the cervical vertebral column. In the absence of other criteria, such as specific soft tissue associations, or genetic information, vertebral morphology is the only clue to resolve this issue. A distinction between cervical and dorsal vertebrae can usually be established, although there are usually one or two vertebrae which exhibit a transitional condition. With the use of 3D geometric morphometric analysis of the presacral vertebrae of *Plateosaurus*, we are able to objectively evaluate the morphology throughout the entire presacral axial column (excluding possible size effects). 3D scans were landmarked with predefined homologous points using the computer software Landmark. The data points were chosen to capture important morphological characteristics, such as the shape of the vertebral body, the form and relative position of the pre- and postzygapophyses, parapophysis and diapophysis, as well as the outline of the neural spine. The relative warps analysis revealed a very distinctive pattern, including four different groupings. The first group is characterized by a general elongated and flat shape, and contains almost all cervical vertebrae. The following groups include a variety of shorter and higher morphologies. The second cluster includes mainly anterior dorsal vertebrae. There is a slight overlap with the third group that includes the last two posterior cervicals, as well as a middorsal vertebra. The fourth accumulation of data points represents the posterior dorsal vertebrae. These results imply that it is very promising to include other taxa in this study to compare species with varying vertebral count. Eventually, we hope to find patterns that reveal new insights into axial patterning in sauropodomorphs.

Poster Session II, (Monday)

BARNACLE COLONIZATION OF MIDDLE PLEISTOCENE SEA LION (CARNIVORA: PINNIPEDIA) BONES ELUCIDATE THE BIOSTRATINOMY OF A FOSSIL MARINE MAMMAL

BOESSENECKER, Robert, Montana State University, Bozeman, MT, USA

Fossil evidence of barnacle encrustation of vertebrate skeletal elements is reported from the Middle Pleistocene Port Orford Formation of southern coastal Oregon. This material includes two associated thoracic vertebrae and a femur referable to the extinct sea lion *Proterozetes ulysses* that are encrusted by a total of 1400+ individual barnacles identified as *Solidobalanus* sp. Because these barnacles are encrusting endoskeletal elements, the host sea lion must have died and been at least partially skeletonized at the time of colonization. It is possible that larger, older individuals representing the first colonization of the bones may have settled on the bony substrate while soft tissue (e.g. ligaments, cartilage) still remained in places; barnacles are absent from most articular surfaces, and large barnacles are unevenly distributed. The size, probable ontogenetic age, and lifespan of extant *Solidobalanus* indicates a minimum exposure time (and thus minimum duration of time averaging) of 4-7 months. Additionally present are much smaller barnacles encrusting larger individuals, which contribute to a bimodal size distribution, and indicate two distinct colonization events. The wide distribution of *Solidobalanus* on some of these elements suggests these were regularly overturned by bottom currents, which would keep some barnacles from smothering by prolonged contact with the sediment, similar to recently reported balanuliths from the modern and fossil record. This is the first example of a balanulith with a vertebrate fossil as a nucleus. The discovery of barnacle attachment scars on these bones indicates the possibility of identifying the former occurrence of barnacles on other vertebrate remains in the fossil record. Detailed study of this assemblage has yielded a wealth of biostratinomic data that otherwise would not have been preserved. This study promotes awareness of encrusting and boring organisms and their traces, as they (when present or recognized) provide rich additional sources of data regarding to the biostratinomic history of fossil vertebrates.

Poster Session IV, (Wednesday)

QUANTIFYING SHIFTS IN OSTEOSCLEROSIS IN THE HUMERUS OF FOSSIL PENGUINS (AVES: SPHENISCIFORMES)

BOLES, Zachary, North Carolina State University, Raleigh, NC, USA; KSEPKA, Daniel, North Carolina State University, Raleigh, NC, USA

Penguin wing bones exhibit substantial modifications in gross morphology and microstructure associated with the transition to flightless wing-propelled diving. One derived feature is the extreme reduction of the marrow cavity in the humerus, presumably related to demands for neutral buoyancy. In this study, we attempt to reconstruct the transition from the hollow humerus ancestral for living birds to the osteosclerotic humerus of penguins by quantifying properties of this bone for a range of stem and crown fossil penguins as well as extant ingroup and outgroup species. Thin-sections through the midshaft were created using standard histological techniques. These thin-sections were imaged and sediment infilling was digitally removed from the fossils. The software Bone Profiler was used to determine center of density and quantify the compactness profiles of the sections. The Cortico-Diaphyseal Index

(CDI), a measure of cortical thickness independent of body size, was calculated as a proxy of density. CDI values ranged from 0.5351 for a basal Eocene penguin species from Seymour Island to 1.476 for the extant *Aptenodytes*. When ancestral CDI values are reconstructed using Mesquite, a clear trend in increasing density along the lineage leading from the basal node in Sphenisciformes to crown Spheniscidae is observed. This trend is supported whether all branch lengths are considered equal or are extrapolated from a time-calibrated cladogram. Thus, we can infer that while basal penguins retained a less dense humeral cross-section (CDI=54%-63% of the reconstructed ancestral value for Spheniscidae), essentially modern levels of osteosclerosis arose within the penguin stem lineage during the Paleogene. While a clear pattern of increasing CDI is observed, the developmental processes underlying this transition remain uncertain in the absence of growth series for stem penguins. Examination of additional skeletal elements may provide more data bearing on this issue.

Poster Session II, (Monday)

NEW LIZARDS (LEPIDOSAURIA, SQUAMATA) FROM THE EARLY CRETACEOUS OF LAS HOYAS (CUENCA, SPAIN)

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The Early Cretaceous Las Hoyas fossil site (Cuenca, Spain, Late Barremian) is known for yielding extremely well-preserved freshwater and terrestrial vertebrate fossils, including those of squamates. Previously described squamate material includes six specimens of *Meyasaurus* (including the *M. diazromerali* holotype), the type and only specimens of *Scandensia* and *Hoyalacerta*, and a taphonomically unusual specimen containing the disarticulated remains of several juvenile *Meyasaurus* and also a *Hoyalacerta*. However, the record has been expanded in recent years with the recovery of five additional specimens of *Meyasaurus*, an undetermined paramacellodid (represented by a fragment of skin with osteoderms), a new specimen of *Scandensia*, and another specimen representing a new genus. The additional *Scandensia* specimen lacks its anterior portion but adds new, phylogenetically important, information such as the presence of ovoid trunk osteoderms (not preserved in the type specimen). The new genus is represented by a single, almost complete, specimen characterized by its small size, elongate body, and short limbs (but proportionally long feet). *Scandensia*, *Hoyalacerta* and the new genus are currently known only from Las Hoyas, but *Meyasaurus* and paramacellodids have been reported from other sites both within and beyond the Iberian Peninsula. Our understanding of Mesozoic squamate paleobiogeography is limited by the known record, but localities like Las Hoyas offer an opportunity to study the composition of a concrete Early Cretaceous squamate assemblage. The quality and abundance of its specimens and their taxonomic diversity is rivalled only by the somewhat older deposits of the Yixian Formation in China.

Poster Session III, (Tuesday)

PRELIMINARY REPORT ON THE DISCOVERY OF A LARGE EOCENE PRIMATE FROM THE UINTA FORMATION OF NORTHEASTERN UTAH

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Cranial and postcranial elements from a large primate were discovered during a reconnaissance survey conducted in late 2009 in the Uinta Basin, Utah. The fossils were discovered in a gray-green, fine-grained, subangular, tuffaceous sandstone high in the Uinta B (Wagonhound Member) of the Eocene Uinta Formation. Skeletal elements discovered surficialy were poorly preserved, while those recovered from the subsurface were relatively well preserved. Cranial elements collected include the greater part of the left mandible (P_3-M_1, length ~33mm), a small portion of the right mandible with nearly complete P_2 (length 5.5mm), a right, anterior maxillary fragment with preserved canine, other isolated tooth fragments including a partial right M^1(length 4.6mm), and other unidentified skull fragments. Postcranial material includes a well preserved distal right humerus (external-internal condyle width 29mm), proximal and distal ends of the right ulna, the right radial diaphysis (length 87mm), twelve partial to complete thoracic and lumbar centra, a nearly complete lumbar vertebra, seven partial caudal centra, rib and innominate fragments,partial left and right tibial diaphyses, partial proximal and distal femora, a complete right calcaneum (length 34mm) and talus (talar neck length 11mm, trochlear length 13mm), assorted tarsals, four partial metatarsals, two proximal phalanges, five medial phalanges, and one complete and three partial unguals. Though incomplete, the M^1 shows a simple paracone and metacone with distal and mesial ridges bearing crenulation. A well developed pyramidal metaconule sits on the mesial edge on the tooth with crenulated boards which run down the side of the tooth toward the alveoli. The size of the animal precludes it from being a strict insectivore, and the teeth imply a possible folivorus or frugivorus diet. The newly discovered material represents a primate significantly larger than the previously reported Uinta Basin primates (*Ourayia*, *Chipetaia*, *Macrotarsius* and *Trogolemur*). The brevity of the distal calcaneal length (3mm) differs from the known local fauna, also suggests a new taxon.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 12:00

NON-AVIAN DINOSAUR AND EXTANT ARCHOSAUR LIMB JOINTS: WHAT'S MISSING, WHAT'S NOT AND WHERE DO WE GO FROM HERE?

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In non-avian dinosaur long bones, the once-living chondroepiphysis (joint surface) overlays a now-fossilized calcified cartilage zone. Although the shape of this zone is used to infer non-avian dinosaur locomotion, it remains unclear how much it reflects chondroepiphysis shape. Previously, we investigated the effect of chondroepiphysis removal in *Alligator*, *Numida*, and *Struthio* using traditional and geometric morphometrics (GM). We reported that whereas extant archosaur long bone dimensions experienced significant changes after removal of the chondroepiphysis, shape changes were less pronounced. In fact, in weight-bearing elements, there were often no significant differences between the shape of the chondroepiphysis and the underlying calcified cartilage. These data suggested that, in non-avian dinosaurs, the shape of calcified cartilage in weight-bearing long bones more closely reflects the shape of the missing chondroepiphysis than previously anticipated. Continued investigation of these data has revealed further trends. In both *Alligator* and the bird taxa, larger individuals show less truncation than smaller individuals. For both the humerus and the femur, length is the least truncated measurement, whereas measures of distal breadth or the distance to the anatomical landmarks (deltopectoral crest, fourth trochanter) are the most truncated. In all cases, humerus dimensions are more truncated than those of the femur. Our GM data on extant archosaur long bones shows that, for adult, stress-bearing elements, condyles and other articular features of the chondroepiphysis are retained as distinct, unambiguous features in the underlying calcified cartilage. Additionally, we have discovered a correlation between radial condyle size and extent on the cranial face of the humerus and the size and shape of the so-called cubital fossa. These data have significant implications for inferring non-avian dinosaur locomotion. We suggest that investigation of these trends in additional extant taxa, the establishment of confidence intervals, and renewed searches for osteological correlates between calcified and epiphyseal cartilages are needed and promising.

Poster Session II, (Monday)

QUANTIFYING VARIATION IN CERATOPSID HORNCORES AND PARIETALS

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The horns and parietal ornaments of ceratopsid dinosaurs show considerable variation between genera and also between, and even within, species. These structures played an important role in ceratopsid evolution and their function has long been a source of discussion. Gaining a better grasp of the variability observed in these structures is a first step toward understanding how selection was acting upon them. Using material from fossil collections within Alberta, Canada I gathered morphometric data relating to horncore morphology in specimens of *Centrosaurus*, *Styracosaurus* and *Triceratops*. I also examined parietal hook and spike morphology in *Centrosaurus* and *Pachyrhinosaurus*. Measurements of horn dimensions, shape and curvature were gathered from three fully articulated specimens as well as several complete or partial skulls. Additional metrics of body and skull size were taken where possible. Morphometric studies of dinosaur material are often hampered by limited sample sizes, a problem potentially alleviated in some ceratopsian taxa by large assortments of disarticulated bones collected from bonebeds. Sixty disarticulated nasal horncores collected from bonebeds are stored at the Royal Tyrrell Museum of Palaeontology in Drumheller, Alberta, Canada and these were measured as well. Comparisons with data from articulated specimens suggest that bonebed fossils have the potential to increase sample sizes but the lack of corresponding body size information limits their usefulness in assessing patterns in horn variation. Although useful at the genera level, horncore morphology was found to be too variable to distinguish between species, but parietal ornaments remain diagnostic despite high variability.

Technical Session XVI, Wednesday 2:30

EVOLUTIONARY RATES AND PATTERNS OF ARTIODACTYL LIMB REDUCTION

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Many clades of artiodactyls show evolutionary reductions in the number of distal elements of their limb skeleton, either through the fusion of two bones or the loss of bones entirely. This reduces the limb's distal weight and provides more stability among elements of the distal limb. It is, therefore, likely an adaptation to cursorial locomotion. Cenozoic environmental changes that led to the spread of open environments (e.g., savannas) might have provided an impetus for artiodactyl limb adaptation. To establish the historical pattern of artiodactyl limb reduction, we defined 50 discrete characters of artiodactyls limbs that describe the reduction, fusion or loss of elements. We then determined the character states of a sample of living and extinct artiodactyl genera, and mapped these onto a composite phylogeny of artiodactyls to determine the timing of evolutionary changes. We then estimated the rate of evolution in each of thirty two-million-year-long intervals. There is a considerable

peak in evolutionary rate in the Middle Eocene. Notably, this coincides perfectly with an observed peak in ungulate origination rate suggesting a possible relationship between the radiation of the major groups of living artiodactyls and the reduction of their limbs. The rate of limb evolution gradually declines throughout the Oligocene, but increases again around the Oligocene-Miocene boundary. This coincides with some recent estimates of the spread of grassland ecosystems in North America, suggesting a possible link between environmental change and artiodactyl limb evolution. Finally, there is a decrease in evolutionary rate after the Middle Miocene, suggesting a biomechanical limit to the degree of limb reduction.

Evolution of the Modern African Fauna, Wednesday 8:15

THE OLDEST FAYUM CREODONT: DENTAL AND HUMERAL MORPHOLOGY OF A NEW PROVIVERRINE HYAENODONTID FROM THE EARLIEST LATE EOCENE OF EGYPT

BORTHS, Matthew, Stony Brook University , Stony Brook, NY, USA; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; GOODENBERGER, Katherine , Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Duke Lemur Center, Durham , NC, USA

Hyaenodontid creodonts were the most abundant and diverse carnivorous mammals of the African Paleogene, and are common in the late Eocene and early Oligocene deposits of the Fayum Depression in northern Egypt. Many of the Fayum hyaenodontids were likely derived from a basal, paraphyletic assemblage of small to medium-sized species known as "proviverrines". The evolutionary history of proviverrines is poorly understood, though recent discoveries in the Paleocene of Morocco suggest an African origin for the clade. Here we present dental and postcranial material of the oldest Fayum proviverrine, from the ~37 Ma (earliest late Eocene) Birket Qarun Locality 2 (BQ-2). The BQ-2 taxon is known from isolated upper and lower teeth and partial mandibles that preserve p3, m2, and m3 with varying levels of wear. The lower molars have relatively small metaconids that abut the protoconids, paraconids that are only slightly shorter than protoconids, and distinct precingulids. On M1-2 the major cusps are nearly equal in height, are relatively short, and the paracone and metacone are fused at their bases; the parastyle is reduced. The metaconule is present on M2, but not on M1, a derived character that the <34 Ma Fayum genus *Masrasector* shares with ~37 Ma *Kyawdawia* from Myanmar. Phylogenetic analysis of dental characters places the BQ-2 proviverrine as a member of a *Kyawdawia – Masrasector* clade, possibly as the sister taxon of *Kyawdawia*. This result is consistent with an African origin for the Pondaung proviverrines. A distal humerus from BQ-2 is the oldest known postcranial bone of an African hyaenodontid, and on the basis of size and abundance likely belongs to the new genus. The humerus is generally similar to that of the arboreal or scansorial early Eocene North American hyaenodontid *Prolimnocyon* in having a wide brachial flange, a shallow olecranon fossa, a well-defined capitulum, and a reduced medial epicondyle. Extant *Nasua* and *Potos* appear to be comparable functional analogues. BQ-2 has yielded remains of three additional hyaenodontids; these taxa promise to illuminate the origin of Fayum lineages, and, more broadly, the early biogeography of Hyaenodontidae.

Technical Session II, Sunday 9:15

BONE HISTOLOGY OF CARNIVORE COPROLITES FROM THE UPPER PERMIAN SOUTH AFRICAN KAROO BASIN

BOTHA-BRINK, Jennifer, National Museum, Bloemfontein, South Africa; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa

Microscopic analysis of fifteen coprolites from the Upper Permian *Tropidostoma* Assemblage Zone (Beaufort Group, Karoo Supergroup) of South Africa reveals well-preserved bone fragments with identifiable histological features, tooth fragments and, in some specimens, numerous narrow filamentous structures. Due to the large size and presence of bone inclusions, the most likely producers of the coprolites are carnivores, such as the gorgonopsian therapsids *Gorgonops*, *Aelurognathus, Cyonosaurus,* and *Lycaenops*. Two distinct bone tissue patterns are observed. Type A, which represents the majority of the inclusions, is characterized by abundant, haphazardly arranged globular osteocyte lacunae in highly vascularized fibro-lamellar bone, and in some cases the vascular canals are extraordinarily enlarged. Annuli are rarely present. Taken together, these characteristics indicate a rapid bone deposition rate. Limb bone cross-sections are small (complete sections up to 3.7 mm in diameter) and combined with the rapid bone deposition rate, suggest that the bone fragments belong to juvenile or perinatal individuals. Type B also comprises small bone sections, but is characterized by more slowly forming parallel-fibered or lamellar-zonal bone tissue and vascularization is either poor or non-existent. Although positively identifying the bone inclusions to generic level is not possible, several features of the bone microstructure allow us to offer several possibilities. As dicynodont therapsids were the most abundant herbivores in the *Tropidostoma* Assemblage Zone, we suggest that the fragments containing bone tissue Type A are most likely from dicynodonts. Those containing bone tissue Type B do not exhibit typical therapsid bone tissue structure and may instead belong to reptiles or parareptiles such as *Youngina*, *Saurorictus* or *Pareiasaurus*, which typically exhibit more slowly forming growth patterns compared to therapsids. This study is the first to analyse bone inclusions in coprolites from the South African Karoo Basin and has provided new insight into the paleoecology of the Upper Permian *Tropidostoma* Assemblage Zone.

Poster Session III, (Tuesday)

THE NOSE KNOWS: THE EFFECTS OF NASAL CAVITY ANATOMY ON AIRFLOW IN ALLIGATORS

BOURKE, Jason, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

The role of respiratory turbinates (RTs) in dinosaur physiology has been contentious. The necessity of RTs for maintaining heat and water balance ultimately relies on knowledge of how air flows through the nasal cavity. However, very few studies have actually addressed the question of respiratory airflow in the nasal passages. Current knowledge has been limited to mammals, where the tortuous nature of RTs has proven difficult to model. Reptilian nasal passages are generally simpler than mammalian or avian ones due to their smaller size and lack of highly branched or coiled turbinates. Thus, as a starting point to a larger project on nasal airflow in dinosaurs, it makes sense to construct accurate models of these simpler passageways as they may provide a foundational look at how airflow is affected by nasal architecture. The right nasal passageway of a large American alligator (*Alligator mississippiensis*) was reconstructed from CT scan data using the 3D reconstruction program Avizo. The reconstructed surface data were converted into a finite element tetrahedral mesh. The governing Navier-Stokes equations were solved using the computational fluid dynamics program Fluent, whereas data analysis was done using Avizo Wind. Results showed distinct heterogeneity in airflow throughout the nasal cavity, with relatively high velocity laminar flow in the respiratory portions of the nasal cavity whereas slower, more stagnant air was located in the section of the nasal passage leading to the olfactory region. These findings agree with mammalian studies showing a disparity in airflow velocities between the respiratory and olfactory regions. Our study presents the first time that airflow in the nasal passage of an extant reptile has been modeled. Future work will model respiratory airflow in birds and squamates to determine how the varied nasal anatomy among these taxa affects the flow of air. Once we have accurate knowledge of how the various anatomical components within the nasal cavity affect airflow patterns in extant taxa, it will be possible to test hypotheses of airflow in the nasal cavity—and hence respiratory physiology— of dinosaurs.

Poster Session III, (Tuesday)

FOSSILS, MOLECULES AND THE HISTORICAL RECORD: NEW APPLICATIONS FOR STRATIGRAPHIC CONSISTENCY METRICS

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Over the past two decades stratigraphic consistency metrics were used to analyze a diverse array of clades covering nearly the entire tree of life, yet misconceptions regarding their calculation and applicability persist. Calculating these metrics requires two sources of data directly linked to the included set of terminal taxa: temporal data and a tree topology. Accurate comparison of stratigraphic consistency values between analyses requires that the included set of terminal taxa remains fixed, and it has long been assumed by most researchers that each terminal taxon has only a single source of temporal data, the stratigraphic record. However, terminal taxa actually possess three potential sources of temporal data: current stratigraphic data (i.e., the fossil record as known today), historical stratigraphic data (e.g., the fossil record as known in 1910), and molecular-based data (i.e., molecular divergence dates). Recognition of these additional sources of temporal data allows stratigraphic consistency metrics to be applied in situations where the tree topology is held constant while different sets of temporal data are assessed. As a result, stratigraphic congruence metrics can now be used to quantify the temporal disparity between molecular divergence estimates and the fossil record. Additionally, these metrics can be used to compare current and historical stratigraphic data to elucidate patterns in fossil data acquisition (i.e., new fossil discoveries) and interpretation (i.e., taxonomic referral and revision) through time. These applications are facilitated by a new methodology that allows multiple sources of temporal data to be evaluated simultaneously by inserting 'anchor taxa' into the tree topology to adjust the ages of the specific nodes under study. Finally, a new program script is introduced that greatly simplifies the calculation of several stratigraphic congruence metrics. Together these advances transform stratigraphic consistency metrics from narrowly-focused descriptive statistics into powerful tools for evaluating molecular divergence estimates and understanding historical trends in fossil data acquisition and interpretation.

Technical Session X, Tuesday 12:00

ECOLOGICAL CHANGE IN A CONSERVATION HOTSPOT: THE FOSSIL AVIFAUNA OF ME AURE CAVE, NEW CALEDONIA

BOYER, Alison, Yale University, New Haven, CT, USA; JAMES, Helen, Smithsonian Institution, Washington, DC, USA; OLSON, Storrs, Smithsonian Institution, Washington, DC, USA; GRANT-MACKIE, Jack, University of Auckland, Auckland, New Zealand

Through the continuing accumulation of fossil evidence, it is clear that first human arrival on islands around the world was linked to a rise in the extinction rate for vertebrates. In addition to remarkable extinct species, subfossil bones from the human era can also reveal changes in the composition and structure of ecological communities due to ancient human environmental impacts. New Caledonia is a large and biogeographically distinct island in the southwest Pacific and is renowned for biotic assemblages found nowhere else in the world. We examined bird bones from the Mé Auré Cave site (WMD007), located in lowland dry forest on the west coast of New Caledonia. The taphonomy of deposition, body-size spectrum, and species composition of faunal remains were consistent with barn owl (*Tyto alba*) predation as the main form of deposition of vertebrate bones. The owl pellet deposit recorded the extinc-

tion of two species and extirpation of at least two other species from the lowlands in the past 1200 years. Species richness of birds in the stratigraphic deposit was quite high, reflecting the catholic diet of barn owls on islands, and many species have continued to persist near the site despite loss and degradation of the dry forest. However, we found substantial turnover in relative abundance of species in the cave deposit, with edge and open country birds becoming more common through time. These changes may reflect a severe reduction of dry forest habitat due to human activities. This work provides a temporal record of avifaunal and environmental change in the threatened dry forest habitat, and this information should be particularly informative for ongoing conservation and restoration efforts.

Technical Session XI, Tuesday 2:30

AN ALGORITHM USING INTRINSIC GEOMETRY OF ANATOMICAL STRUCTURES FOR AUTOMATIC IDENTIFICATION OF HOMOLOGOUS FEATURES

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The first step in any biometric study is the identification of anatomical reference points on which to base comparisons among specimens. Once corresponding sets of reference points are defined on specimens of interest, measurements are collected and used for analyses of shape variation in order to address phylogenetic, functional, or developmental questions. Despite the quantitative rigor of shape studies, the more fundamental step, the determination of anatomical correspondence points, is largely qualitative. Assuming the possibility of error in this step, proceeding analyses of measurements representing non-equivalent sets of reference points will have reduced efficacy or reveal misleading patterns of shape variation. We present the first fully automatic geometric algorithm for defining biologically meaningful correspondences among specimens. Using a sample of 114 euarchontan (primates, treeshrews, colugos) m/2's, we show that anatomical landmarks identified by our algorithm, which uses the intrinsic geometry of the tooth surfaces, are well-matched to those identified by human observers in most cases. Additionally, the correspondences identified by our algorithm result in a shape space that classifies teeth taxonomically with equal or greater success compared to a distance matrix derived from observer landmarks in the same sample. Finally, this algorithm allows for tests of historically accepted/debated hypotheses on feature identifications among morphologically disparate teeth. We use it to do this by propagating correspondence computations through pathways of "intermediate" dental forms hypothesized to link various teeth through evolutionary history. Specifically, we show that the lingual cusp distal to the metaconid of the molar of the extant strepsirrhine primate *Lepilemur*, for which the homology is debated, may be matched either with entoconids or with metastylids of other taxa, given alternate hypotheses of ancestral morphology and phylogenetic position of *Lepilemur*. Thus, like comparative biologists, our algorithm is capable of generating different conclusions about anatomical correspondence depending on the treatment of available comparative data.

Poster Session II, (Monday)

DISCOVERY OF A NEW CHASMOSAURINE BONEBED FROM THE KAIPAROWITS FORMATION (CAMPANIAN) OF SOUTHERN UTAH

BRANDAU, Deanna, University of Utah, Dept. Geology and Geophysics and Utah Museum of Natural History, Salt Lake city, UT, USA; GETTY, Michael, Utah Museum of Natural History, Salt Lake City, UT, USA

Extensive bonebeds of centrosaurine ceratopsid dinosaurs are known from Canada and Montana, containing dozens to hundreds of individuals, whereas similar chasmosaurine bonebeds are unknown to date, and multiple associated chasmosaurine specimens are extremely rare. Here we report the discovery of an unusual multi-individual chasmosaurine ceratopsid bonebed from the lower half of the Upper Cretaceous Kaiparowits Formation (middle Campanian) in Grand Staircase-Escalante National Monument, Utah. Most of the ceratopsid remains from the Kaiparowits Formation are associated or partially articulated single individuals associated with channel sandstones. In contrast, UMNH Locality 945 is a multitaxic bonebed containing the articulated skeleton of a juvenile chasmosaurine, a disarticulated skeleton of a second juvenile chasmosaurine individual, and a partially articulated alligatoroid crocodylian skeleton, along with isolated turtle fragments, preserved in a sandy clayey siltstone. The larger, articulated chasmosaurine contains parts of the skull, most of the axial skeleton, and nearly complete limbs, and is the most complete articulated vertebrate skeleton discovered in fine-grained matrix from the Kaiparowits Formation. The smaller ceratopsid is fragmented, but includes a supraorbital horn, portions of the frill, both dentaries, an articulated forelimb, isolated humerus and ulna, and both femora and fibulae. The crocodylian was discovered directly above the larger articulated ceratopsian and appears to be nearly complete, including the skull, limbs, axial skeleton and osteoderms. We interpret locality 945 as a mud-dominated floodplain where slight fluvial reworking partially disarticulated and deposited the carcasses together prior to burial, in stark contrast to the channel environment for other Kaiparowits chasmosaurine localities. A similar depositional setting is found at two other juvenile chasmosaurine localities in the Kaiparowits Formation, but these are isolated partial skeletons. The juvenile chasmosaurine specimens from locality 945 provide further insight into chasmosaurine osteology by clarifying the phalangeal count for the chasmosaurine manus and pes.

Technical Session VIII, Monday 2:15

PHYLOGENETIC EXPERIMENTS ON CURRENT SCENARIOS OF EARLY GNATHOSTOME EVOLUTION

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Despite an ever-growing wealth of fossil data, the problems of early gnathostome origins and interrelationships remain contentious and unresolved. At present, early transformations leading to the origin of jaws from a jawless antecedent are undocumented, and the origins of chondrichthyans and osteichthyans remain hazy. With the exception of a few recent examples, these questions have resisted explicit cladistic solutions in favor of traditional taxonomic methods. Thus, existing approaches are insufficient to document the early morphological transitions leading to each of these major clades. This investigation uses recently published cladistic character data sets to examine character evolution in early gnathostomes. A series of experiments on different branching arrangements reflecting different views of gnathostome evolution are compared. The results have manifold implications for hypotheses of early gnathostome evolution. Firstly, 'acanthodians' cannot be sustained as a monophyletic group if one or more spiny gnathostomes are considered stem chondrichthyans. Secondly, a long list of characters used in support of placoderm monophyly is shown to likely mislead identification of new fossil stem gnathostomes. This arises from the fact that untested character lists (as opposed to synapomorphy schemes arising from cladistic analysis) will tend to overestimate the actual number of synapomorphies arising from the congruence test. In any case, competing monophyletic and paraphyletic interpretations share similar implications about gnathostomes as primitively flat-bodied, benthic animals. Thirdly, the notion of placoderms as stem-osteichthyans is examined critically on the grounds that the shared features of placoderms and some newly discovered osteichthyans are shown to be gnathostome symplesiomorphies or convergences. These experiments illustrate the value of explicit, tree-based approaches to character data and the value of rooting ingroup analyses of jawed vertebrate evolution on jawless vertebrate outgroups.

Poster Session III, (Tuesday)

AN EARLY JURASSIC DESERT ICHNOFAUNA: PALEONTOLOGICAL RESOURCES IN THE VERMILION CLIFFS NATIONAL MONUMENT AND PARIA CANYON-VERMILION CLIFFS WILDERNESS

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The Vermilion Cliffs National Monument (VCNM) and the Paria Canyon-Vermilion Cliffs Wilderness encompass nearly 400,000 acres of land managed by the BLM (under the National Landscape Conservation System) in Coconino County, Arizona and Kane County, Utah. In Early Jurassic times (~190 million years ago), a vast (~350,000 sq.km) desert covered the region, which was approximately 10 degrees N latitude on the western edge of Pangaea. This geographic position led to a dry, hot, sparsely vegetated, eolian environment. Tropical winds blowing from the north formed the largest deposit of windblown sand in earth's history. At times, this erg (sand sea) may have reached thicknesses in excess of 700 m. Today, these sands of the Navajo Sandstone create the picturesque geology in the VCNM area. In addition, this region contains thousands of fossil tracks preserved as underprints in convex hyporelief and occasionally in concave epirelief on dune foreset beds, as well as interdune bounding and truncation surfaces. Various trace fossils have been observed, including tridactyl (*Grallator*) and tetradactyl (*Batrachopus* and *Navahopus*) forms, as well as unique invertebrate traces (i.e., *Entradichnus* Ichnofacies). These ichnites preserve a variety of interesting preservational and behavioral features related to a desert fauna of theropods, prosauropods, crocodylomorphs, protomammals, and arthropods moving up, down, and across the angle of repose on the lee sides of dunes during the monsoonal summer season. This unique, ichnoassemblage warrants the high level of documentation provided by close-range photogrammetry. Three-dimensional image datasets created from digital photography provide a permanent digital record of fossil tracks and is a non-destructive method to obtain 3D data for assessment. These data provide valuable information for the understanding of this Early Jurassic desert ecosystem, as well as understanding the kinematics of footprint formation in arid, eolian environments.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 9:30

MAMMALIAN SKULL CONSTRUCTION AND THE IMPORTANCE OF CRANIAL SUTURES IN BIOMECHANICAL FINITE ELEMENT ANALYSIS

BRIGHT, Jen, University of Bristol, Bristol, United Kingdom; GRÖNING, Flora, University of York, York, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom

Cranial sutures are important sites in the mammalian skull, as they have been proposed to act not only as regions of growth, but also as areas of micrometer-scale flexibility that mitigate high bone strains associated with feeding. Finite Element (FE) Analysis is steadily gaining popularity with vertebrate palaeontologists by offering a unique opportunity to observe the cranial biomechanics of extinct animals. Validation studies on extant taxa are essential in order to understand the effects of sutures on FE models, and are crucial for producing biomechanically valid results when investigating skull function in fossil taxa. A full-field strain study using Digital Speckle Pattern Interferometry (DSPI) was used *in vitro* on the zygomatic arch of a modern domestic pig (*Sus scrofa*) to assess the nature of strain and displacement across a large and patent suture. Our results show that the suture localises a high strain gradi-

ent, and whilst it does not greatly reduce the nearby bone strain, it does permit the independent movement (less than 2µm) of the two adjacent bones. This experimental data was used to determine that the best way of modelling cranial sutures both in tension and compression in FE analysis is to introduce regions of more compliant 3D elements. Further sutures were then introduced to the FE model of the pig skull used, and the results compared with *in vitro* strain gauge data from the same animal, and models without sutures. Thus, the cumulative effects on the overall distortion of the skull from multiple small displacements at the sutures were observed. With a better picture of sutural mechanical behaviour established, questions regarding the ontogenetic and evolutionary patterns of suture fusion in fossil taxa may begin to be addressed with the FE method.

Poster Session IV, (Wednesday)

AFFINITIES OF LAMBEOSAURINE (ORNITHISCHIA: HADROSAURIDAE) EMBRYOS FROM DEVIL'S COULEE (CAMPANIAN), ALBERTA

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Juvenile individuals of lambeosaurine hadrosaurids are difficult to assign to lower taxonomic levels because they lack a developed cranial crest. Juvenile lambeosaurine skulls are relatively well known from the Late Cretaceous of North America, and include rare nestling and articulated embryonic skulls from the upper Oldman Formation at Devil's Coulee, Alberta. These embryos were previously assigned to *Hypacrosaurus stebingeri*, a taxon known from the Two Medicine Formation of Montana, based on their stratigraphic occurrence and the presence of a rostrally bifurcated nasal process (diagnostic of Corythosaurini). Here, these embryonic specimens are re-evaluated for species-specific characters and to determine their precise stratigraphic context. Re-examination of the embryos reveals that the nasals are less complete than previously suggested, and evidence of a bifurcated rostral process is not preserved. In order to quantitatively assess possible morphological affinities of the embryonic material, we performed a principal components analysis of size corrected, cranial linear measurements of 20 juvenile skulls, representing four lambeosaurine species. This analysis reveals little differentiation between taxa, stressing the lack of quantitative diagnostic features exclusive of the cranial crest, although the embryonic skull is most similar to juveniles of *Corythosaurus* in PC morphospace. Furthermore, the current understanding of the stratigraphic record in Alberta and Montana suggests that the Alberta embryos are approximately one million years older than the oldest occurrence of diagnostic *H. stebingeri* material. Temporally, the upper Oldman Formation at Devil's Coulee is equivalent to the upper Dinosaur Park Formation in Dinosaur Provincial Park, Alberta, where both *Lambeosaurus* and *Corythosaurus* are found. The lack of diagnostic features of the embryos from Devil's Coulee, and their stratigraphic occurrence, suggests that the precise, species-level identification is uncertain, and therefore may not represent *H. stebingeri* as previously suggested.

Technical Session XIV, Wednesday 9:45

MULTI-TAXIC THEROPOD BONEBEDS IN AN INTERDUNAL SETTING OF THE EARLY JURASSIC EOLIAN NUGGET SANDSTONE, UTAH

BRITT, Brooks, Brigham Young University, Provo, UT, USA; CHURE, Daniel, Dinosaur National Monument, Jensen, UT, USA; ENGELEMANN, George, University of Nebraska, Omaha, NE, USA; SCHEETZ, Rodney, Brigham Young University, Provo, UT, USA; HANSEN, Robin, Bureau of Land Management, Vernal, UT, USA

Worldwide, Early Jurassic theropods are rare and poorly known, with only three reported North American genera (*Dilophosaurus*, *"Syntarsus" kayentakatae*, *Segisaurus*). Here, we report the discovery of three theropod bonebeds preserved in decimeter-scale, superimposed sandstones deposited in an interdunal environment in the Early Jurassic Nugget Sandstone of northeastern Utah.Based on the presence of two scapular forms (narrow and distally expanded blades), two coelophysoid-grade genera may be present. One taxon is represented by a small (16 cm-long femur) associated postcranial skeleton (BYU 19002) consisting of a pelvis, hind limbs, caudals, and other bones. All components of the broad pelvis are fused. The hind limb is gracile with a relatively short femur, long tibiotarsus (fused tibia-astragalus-calcanium) and derived metatarsals with shafts of II and IV reduced to 2 mm-thick splints appressed against metatarsal III to form a narrow, lightweight foot; all of which are features of extreme cursorial adaptation. This taxon is distinct from known theropods. The full fusion of the pelvis and tibiotarsus suggest this specimen is an adult, despite its diminutive size.The other coelophysoid is larger and represented by multiple disarticulated individuals and hundreds of bones, including a partial, disarticulated skull with fully fused quadrate-quadratojugal and possibly procumbent dentary teeth; an array of postcranial elements of typical coelophysoid form, including complete, uncrushed vertebrae from all portions of the column, elongate cervical ribs as long as five vertebrae, most limb elements, pelves, and robust furculae.

Large (3 cm long) teeth indicate the presence of another, larger theropod of unknown affinity. Other taxa in the bonebeds are a small sphenodontid and foliage impressions, possibly cycadeoid. The deposit can be traced laterally to a mudstone and sandstone horizon with theropod tracks.Only 5% of the fossiliferous layers have been excavated. The abundance of bone, excellent preservation, and taxonomic diversity suggest the site will provide important data on theropod evolution in a generally harsh eolian environment.

Technical Session XII, Tuesday 3:00

CROCODYLIANS FROM THE UINTA FORMATION (MIDDLE EOCENE, UINTAN) OF WESTERN NORTH AMERICA, RESPONSE TO CLIMATE CHANGE AND THE ORIGINS OF *ALLIGATOR*

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We identified four crocodylian species (at least two of which are new) from the Middle Eocene Uinta Formation of eastern Utah. Two are alligatorines - *Procaimanoidea utahensis* and a new species that phylogenetic analyses indicate is the sister taxon to *Alligator*. Although the new alligatorine has a relatively short snout, it lacks the enlarged cheek teeth that characterized earlier relatives. This is consistent with suggestions that the American alligator, an ecological generalist, evolved from more specialized ancestors. The other two species are stem crocodyloids – a large form similar (and possibly referable) to "*Crocodylus" affinis* and a new species of *Brachyuranochampsa* preserving the first known lower jaw for the genus, revealing a relatively long mandibular symphysis including the splenial. Hoofed crocodiles (pristichampsines) are known from Uintan units in Texas and California but have not been found in the Uinta Formation. These deposits help fill a substantial gap in the crocodylian record of western North America between the diverse faunas of pre-Uintan age (when five or more species may have cooccurred) and depauperate Chadronian faunas with only a single species (*Alligator prenasalis*). Lower crocodyliform diversity in Uintan units relative to the Bridgerian and earlier times might indicate a response to the global transition from greenhouse to icehouse conditions that took place during the Eocene.

Poster Session III, (Tuesday)

ASSESSING CALCIUM ISOTOPES AS DIETARY PROXY FOR TERRESTRIAL VERTEBRATES

BROSKA, Julia, Institut für Anthropologie, Johannes Gutenberg-Universität Mainz, Mainz, Germany; TÜTKEN, Thomas, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany; ALT, Kurt, Institut für Anthropologie, Johannes Gutenberg-Universität Mainz, Mainz, Germany

Calcium (Ca) is an essential major element of great importance for the physiology and skeletal tissue formation of all vertebrates. Animals ingest Ca with their diet. During biomineralization the light Ca isotopes are preferentially enriched in the bioapatite of bones and teeth. Bone $\delta^{44/42}$Ca values seem to decrease about 0.5‰ with each trophic level in modern terrestrial and marine food chains. However, recent studies found no clear trophic level effect for skeletal remains of archaeological fauna and dinosaurs. This illustrates the need for a better understanding of the Ca isotope fractionation processes in vertebrates. It is necessary to characterize the influence of diet and physiology on Ca isotopes in skeletal tissues of modern animals before applying them as a proxy to determine the diet of extinct vertebrates and to reconstruct ancient foodwebs.

In this study bone $^{44}Ca/^{42}Ca$ of different extant vertebrates with a broad range of diets from savannah ecosystems in eastern Africa were analyzed by TIMS and isotope dilution using a ^{43}Ca-^{46}Ca double spike. The aim was to infer how dietary and trophic level differences are reflected in bone $\delta^{44/42}$Ca values. Investigated taxa, predominantly mammals, were ideally sampled from the same area/foodweb and comprise grazers and browsers (small/large body size, ruminants/non-ruminants), carnivores, insectivores, frugivores, and tubers. Established proxies for diet and trophic level such as δ^{13}C and δ^{15}N values of collagen as well as Sr/Ca and Ba/Ca of skeletal apatite were analyzed on the same bone specimens and compared with the $\delta^{44/42}$Ca values to further assess dietary differences and trophic level relationships.

$\delta^{44/42}$Ca values of enamel, dentin, and bone from the same individual were analyzed to check for tissue-dependent Ca isotope fractionation during biomineralization processes. Additional samples of different parts of the cranial and postcranial skeleton of one animal were analyzed tocheckthe intra-individual $\delta^{44/42}$Ca variability. Implications of the skeletal bioapatite Ca isotope data for the reconstruction of the diet and trophic level of extant and extinct vertebrates in terrestrial foodwebs will be discussed.

Poster Session IV, (Wednesday)

BASAL ORNITHOPOD (DINOSAURIA: ORNITHISCHIA) TEETH FROM THE PRINCE CREEK FORMATION (CAMPANIAN-PALEOCENE), NORTH SLOPE, ALASKA: TAXONOMY AND FAUNAL COMPARISON

BROWN, Caleb, University of Toronto, Toronto, ON, Canada; DRUCKENMILLER, Patrick, University of Alaska Museum of the North, Fairbanks, AK, USA

A diverse and prolific record of polar dinosaurs comes from the Upper Cretaceous (Campanian-Maastrichtian) sediments of the Prince Creek Formation exposed on Alaska's North Slope. Previous assignment of basal ornithopod ('hypsilophodontid') material from this formation is based on a single cheek tooth, which has been referred to *Thescelosaurus.* However, reexamination of this material does not support its assignment to this taxon. Here we describe more recently discovered material, including five, isolated premaxillary teeth and one lateral tooth, which confirms the presence of a basal ornithopod taxon in this formation. The premaxillary tooth crowns are bulbous and turnip-shaped, with multiple longitudinal striae circumscribing the tooth. The lateral tooth is leaf-shaped and characterized by ten vertically oriented, parallel ridges. The premaxillary teeth are most similar to those of *Thescelosaurus*, whereas the cheek tooth is more similar to its sister taxon *Parksosaurus,* for which premaxillary teeth are unknown. Referral of this new material to *Thescelosaurus* would represent the oldest occurrence of this taxon and considerably extend its stratigraphic range.

A more intriguing possibility is that the premaxillary teeth may also be referred to *Parksosaurus*, an interpretation that is more parsimonious from a stratigraphic perspective. *Parksosaurus* is known exclusively from coeval deposits of the upper Horseshoe Canyon Formation (Edmontonian). In contrast, *Thescelosaurus* is known from younger, latest Maastrichtian formations of Lancian age. Previously, faunal comparisons of the Prince Creek Formation have largely been made with non-contemporaneous formations including the Campanian-aged Judith River and Aguja formations, or to the latest Maastrichtian Hell Creek Formation. On the basis of age and faunal similarities, we suggest that a more appropriate comparison may be made with coeval rocks of the Horseshoe Canyon and Wapiti formations. This study expands our knowledge of ornithischian diversity at polar latitudes in the Late Cretaceous of Alaska and underscores the importance of small, rare, or easily misidentified fossils in paleoecological studies.

Preparators' Session, Monday 9:00

BONE BANDAGES: A CONSERVATIONALLY-SOUND REPAIR TECHNIQUE FOR BROKEN BONES HAVING LIMITED CONTACT SURFACE AREA

BROWN, Gregory, University of Nebraska State Museum, Lincoln, NE, USA

Traditional methods of repairing broken fossil bones that have significant sections missing from the surfaces to be joined include using gap fillers such as plaster or epoxy and internal reinforcement such as wooden dowels or metal rods or wires. Broken bones that have a limited contact surface area relative to the stress expectedon the join have often been repaired using similar reinforcements adhered externally to the bones with various polymers. While some of these techniques may occasionally be necessary for very large, heavy bones destined for self-supporting display, they are seldom needed or appropriate for small to moderate sized research specimens. Such methods suffer from several disadvantages: filling voids can obscure potentially significant internal features or the true nature of an element; removal of traditional gap fillers and the repair of partially failed joints are often difficult or impossible without damaging the specimen; incompatible materials may actually exacerbate stress and damage to the specimen. Alternatively, the use of lightweight woven or mat (veil cloth) fiberglass or polyester fiber strips saturated with a 1:2 solution (w/w) of Paraloid B-72 in acetone and applied externally across a joint or unfilled gap will greatly increase the effective surface area of the joint while significantly improving shear and tensile strength and, when applied in opposition, bending strength as well. These "bone bandages" eliminate the need for gap fillers or reinforcement rods, minimally obscure both surface and internal features, are easily reversible, are stable over time and are more consistent with good conservation principles. This technique is also appropriate as a preventative reinforcement for very thin, unbroken bone which might not otherwise survive normal preparation or handling.

Preparators' Session, Monday 12:00

DESIGNING THE MODERN PREPARATION LAB: INTEGRATING NEW TECHNOLOGIES

BROWN, Matthew, University of Texas at Austin, Austin, TX, USA; ROWE, Timothy, University of Texas at Austin, Austin, TX, USA

During a recent renovation of the University of Texas at Austin Fossil Preparation Laboratory, an aging facility was updated by replacing equipment, tools, and furniture with mobile, ergonomic, and efficient systems while placing emphasis on worker and specimen safety. Traditional mechanical and chemical preparation methods are augmented by new digital technologies, and every effort was made to efficiently and cost-effectively integrate these into the laboratory workflow. Through the addition of high definition digital photo- and video-microscopy tools, workstation access to preparation record and collections databases, and wireless networking of chemical, technical, and anatomical references, Material Safety Data Sheets, map, and photographic libraries, preparators are able to immediately access any reference material necessary with the click of a mouse. Additionally, computed tomography (CT) datasets and three-dimensional digital models of specimens can be presented directly to the workbench, eliminating trips back and forth to offices or computer labs, as well as risks to laptop computers and other delicate equipment. In addition to aiding an experienced individual preparator, these digital methods also facilitate more precise instruction of new employees, ease and accuracy of record keeping, and provide exciting and engaging visual aids during education and outreach exercises.

Poster Session III, (Tuesday)

NEW COLLECTIONS OF LATE HEMINGFORDIAN AND EARLY BARSTOVIAN SMALL MAMMALS FROM THE BARSTOW FORMATION, MOJAVE DESERT, CALIFORNIA

BROWNE, Ian, Oklahoma State University, Center For Health Sciences, Tulsa, OK, USA; SMITH, Kent, Oklahoma State University, Center for Health Sciences, Tulsa, OK, USA; CZAPLEWSKI, Nicholas, University of Oklahoma, Norman, OK, USA

The middle Miocene is, in part, characterized by a period of global warming that occurred from approximately 17.2 to 14.9 Ma. Warming began during the late Hemingfordian (He 2), peaked during the early Barstovian (Ba 1), and gradually declined during the late Barstovian (Ba 2). The fossil mammal- bearing strata of the Barstow Fm. were deposited during this span of time and have the potential to provide valuable insights into the response of mammalian faunas to climate change. While the Barstow Fm. is well known for fossils of both large and small mammals, they have generally not been recovered in association with each other, and the relationships between the two groups are often unclear. In order to integrate what is known about the two groups of fossils at any given stratigraphic horizon, we are screenwashing previously known megafaunal localities (from *in situ* fossiliferous strata or quarry tailings) in the Mud Hills for microvertebrates. We concentrated our initial efforts on the early Barstovian (Ba1) localities for two reasons: this portion of the section has not been well sampled for microfossils, and warming peaked during this period of deposition. Our preliminary work in this part of the section yielded a diverse assemblage of rodents that includes: the heteromyids *Cupidinimus halli*, *Cupidinimus nebraskensis, Perognathus minutus*, and *Proheteromys lophatus*; the cricetids *Copemys pagei* and *Copemys* cf. *tenuis*; a sciurid *Miospermophilus* sp.; and an undescribed zapodine (the first record of the group in the Barstow Fm.). In addition, we recovered a chiropteran (possibly a vespertilionid) from this part of the section. Our work at one of the late Hemingfordian (He 2) localities produced a well preserved right maxilla of an archaeolagine leporid that shares affinities with both *Hypolagus fontinalis* (small size) and *Hypolagus parviplicatus* (P^2 with a cement-free external anterior reentrant). This specimen is the first leporid reported from the Hemingfordian-age strata of the Barstow Formation.

Technical Session XIV, Wednesday 8:00

NEW POLISH FOOTPRINTS PULL ORIGIN AND DIVERSIFICATION OF DINOSAUR STEM-LINEAGE INTO EARLY TRIASSIC

BRUSATTE, Stephen, American Museum of Natural History, New York, NY, USA; NIEDZWIEDZKI, Grzegorz, University of Warsaw, Warsaw, Poland; BUTLER, Richard, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany

The ascent of dinosaurs and their closest relatives in the Triassic was an exemplary evolutionary radiation and has long been a subject of interest. Problematically, the earliest phase of dinosaur history, following the divergence of the dinosaur lineage from crocodile-line archosaurs, remains poorly understood. Body fossils of close dinosaur relatives are rare, but indicate that the dinosaur stem group (Dinosauromorpha) originated by the latest Anisian. Here we report dinosauromorph footprints from three sites in the Early-Middle Triassic of Poland, stratigraphically well constrained and identified using a conservative synapomorphy-based approach that matches diagnostic characters of skeletal hindlimb morphology with features of footprints. The oldest Polish site, dated as early Olenekian (ca. 248 million years ago), includes rare specimens of *Prorotodactylus*, which exhibit synapomorphies of dinosauromorphs in general and the aberrant genus *Lagerpeton* in particular (e.g., bunched digits, digitigrade posture, digit IV longest). These specimens are the oldest global record of dinosauromorphs, are approximately eight million years older than the oldest body fossils of this clade, and several million years older than the oldest dinosauromorph footprints. As these tracks are only a few million years younger than the Permo-Triassic mass extinction, they raise the possibility that the dinosauromorph radiation may have been triggered by post-extinction recovery, and was not an unrelated event that occurred 15-20 million years later as widely considered. Dinosauromorph tracks are rare in all three Polish assemblages, suggesting that these animals were minor faunal components. The oldest tracks are small (4 cm maximum length) and quadrupedal, a posture uncommon among the earliest dinosauromorph body fossils. However, bipedality and moderately large body size (14 cm maximum track length) had arisen by the early Anisian (ca. 244 Ma). Integrating trace fossils and body fossils demonstrates that the rise of dinosaurs was a prolonged affair, with approximately 50 million years between the origin of Dinosauromorpha and the first faunas entirely dominated by dinosaurs.

Poster Session III, (Tuesday)

STABLE ISOTOPE ANALYSIS OF AN EXTINCT PLEISTOCENE GROUND SLOTH, *MEGALONYX JEFFERSONII,* FROM THE TARKIO VALLEY OF SOUTHWESTERN IOWA: IMPLICATIONS FOR BIOAPATITE DIAGENESIS

BRYK, Alexander, Penn State University, University Park, PA, USA; FERANEC, Robert, The New York State Museum, Albany, NY, USA; SEMKEN, Holmes, The University of Iowa , Iowa City, IA, USA

Stable isotope analyses from Xenarthran species are increasing in abundance in Pleistocene paleoecological interpretations. Diagenesis and isotopic exchange must always be a concern in these studies. The chemical processes which alter primary apatite are poorly understood. As a result, there is no unambiguous method to assess diagenetic alteration of primary isotopic signatures in bioapatite. This necessitates the use of multiple independent proxies (e.g. crystalinity indices, REE analysis, preserved organic content) to assert that primary isotopic ratios are preserved. Moreover, there is consensus that animalbone, dentine, and enamel display differential diagenetic alteration and that enamel is the most resistant. In addition, differential alteration can occur between discrete functional groups within the bioapatite crystal lattice. For Xenarthrans, diagenesis is of special concern because they lack enamel-coated teeth. This study focuses on carbon and oxygen isotope composition variation within a single tooth from a late Pleistocene ground sloth, *Megalonyx jeffersonii* from the Tarkio Valley, Iowa. SEM examination and optical/X-ray analysis of the tooth revealed the presence of four dentine layers, all exhibiting distinct hardnesses, porosities, and thicknesses. Fifty-six samples (total) between four separate dentine layers were taken from a longitudinally sectioned molariform. Samples were processed for carbonate carbon and oxygen isotope ratios as well as for phosphate oxygen. In addition, a bulk collagen sample was prepared for an organic carbon isotopic ratio and for an AMS ^{14}C date. These data interpreted here will facilitate our understanding of potential differential diagensis among dentine layers in Xenarthran teeth.

Poster Session IV, (Wednesday)

AXIAL PATTERNING IN THE PYGMY RIGHT WHALE *CAPEREA MARGINATA*: IS IT A FOURTH EXCEPTION TO THE RULE OF SEVEN?

BUCHHOLTZ, Emily, Wellesley College, Wellesley, MA, USA

Rare morphological systems display stasis across diverse environments and long geological time spans. Stasis may be the product of bias in the generation of variation or of negative pleiotropic effects that occur when entrenched morphologies are disrupted. Three genera (*Choloepus*, *Bradypus*, *Trichechus*) are traditionally recognized as exceptions to the nearly universal count of seven cervical vertebrae in Mammalia. Here I examine the possibility that the pygmy right whale, *Caperea marginata*, represents a fourth and unique violation of the cervical constraint. *Caperea* is a rare mysticete cetacean with an unusual suite of axial skeletal characters. A gracile first thoracic vertebra without rib facets, broadly expanded anteriormost ribs, a long thorax with broadly overlapping vertebral transverse processes, plate-like posterior ribs, and an extremely short lumbos all contrast with other cetaceans and suggest unique developmental patterning. Twenty-four individuals of diverse ontogenetic age were available for analysis at the South Australia Museum (Adelaide) and the Museum of New Zealand Te Papa Tongarewa (Wellington). Multiple, variable examples of incomplete rib fusion in neonates and dependent calves indicate that the expanded anteriormost rib of adults is an ontogenetic fusion product of ribs 1 and 2. The composite rib articulates by way of its anterior (Rib 1) component to the sternum and by way of its posterior (Rib 2) component with thoracic vertebra 2. When rib fusion is taken into account, vertebral count in *Caperea* is nearly stable at C7T18L1Cd16-17 or C7T17L1Cd16-18. The composite rib does not violate the traditional cervicothoracic boundary, as its anterior component does articulate (albeit distantly) with both the vertebral column and the sternum. Analysis of axial morphology in *Caperea* and other atypical mammals suggests that structures with abaxial patterning have played key roles in providing morphological flexibility when primaxial developmental constraints are very rigid.

Poster Session I, (Sunday)

CHRONIOSUCHIANS AS CROCODILE MIMICS

BUCHWITZ, Michael, TU Bergakademie Freiberg, Freiberg, Germany; WITZMANN, Florian, Museum für Naturkunde der Humboldt-Universität, Berlin, Germany; KOGAN, Ilja, TU Bergakademie Freiberg, Freiberg, Germany; VOIGT, Sebastian, TU Bergakademie Freiberg, Freiberg, Germany

Chroniosuchians are a species-poor tetrapod group from the Permian and Triassic of Eurasia. On the basis of their cranial and vertebral structure they have been related to Paleozoic stem-amniotes, such as embolomeres or seymouriamorphs. Introduced with the naming of *Chroniosuchus* in 1957, the comparison of chroniosuchians to crocodilians initially alluded to *Chroniosuchus*' elongated snout, archosaur-like preorbital openings, and overall reptiliomorph appearance. The characteristic chroniosuchian dorsal shields constituted a further analogy. Following the abundant discovery of chroniosuchian remains in association with aquatic vertebrate fossils, they soon became an example for larger aquatic to semi-aquatic predators that represented an ecomorphotype similar to those hold by crocodilians during the later Mesozoic. The hypothesis that the chroniosuchian dorsal shields evolved in a more terrestrial context – as a device for the protection of the vertebral column and trunk against damaging shear and torsional loads associated with locomotion on land – is based on their comparison with certain fossil crocodilian osteoderm shields that apparently had such a function. In fact, the dorsal osteoderm systems of chroniosuchians are remarkably similar to those of crocodilians and other suchian archosaurs in forming a craniocaudally segmented shield whose segments are attached to the spinal processes of corresponding vertebrae and can be connected to each other through joints. In a histological study of chroniosuchian osteoderm bone we found distinct bundles of anteriorly and posteriorly trending Sharpey's fibres in the internal osteoderm cortices of four sampled chroniosuchian taxa, indicating the attachment of epaxial muscles on the posteromedial parts of the ventral osteoderm surfaces. This feature is paralleled by crocodilians, whose paravertebral osteoderms constitute a crucial part of the trunk bracing system by forming muscle attachment sites. We find likely that the chroniosuchian dorsal shield was part of an analogous type of bracing system that enforced the terrestrial capability of its bearer.

Poster Session III, (Tuesday)

FORELIMB MYOLOGY OF THE BASAL THEROPOD DINOSAUR *TAWA HALLAE* FROM THE LATE TRIASSIC HAYDEN QUARRY OF NEW MEXICO

BURCH, Sara, Stony Brook University, Stony Brook, NY, USA; SMITH, Nathan, Field Museum of Natural History, Chicago, IL, USA; NESBITT, Sterling, The University of Texas at Austin, Austin, TX, USA; IRMIS, Randall, Utah Museum of Natural History, Salt Lake City, UT, USA; TURNER, Alan, Stony Brook University, Stony Brook, NY, USA

Reconstructing limb musculature provides important information about the function and capability of tetrapod limbs. Previous reconstructions of theropod forelimb myology have focused on shoulder musculature in derived taxa and its relation to the evolution of flight, but the forelimb myology of a basal taxon has yet to be documented. The basal theropod *Tawa hallae* from the Late Triassic of New Mexico provides a nearly complete osteology of the forelimb and pectoral girdle, allowing a full reconstruction of forelimb musculature. Integrated phylogenetic and extrapolatory methods were used to infer muscle presence and attachment sites by comparing the forelimb musculature of extant archosaurs, lepidosaurs, and testudines. The shoulder musculature of *Tawa* is similar to previous reconstructions for dromaeosaurids, with distinct muscle scars for several large muscles including the insertion of *m. latissimus dorsi* and the origin of *m. triceps brachii caput scapulare*. Other muscle scars were identified that provide further insight into the pectoral musculature. Unlike dromaeosaurids, crocodylians, and most birds, *Tawa* has an insertion scar for *m. pectoralis* on the anterior surface of the deltopectoral crest as an elongate, rectangular striated area extending across most of the length of the deltopectoral crest. Two small, round striated areas on the posterior surface of the internal tuberosity may represent insertions for *m. coracobrachialis longus* and *m. scapulohumeralis posterior,* and an elongate, rugose, slightly depressed area on the medial surface of the humeral shaft indicates the distal extent of *m. triceps brachii caput mediale.* A small raised area on the anterior surface of the ulna is likely an attachment site for m. biceps brachii, indicating a split attachment to the radius and ulna, as in birds. The forelimb myology of *Tawa* established here helps infer the basal conformation of the forelimb musculature and the osteological correlates of major muscle groups in early theropods. These data are critical for investigations addressing questions relating to the evolution of specialized forelimb function across Theropoda, including instances of forelimb reduction.

Poster Session II, (Monday)

IS THERE A MAMMALIAN FAUNAL TURNOVER ASSOCIATED WITH THE MECO GLOBAL WARMING EVENT IN THE DUCHESNE RIVER FORMATION IN UTAH? PRELIMINARY EVALUATION OF NEW FOSSIL DISCOVERIES FROM THE BRENNAN BASIN MEMBER

BURGER, Benjamin, SWCA, Vernal, UT, USA; MURPHEY, Paul, San Diego Natural History Museum, San Diego, CA, USA

The Middle Eocene Climatic Optimum (MECO) is a perplexing global warming event that represented a rapid reversal of the long term cooling trend that occurred during the late middle Eocene 40.0 million years ago. Little is known of the consequence this global warming event had on mammalian communities living at the time. The deposition of the late middle Eocene Duchesne River Formation in northeastern Utah is contemporaneous with the MECO event. The Lapoint tuff, which is situated at the base of the Lapoint Member of the Duchesne River Formation, has a published radiometric age of 39.74 ±0.07 million years. Slightly older strata in the underlying Dry Gulch Creek and Brennan Basin members preserve a more sparse fossil record of mammals, mostly confined to the lower part of the Brennan Basin Member, an interval that was formerly referred to as the Randlett Horizon (Chron C19n-C18r; 41.26 million years), and considered by many to be Uintan in age on the basis of its mammalian fauna. Although recent work has demonstrated that the upper part of the Dry Gulch Creek Member is undoubted Duchesnean age, the stratigraphic location of the Uintan-Duchesnean boundary within the upper part of the Brennan Basin Member or lower part of the Dry Gulch Creek Member remains undocumented, as does the nature of the associated faunal transition and relationship, if any, to the MECO. Here we describe an unusual fossiliferous horizon within the Brennan Basin Member that has so far yielded a new sample of rodents and artiodactyls. The Brennan Basin Member consists of sandstone and conglomeratic lenses interbedded with reddish-brown siltstone. The fossiliferous horizon is a single layer of light greenish-gray siltstone that contains isolated mammalian remains, with lesser amounts of turtles and crocodilian fossils that are more abundant in the underyling Uinta Formation. Continued sampling of this horizon will add to the poorly documented fauna of the lower part of the Duchesne River Formation and help to better characterize the mammalian faunal turnover at the Uintan-Duchesnean boundary and its possible association with the MECO event.

Poster Session I, (Sunday)

TWO PREVIOUSLY UNREPORTED TURTLES FROM THE EOCENE UINTA FORMATION, UTAH

BURK, Daniel, Intermountain Paleo-Consulting, Vernal, UT, USA; SANDAU, Stephen, Intermountain Paleo-Consulting, Vernal, UT, USA; KLIMEK, Jason, Intermountain Paleo-Consulting, Vernal, UT, USA

Nine individual turtles representing two previously unreported taxa were collected during reconnaissance surveys in the Uinta Basin of northeastern Utah. The specimens were recovered from variegated siltstones and mudstones from the uppermost Uinta C (Myton Member) of the Uinta Formation where it interfingers with the Brennan Basin Member of the Duchesne River Formation. All individuals are fragmentary and consist almost entirely of carapace and plastron fragments. Seven individuals, ranging from juvenile to adult, share characteristics with the superfamily Testudinoidea, specifically the families Emydidae and Testudinidae. Similarities to the Emydids include an anterior notched nuchal with a trapezoid shaped cervical scale wider on the posterior end, a well developed longitudinal carina beginning on the ventral side of the 3rd peripheral and traveling posteriorly, along with a elongate rhombus shaped entoplastron. Similarities to the Testudinids include costo-peripheral vacuities spanned by rib extremities originating dorsally from the distal margin of the costals and articulating in pits medially positioned on the interior margins of the peripherals beginning with the 3rd, a convex posterior margin of the nuchal, and buttresses rising from the peripherals. Similarities to both families include a deep caudal notch and prominent growth rings on the costal elements. A unique characteristic of these seven specimens is a relatively flat costal profile with a sharp angled structural carina near the proximal end of the costals maintaining an overall convex carapace shape. The remaining two individuals are more fragmentary and exhibit certain characteristics similar to the Paleocene Kinosternoid turtle *Hoplochelys*, including carina on the dorsal side of the peripherals, digitations and dentate

sutures between the plastron and peripherals, and a carina running longitudinally down the dorsal surface of the neurals. The addition of these two new taxa increases the characteristically low reptilian biodiversity of the Uinta Formation. This bias may be due to collecting or local taphonomic and climatic controls.

Poster Session II, (Monday)

USING SKIN TO INFER PHYLOGENY: QUANTITATIVE AND QUALITATIVE ANALYSES OF VARIATION IN THE STRUCTURE OF ANKYLOSAUR (DINOSAURIA: ORNITHISCHIA) OSTEODERMS

BURNS, Michael, University of Alberta, Edmonton, AB, Canada

Ankylosaur osteoderms have been used in the diagnoses of ankylosaur species, genera, and subfamilies, but no work has explored all possible sources (textural, morphological, and histological) of their taxonomic characters together. This study assesses the phylogenetic and taxonomic utility of these elements, using comparative material from fossil and extant tetrapod taxa. Putative differences among three ankylosaur groups (ankylosaurid, nodosaurid, and polacanthid) are evaluated via statistical and phylogenetic tests.Archosaur osteoderms all share two cortices (superficial and deep) surrounding a core of spongy bone. Ankylosaur osteoderms are united by a distinct superficial cortex, a lack of Sharpey's fibers, and mineralized collagen structural fibers. Nodosaurid osteoderms lack a well-developed deep cortex and have a dense structural fiber system in the superficial cortex. Polacanthids have a cancellous core, although this is shared with some ankylosaurids and nodosaurids. A t-test comparing cortical thickness shows significant overlap among groups, suggesting a thick cortex is not diagnostic for polacanthids. Ankylosaurid osteoderms are comparatively thin.

Small ossicles (< 5mm thick) are morphologically and histologically similar among all three groups. Modified elements (e.g. tail club osteoderms) do not exhibit histology consistent with the basal condition for their given ankylosaur group. This is supported by extant *Caiman* osteoderms, which show significant correlation between histological variation (cortical thickness) and osteoderm shape in a t-test. Core Haversian bone is found only in some ankylosaurid and nodosaurid osteoderms and is not necessarily indicative of any particular group. Some osteoderm shapes are diagnostic for specific ankylosaur taxa (e.g. cervical/thoracic distal spines in nodosaurs). The same is true of superficial texture, which is only useful for species-level identification in isolated cases.

Incorporation of these characters into several parsimony analyses provides strong support for the Ankylosauridae and Nodosauridae, but not for a monophyletic "Polacanthidae," which is considered a grade of primitive ankylosaurids.

Technical Session I, Sunday 9:00

INTERACTIONS BETWEEN SEA LEVEL, SAMPLING AND DINOSAUR DIVERSITY DURING THE MESOZOIC ERA

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The fossil record is our only window on the diversification of life in deep time, butthere is widespread concern over the effects of sampling on observed paleodiversity. However, it is also possible to overcorrect this interdependence (or worse), especially if sampling and diversity are driven by common factors (e.g. sea-level change). Non-avian dinosaurs represent an excellent study group for investigating these relationships in the terrestrial realm, becausethey offer a rich, temporally extensive, and geographically varied fossil record. Additionally, several causal hypotheses exist regarding their 160-million-year diversification.

Here we present the results of a detailed quantitative analysis of the dinosaur fossil record in conjunction with data on sampling and the rock record. We test two specific hypotheses: 1) whether a robust diversity signal is present within the existing fossil record; and 2) whether changes in sea level are correlated with changes in diversity. Our dataset include multiple sea level curves, species-level information on more than 750 dinosaur taxa, and associated formational, temporal, and sampling data, available in the Paleobiology Database.

Although raw data show correlations between sea level and both taxonomic diversity and sampling, these do not survive detrending or removal of short-term autocorrelation via generalized- or first-difference transformations. However, the strong correlation between diversity and sampling appears genuine even after transformation, whereas sampling-corrected diversity correspondingly shows no correlation with sea level.

In fact, sea level correlations appear to result from general upward trends in all data series, and we detect no correlations between short-term sea level changes and similar-scale fluctuations in diversity or sampling. Therefore we consider the hypothesis that dinosaur diversity is tied to sea level to be poorly supported, either via direct influence or a common causative factor. Our results instead support the view that sampling variation is the preferred null hypothesis for diversity variations in the Mesozoic terrestrial realm.

Poster Session IV, (Wednesday)

DISCRIMINATING FOSSILS ARE NOT STATIC: AN ASSESSMENT OF THE DISCRIMINANT FUNCTION ANALYSIS METHOD FOR TESTING STASIS

BYKOWSKI, Richard, Indiana University, Bloomington, IN, USA; GREEN, Robin, Indiana University, Bloomington, IN, USA; O'DONNELL, Kenneth, Indiana University, Bloomington, IN, USA; SMITH, Michael, Indiana University, Bloomington, IN, USA; POLLY, P. David, Indiana University, Bloomington, IN, USA

The fossil record preserves the history of the morphological evolution of taxa throughout the Phanerozoic. However, the rate and mode of evolutionary change has been the subject of debate since the advent of the punctuated equilibrium model of species evolution. One classic statistical approach for determining whether a species exhibits evolutionary stasis uses discriminant function (or canonical variates) analysis to maximize the difference between samples from the first and last time slice of a species lineage: if the two samples overlap, then the lineage is judged to be in stasis. This method does not consider statistical time-series theory and may be subject to type I and type II error. We developed a Monte Carlo experiment in the freeware statistical program *R* to systematically assess the power of this method in different situations. We controlled for seven parameters: the number of traits, the number of generations in a lineage, the per-generation rate of evolution, the strength of stasis, and the standard deviation and the size of the samples. We varied each of these parameters and repeated the model with 1000 replications to determine the success rate of the discriminant function test for stasis. In this study, type I error occurs when the test incorrectly identifies a pattern as stasis and type II error occurs when the test incorrectly rejects stasis. In cases of weak or no stasis, with small numbers of traits, generations, or sample sizes, the method is prone to error. Type I error is high when there is a large population size, low rate, and no stasis. Type I error is low and type II error is high when there is a large number of traits and generations. Type II error is low when there is weak stasis and large population size. There is no type II error when stasis is strong with few traits and generations, regardless of sample size. The error rate of the discriminant function test for stasis is case dependent; however, our results suggest that it is most appropriate for evolutionary studies spanning many generations (greater than one million).

Technical Session V, Sunday 2:15

MICROWEAR, DIET AND FOSSORIALITY IN MIOCENE RODENTS FROM THE GREAT BASIN

CALEDE, Jonathan, University of Oregon, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

Low-magnification microwear analysis has been the subject of much interest in reconstructing the diet of fossil species. This method is based on counts of scratches and pits (i.e. the microwear signature) and has proven effective in studies of the paleodiet of ungulates, proboscideans, lemurs, and rodents. In this study, we include eleven species of rodents ranging in diet from fungivory to folivory and focus on burrowing herbivores. In addition, we also gathered data on the microwear signature of six species of burrowing rodents from the Miocene of the Great Basin belonging to the family Geomyidae and Mylagaulidae. Our results suggest that *Pliosaccomys magnus* and *Mojavemys mascallensis* were very similar in diet to each other and to *Thomomys talpoides*, the northern pocket gopher. Mylagaulids exhibit very diverse diets both across and within species and seem to be more opportunistic in their feeding behavior. *Alphagaulus vetus* appears to have fed on a diet of aboveground plants supplemented by seeds and nuts. *Hesperogaulus gazini* overlaps with numerous species with diverse diets and may have been an opportunistic feeder. Initial results for *H. wilsoni* suggest that it could have fed on a diet of fungi and fruits similar to that of modern chipmunks. A new, yet to be described species of the genus *Hesperogaulus* displays a microwear signature closest to that of the North American porcupine, hinting at a mixed feeder diet. We find discrepancies between the degree of fossoriality of mylagaulids as suggested by microwear and that demonstrated by cranial and skeletal evidence. Some diets may be over-imprinting the signal from burrowing, erasing evidence for an underground way of life. It appears that linking microwear signature to diet and fossoriality is challenged by the conflict between those two signals, the variability in diet in opportunistically-feeding small mammals, and possible evolutionary baggage. This last issue suggests the need for a more careful examination of the influence of phylogeny on microwear signature using an extended dataset carefully sampled across the rodent phylogeny.

Poster Session I, (Sunday)

A NEW VERTEBRATE ASSEMBLAGE FROM THE LATE CRETACEOUS (MAASTRICHTIAN) NEW EGYPT FORMATION OF NEW JERSEY

CALLAHAN, Wayne, New Jersey State Museum, Trenton, NJ, USA; JOHNSON, Ralph, Monmouth Amateur Paleontologist's Society, West Long Branch, NJ, USA; MEHLING, Carl, American Museum of Natural History, Nwe York, NY, USA

Recent explorations of small creeks in the New Jersey Inner Coastal Plain have revealed a new vertebrate fauna from the Maastrichtian New Egypt Formation. Spheno Run, nicknamed for common septal fragments of the ammonite *Sphenodiscus lobatus*, is producing a well preserved vertebrate fauna. This assemblage preserves a non-lag vertebrate bearing horizon in the lower portion of the formation approximately 8 meters below the Cretaceous/Paleogene boundary. This part of the lower New Egypt is not well exposed elsewhere in New Jersey and represents a relatively deep water environment. Invertebrates found in association with the vertebrate fossils correlate well with the middle Severn Formation of

Maryland. Spheno Run has thus far produced a diverse vertebrate fauna especially rich in marine reptiles. These include the turtles *Peritresius ornatus* and *Taphrosphys sulcatus*; the mosasaurs *Prognathodon rapax*, *Mosasaurus hoffmanni*, a probable plioplatecarpine and the plesiosaur *Cimoliosaurus magnus*. Chondrichthyans include the associated teeth and vertebrae of a very large specimen of the anacoracid shark *Squalicorax pristodontus*, the lamnid sharks *Cretalamna appendiculata* and *Odontaspis* sp., the sclerorhynchid sawfish *Ischyrhiza mira* and thechimaeroid *Edaphodon mirificus*. Bony fish are represented by *Enchodus ferox*, *Anomoeodus robustus*, *Cylindracanthus ornatus*, associated scales, fin spines and vertebrae of an as yet unidentified beryciform fish and rare teeth that favorably compare to the aulopiform genus *Apateodus*. If additional material confirms the occurrence of *Apateodus* it will expand the geographic range of this taxon to include the Atlantic Coastal Plain. Rare elements from the Spheno Run locality include hollow, thin-walled bone fragments representing the remains of pterosaurs and a partial maxilla from a juvenile hadrosaur. Although associated skeletal elements are found at Spheno Run articulated specimens are not. This is likely due to scattering of post mortem remains by scavenging. The evidence for this interpretation lies in the great number of bony elements that display bite and scrape marks from both small and large toothed scavengers.

Technical Session II, Sunday 9:00

A GEOMETRIC MORPHOMETRIC ASSESSMENT OF GONDWANAN *LYSTROSAURUS* AND THEIR RELATION TO LAURASIAN FORMS

CAMP, Jessica, University of Iowa, Iowa City, IA, USA

Lystrosaurus is one of the few terrestrial vertebrate genera to have crossed the Permian-Triassic boundary and the only one to increase greatly in abundance following the faunal turnover. These factors, in conjunction with its cosmopolitan presence in both Gondwanan and Laurasian faunas, make it a unique case study for use in tests of the nature of the end-Permian extinction and subsequent ecosystem recovery across Pangaea. This potential has been hindered by oversplitting and a poorly understood taxonomy. Some researchers have questioned whether two of the four currently recognized Gondwanan species (*L. declivis* and *L. murrayi*) are valid or represent a single, sexually dimorphic species. I assessed morphological variation in *Lystrosaurus* crania using geometric morphometrics. My results indicate all four currently recognized species are valid. While *L. declivis* and *L. murrayi* exhibit the greatest degree of similarity, they also show significant separation in several relative warp analysis plots. These analyses include juveniles of both species, so therefore imply taxonomic separation as opposed to sexual dimorphism. Results of analyses including several Chinese specimens suggest they are taxonomically distinct from Gondwanan species. As the Chinese forms cluster together in a single group separate from their Gondwanan relatives, they may represent a single dispersal event into Laurasia. These results have implications for biogeographic patterns in the latest Permian. In addition, this study supports the ability of geometric morphometrics to more precisely distinguish morphological variation than was previously possible.

Technical Session V, Sunday 3:00

AMAZONIAN MAGNETOSTRATIGRAPHY: DATING THE FIRST PULSE OF THE GREAT AMERICAN FAUNAL INTERCHANGE

CAMPBELL, Kenneth, Natural History Museum of Los Angeles County, Los Angeles, CA, USA; PROTHERO, Donald, Occidental College, Los Angeles, CA, USA; ROMERO-PITTMAN, Lidia, INGEMMET, Lima, Perú; HERTEL, Fritz, California State University, Northridge, Los Angeles, CA, USA; RIVERA, Nadia, Occidental College, Los Angeles, CA, USA

The Great American Faunal Interchange (GAFI) has long been considered a Plio-Pleistocene event, with uplift of the Panamanian isthmus and most interchange of faunal elements between North and South America taking place at that time. However, recent discoveries in Mexico and Argentina have documented that major events of the GAFI actually took place much earlier than previously thought possible. Now, we have confirmed the previously reported late Miocene age of a North American-derived gomphothere recovered from southeastern Amazonian Peru by analyzing the magnetostratigraphy of the upper Miocene-upper Pliocene Madre de Dios Formation. The outcrop analyzed, known as Cerro Colorado, is on the Madre de Dios River in southeastern Peru. The gomphothere came from the Ipururo Formation beneath the Pan-Amazonian late Miocene Ucayali Unconformity, which occurs at the base of Cerro Colorado. A total of 18 polarity zones was obtained in the ~65-m-thick Cerro Colorado section, which we correlate to magnetozones Chrons C4Ar to C2An (9.5-3.0 Ma) based on prior $^{40}Ar/^{39}Ar$ dates on two volcanic ashes from the Madre de Dios Formation in southeastern Peru. These results also support earlier interpretations of a late Miocene age for other fossils of North American mammals recovered from basal deposits of the Madre de Dios Formation immediately above the Ucayali Unconformity. These mammals include other gomphotheres, tapirs, and two genera of peccaries. The presence of these North American mammals in South America in the late Miocene is recognized as the first pulse of the Great American Faunal Interchange. Although the well-known swimming ability of elephantoids might have facilitated their very early (~10+ Ma) dispersal to South America, geologic data are now available that indicate the presence of a terrestrial pathway connecting North and South America in the late Miocene. The presence of such a terrestrial link has implications for many fields of scientific endeavor.

Technical Session I, Sunday 9:45

CRANIAL MORPHOLOGY AND THE DIVERSITY OF LATE CRETACEOUS EDMONTOSAURS (ORNITHISCHIA: HADROSAURIDAE) FROM NORTH AMERICA

CAMPIONE, Nicolás, University of Toronto, Toronto, ON, Canada; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada

Edmontosaurs are common in Late Campanian and Maastrichtian terrestrial deposits of western North America, and they are the latest occurring hadrosaurids. Based on numerous complete specimens, five taxa have been historically recognized: *Edmontosaurus regalis*, *Thespesius edmontoni, E. annectens*, *E. saskatchewanensis,* and *Anatotitan copei*. Unfortunately, published faunal lists and synonymies have created confusion regarding the validity and biostratigraphic ranges of these species, which has led to uncertainty about the species-level diversity of edmontosaurs leading up to the end-Cretaceous extinction event. Here we use a morphometric approach including bivariate plots and principle components analysis (PCA) to quantify allometry and cranial variation in a sample of 13 complete skulls, representing the five named taxa. The PCA reveals separation of the latest Campanian specimens from Alberta (*E. regalis*, *T. edmontoni*) from those of the Late Maastrichtian (*E. annectens*, *E. saskatchewanensis*, *A. copei*). This division is primarily related to the morphology of the snout. *Edmontosaurus saskatchewanensis*, *E. annectens*, and *A. copei* have a longer antorbital region of the skull, whereas *E. regalis* and *T. edmontoni* are typified by a taller skull with a more prominent reflected oral margin of the premaxilla. Based on these morphometric analyses we conclude that *Thespesius edmontoni* is synonymous with *E. regalis*, and *E. saskatchewanensis* is synonymous with *E. annectens*, and each is restricted to a narrow stratigraphic interval in the latest Campanian and Late Maastrichtian, respectively. *Anatotitan copei* is morphologically most similar to *E. annectens* and may represent a member of this species, but its validity as a distinct taxon remains unresolved, pending further analysis. When considered in a biostratigraphic framework, this study suggests a significantly lower standing diversity of edmontosaurs, and hadrosaurs in general, than is often suggested for the latest Cretaceous.

Poster Session IV, (Wednesday)

SYSTEMATIC REEVALUATION OF "TONI", THE JUVENILE SAUROPOD FROM THE MORRISON FORMATION

CARBALLIDO, Jose, Institute of Paleontology, University of Bonn, Germany-Museo Paleontológico Egidio Feruglio, Bonn, Germany; SCHWARZ-WINGS, Daniela, Museum für Naturkunde, Leibniz, Institut für Evolutions und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Berlin, Germany; MARPMANN, Sebastian, Steinmann Institute, Division of Paleontology, University of Bonn, Bonn, Germany; SANDER, Martin, Steinmann Institute, Division of Paleontology, University of Bonn, Bonn, Germany; PABST, Benn, Sauriermuseum, Aathal, Switzerland

Morphological changes in the ontogeny of sauropods are poorly known, making it difficult to establish the systematic affinities of very young individuals. A headless but almost complete juvenile sauropod nicknamed "Toni" with an estimated total length 2 m was recently recovered from Morrison Formation (Upper Jurassic, western USA). The specimen was described as a diplodocid due to the presence of some putative synapomorphies of this group. However, recent further preparation revealed a number of non-diplodocid characters. To detect the affinities of "Toni", a phylogenetic analysis was conducted. In the strict consensus tree the specimen was recovered among titanosauriforms as a basal brachiosaurid. Fifteen extra steps are needed to place this specimen among Diplodocidae. Characters supporting titanosauriform affinities include: low sacral neural spines, middle caudal vertebrae with anteriorly positioned neural spine, and undivided distal condyle on metacarpal I. The absence of medially divided centroprezygapophyseal lamina in the posterior dorsals and the anteroposteriorly compressed femur support its inclusion in Brachiosauridae. Several diplodocid characters are absent in "Toni" such as the bifid cervical neural spines, procoelous first caudal centrum, weakly procoelous anterior caudals, long middle caudal vertebrae, short cervical ribs, and caudolateral projection of distal condyle of metatarsal I. The autapomorphic characters recovered in the analysis can reflect major ontogenetic transformations. These mainly affect pneumaticity (e.g., change from simple pleurocoels in the cervicals to complex pleurocoels and the development of lateral excavations in the dorsal vertebrae) but also include unexpected transformations (e.g., development of the spinodiapophyseal lamina, widening of the neural spines in the dorsal vertebrae). We thus identify the specimen as a juvenile of *Brachiosaurus* or a new titanosauriform taxon. The study of "Toni" allows a comparison of character acquistion during ontogeny and phylogeny.

Preparators' Session, Monday 10:15

CT IMAGING OF FOSSIL-BEARING CALCIFIED CLASTIC SEDIMENTS FROM THE MALAPA SITE, SOUTH-AFRICA — ADVANCES IN DISCOVERY, IDENTIFICATION AND PREPARATION OF FOSSIL HOMININS AND FAUNA

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Integrating a dedicated programme of computed tomography (CT) scanning of calcified clastic sediment blocks into the traditional arsenal of palaeontological preparation techniques

is being tested at the hominin rich site of Malapa, South Africa. There are several advantages to incorporating a virtual preparation technique. First, this considerably shortens overall preparation time, making more efficient use of a given number of preparation hours. Exact positions of fossils within the hard matrix can be communicated to preparators before extraction begins. Second, this method provides an opportunity to finish particularly delicate preparations virtually, which saves specimens from damage during risky extractions. Copies of specimens can be produced using 3D printing technology. Third, the method removes an additional element of chance from discovery by allowing more systematic searching of matrix for fossils (i.e., fossils buried completely in blocks of matrix are no longer invisible). This procedure also reduces the potential for damaging unknown specimens that are encountered as a surprise during preparation of known specimens. Results are scanner-specific and the choice of scan parameters will produce varying results. Thus, there appears to be no single 'best practice', although similar protocols may be applicable for blocks from similar sedimentary units. Formalizing the process by creating reporting forms to aid in the prioritization of preparation, as well as involving technicians in the process by showing the location, direction and position of fossils within the matrix have produced excellent results. For example, the methods employed have resulted in the discovery and identification of early hominid fossils that were not visible on the surface of individual blocks, thereby enhancing our search capabilities for typically rare fossils, and by further minimizing destructive extractive and preparation techniques.

Poster Session I, (Sunday)

TAPHONOMY OF THE DOUGLASS QUARRY, DINOSAUR NATIONAL MONUMENT, UTAH

CARPENTER, Kenneth, Denver Museum of Nature & Science, Denver, CO, USA

The taphonomy of the dinosaur quarry is presented using unpublished manuscripts, diaries, notes, quarry maps, and historical photographs, as well as sedimentology, petrography, and analysis of specimens. Three-dimensionally preserved dunes (up to 1.25 m tall), bone distribution and orientation, unsorted to poorly sorted gravelly or pebbly quartz sandstone, stacked sandstone beds, and unionids in life position indicate repeated episodes (3-4) of deposition in a sandy braided river flowing southeast. Clay drapes separate depositional episodes. Based on movement of the largest femur (of*Apatosaurus louisae*), water velocity during flood stage was approximately 4.2 m/s and discharge was 1181 m^3/s across a 225 m wide braidplain. Most articulated and semi-articulated skeletons were collected upstream (physically above) of the present quarry. Quarry specimens typically show Stage 0 or rarely Stage 1 weathering (Behrensmeyer scale), and thin sections show some fungal micro-borings. Stages of disarticulation and weathering suggest attritional and non-catastrophic mass mortality due to drought. That droughts occur is supported by regional evidence (e.g., rain shadowing effect) and semiarid paleosol development.

Technical Session VIII, Monday 3:45

PLACODERM REPRODUCTIVE STRATEGIES

CARR, Robert, Ohio University, Athens, OH, USA

Among extant chondrichthyans, internal fertilization results in the production of oviparous egg cases or retained oviparity (viviparity). Oviparous chondrichthyans are substrate dependent for the laying of their eggs, while viviparous taxa range from pelagic births to coastal nurseries. Recent discoveries of *in situ* placoderm embryos in ptyctodonts and arthrodires extends the occurrence of internal fertilization and retained oviparity to basal gnathostomes. The unique fish fauna of Merriganowry NSW, Australia (Late Givetian–Early Frasnian), consists of a single species assemblage of *Cowralepis mclachlani* (a phyllolepid placoderm) that includes a complete range of ontogenetic stages. This unusual assemblage in a restricted basin suggests the presence of a nursery. In contrast, the Cleveland Shale fishes (Famennian) represent an epipelagic fauna isolated from the open basin benthos due to the toxic bottom habitat. A common member of the fauna is *Dunkleosteus terrelli*, a free-swimming placoderm species (up to an estimated 6 m length). For *D. terrelli*, a single pup has been discovered. Its estimated body length of less than 5% of the body length of an average adult implies that it represents a prenatal embryo (based on comparisons to extant chondrichthyan birth sizes). A discovery that adds to an understanding of placoderm reproductive strategies is the presence of egg cases in the Cleveland Shale. Three cases, up to 20 cm in length, are known. One case clearly demonstrates the presence of dermal bone (confirming its placoderm origin). The cases lack tendrils (necessary for anchorage) and lack evidence for respiratory pores. Based on this anatomy, it can be hypothesized that cases of this type are restricted to the aerated shallow parts of the basin, potentially in near-shore nurseries. This can be tested based on the geographic distribution of juvenile remains relative to their adult counterparts. It is clear that placoderms share with chondrichthyans the diversity of oviparous to retained oviparous reproductive strategies and the presence of both in basal gnathostomes suggests that these strategies may be the plesiomorphic condition among gnathostomes.

Technical Session XIV, Wednesday 10:45

ONTOGENETIC VARIATION IN *TYRANNOSAURUS REX*: RESULTS FROM A NUMERICAL CLADISTIC ANALYSIS

CARR, Thomas, Carthage College, Kenosha, WI, USA

Many new specimens of *Tyrannosaurus rex* have been discovered in the past 20 years, providing the opportunity to thoroughly document variation in this taxon. Several of the new specimens occupy the gap between the smallest juveniles and the largest adults; this is significant because the differences between these ontogenetic stages are so extreme that they have been mistaken for different taxa. Therefore, the present sample provides the opportunity to document the morphological transformation from juvenile to adult with unprecedented completeness and detail. The objective of this project was to reconstruct the growth series of *T. rex* using a robust sample size and more characters than have been used previously. A cladistic analysis of 20 specimens was executed in PAUP under a branch and bound search with all characters equally weighted. A total of 930 hypothetical ontogenetic characters were analyzed (893 from the skull and jaws, 1 from the axial skeleton, 18 from the pectoral girdle and limb, 20 from the pelvic girdle and limb). The analysis resulted in 6 most parsimonious trees, each with a length of 1,188 steps, and with the statistics: CI: 0.77, HI: 0.23, RI: 0.85, RCI: 0.66. The lack of resolution pertains to two pairs of subadults, otherwise the topology is nearly pectinate. The results reconstruct a sequence of 15 steps of growth changes, where the most mature specimen is LACM 23844. There are two gaps in the growth series that are between the juveniles and subadults, indicating that this interval of the greatest– and presumably the most rapid – amount of growth change is still incompletely represented by the known fossils. *T. rex* displays a variety of ontogenetic patterns that pertain to: (1) tooth morphology, (2) tooth number, (3) cranial ornamentation, (4) suture fusion, (5) pneumatization, (6) muscle attachments, (7) growth rings, (8) proportions, and (9) joint surface morphology. The results do not support the recent hypothesis of a second species of *Tyrannosaurus* in the American west.

Poster Session III, (Tuesday)

ADVANCES IN LATE TERTIARY MEXICAN PALEONTOLOGY: THE EARLY-LATE HEMPHILLIAN FAUNA FROM THE JUCHIPILA BASIN, STATE OF ZACATECAS MEXICO

CARRANZA-CASTAÑEDA, Oscar, Centro de Geociencias, Campus UNAM, Juriquilla, Queretaro., Mexico; ARANDA-GÓMEZ , José, Centro de Geociencias, Campus UNAM, Juriquilla, Queretaro., Mexico; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Intensive fieldwork was done in a fault-bounded basin at the Juchipila-Tabasco region (N 21.5°, W 102-103°). The graben-fill sequence consists of river, lake, and overbank deposits interbedded with thin ash-fall layers. The fossil assemblage includes the oldest megalonychid record in Central Mexico, and it is represented by two molariform teeth and the right metatarsal (MT) III. Based on the size and facets for MT IV, MT II, and ectocuneiform, it is closely related to *Pliometanastes*. The first Mexican record of *Cosoryx* is represented by a skull and jaw fragment with reduced premolars. The skull has a fragment of left horn, which has a rounded cross-section and is planted over the orbit. In another skull fragment assigned to *Plioceros*, there is a flat suture near the orbit. Another horncore is laterally flattened and bifurcates ending in blunt tips, features typical of *Plioceros*. Equids are abundant in the Juchipila localities, and are crucial for correlation with other late Tertiary mammalian faunas in Central Mexico. An almost complete skull, assigned to *Dinohippus mexicanus,* has teeth with the characteristic features of this species, including the "wooden-shoe shape" of the protocone. However, the facial region shows critical differences from other late Hemphillian horses of Mexico, such as absence of malar fossa and that the Dorsal Preorbital Fossa (DPOF) is only a faint depression without pocket or well defined boundaries. These features contrast with the well defined and deep DPOF found in specimens from other localities. These differences are interpreted as individual variability or may represent taxonomically distinct characters. An almost complete maxilla and isolated upper and lower teeth are assigned to *Calippus* (*Grammohippus*) *hondurensis.* The presence of *Calippus* and lack of *Nannippus aztecus* are pivotal in the biostratigraphic correlation with other late Tertiary Mexican faunas. A 5.58 ± 0.10 Ma radiometric date ($^{238}U/^{206}Pb$, zircon) of the upper volcanic ash layer from El Resbalón locality is consistent with an early-late Hemphillian land mammal age.

Technical Session XI, Tuesday 1:45

A CONSTRAINT-BASED MODEL FOR PHYLOGENY RECONSTRUCTION

CARTER, Katherine, New York University, New York, NY, USA

Teeth are more often preserved than any other vertebrate skeletal element in the fossil record, thus forming the basis for much taxonomic and phylogenetic analysis. Reconstructions done with phenotypic characters based on parsimony optimization are problematic, however, as it has been shown that dental morphology has a high tendency for homoplasy and that dental traits are not independent from one another. Attempts to use geometric morphometrics as a tool for phylogenetic analysis require no assumptions of character individuation, but have also proven problematic. To circumvent these problems, I argue here for phylogenetic reconstruction of dental characters using tooth occlusion as a functional constraint. Occlusion enacts a strong functional pressure on teeth and the need to occlude significantly constrains both the viable molar morphospace and the shapes of dental evolutionary trajectories. This hypothesis was tested using three-dimensional scans of the upper and lower molars of 4 species of *Tarsius : T. tarsius, T. bancanus. T. borneanus* and *T. syrichta.* Morphospaces of occlusal viability were generated through analysis of the arbitrary juxtaposition of upper and lower molar morphospaces created from landmark data. Theoretical occlusally viable clusters in this morphospace were quantified and the operational taxonomic units (OTU) were defined using multivariate clustering analyses from the empirical data within the morphospace. After the morphospace has been generated, the number of occlusal steps necessary to progress from one OTU to another was measured. These steps are weighted by develop-

mental models to accurately capture differential cusp plasticity. Using the methods described above, the phylogeny expected from molecular studies was obtained. This new technique of phylogenetic reconstruction would also be applicable to fossil taxa.

Poster Session II, (Monday)

THE DEVELOPMENT OF CRUSHING PREMOLARS IN THE STAGODONTID, *DIDELPHODON*

CASE, Judd, Eastern Washigton University, Cheney, WA, USA

The dentition of the stagodontid marsupial, *Didelphodon*, is distinguished by inflated and bulbous premolars. The premolars have a massive central cusp which is a highly derived condition compared to the more typical gracile and trenchant premolars of most other Late Cretaceous marsupials. The Judithian-aged stagodontid, *Eodelphis*, has the more typical marsupial premolar morphology compared to its highly Lancian-aged relative, *Didelphodon*. The tranisition between these two morphologies is not well documented. Stagodontid specimens from Red Owl Quarry in South Dakota exhibit intermediate premolar morphologies between *Eodelphis* and *Didelphodon*. The transitional states in premolar morphology culminating in the highly derived, crushing premolars in *Didelphodon*, may be explained through a morphodynamic model of tooth development.

Technical Session XV, Wednesday 11:15

ASCENT WITH MODIFICATION: FOSSIL FISHES WITNESSED THEIR OWN GROUP'S ADAPTATION TO THE UPLIFT OF THE TIBETAN PLATEAU DURING THE LATE CENOZOIC

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The rapid uplift of the Tibetan Plateau during the late Cenozoic changed it into a habitat island isolated from an increasing complexity of less elevated environments. This makes it a laboratory similar to the Galápagos Islands for studying evolution in action. Inspired by studies on the spatial distribution of Recent schizothoracine fishes on the Tibetan Plateau, we report on evolution of Cenozoic fossil schizothoracines and habitat fragmentation against the backdrop of tectonic uplift. Our results show that the earlier fossil schizothoracines have more rows of pharyngeal teeth and lived at lower altitudes than their relatives from younger deposits. They belong to the primitive grade whose living representatives now live in the peripheral area of the Tibetan Plateau at relatively low altitude. These earlier fossil schizothoracines have been uplifted to the present elevation, and some are in the central area of the Plateau, where extant schizothoracines could not presently survive. Thus, the temporal distribution pattern of the fossil schizothoracines approximately mirrors the spatial distribution pattern of their living counterparts, which reflects the biological responses to the stepwise uplift of the Tibetan Plateau. The consistency in independent lines of evidence between extant and extinct fishes illustrates the beauty of Darwinism. Through ascent with modification, the fossil schizothoracine fishes demonstrate how their own group has adapted to the ever-changing environment caused by geological, biological, and climatic interplays.

Technical Session II, Sunday 11:30

NEW STUDY OF THE CRETACEOUS MAMMAL *AKIDOLESTES* WITH ITS IMPLICATIONS FOR EARLY THERIAN MAMMAL POSTCRANIAL EVOLUTION

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Recent study of the postcranial skeleton of the spalacotheriid *Akidolestes cifellii,* a basal taxon of the trechnotherian clade from the Lower Cretaceous of China, sheds new light on the diversity of locomotory adaptations of basal therian mammals. The postcranial skeleton of *Akidolestes* shows both scansorial and terrestrial locomotory features. The astragalus and the calcaneus lack the specialized features for a wide range of inversion and eversion at the mid-tarsal joint that is typical of scansorial didelphid marsupials. This seems to suggest a terrestrial habitat preference. By contrast, other features would favor a hypothesis that *Akidolestes* had a scansorial locomotory function. These include the triangular shape of the scapula, a relatively higher phalangeal index, a more elongate intermediate phalanx to the proximal phalanx, the profile of terminal phalanx of the manus, and an asymmetrical knee joint, as indicated by the larger lateral distal condyle than the medial distal condyle of the femur. In these features *Akidolestes* is significantly different from the closely related zhangheotheriids (*Zhangheotherium* and *Maotherium*) that were interpreted as generalized terrestrial mammals by the characteristics of the scapula, the manual phalangeal proportion, and by a more symmetric knee joint. Additionally, *Akidolestes* is different in having lumbar ribs and a hypertrophied parafibular process of fibula, which are absent in zhangheotheriids, although the differences in function by these divergent features remain to be understood. As *Akidolestes* and zhangheotheriids both belong to the spalacotheroids, the differences in their scapula, knee, and phalangeal proportion suggest that the known spalacotheroid species are more diverse in locomotory functions than previously thought, and that some degree of ecomorphological diversification occurred within the spalacotheroid clade. Spalacotheroids (including both *Akidolestes* and zhangheotheriids) are basal in the trechnotherian mammal lineage that includes modern marsupials and placentals. Our new data provide a new understanding that the ecomorphological diversification occurred at the generic or even species level within basal clades leading to therian mammals.

Poster Session III, (Tuesday)

LATE PALEOCENE MICROMOMYID PLESIADAPIFORMS (MAMMALIA, EUARCHONTA) FROM BIG MULTI QUARRY, WASHAKIE BASIN, WYOMING

CHESTER, Stephen, Yale University, New Haven, CT, USA; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Big Multi Quarry in the upper Fort Union Formation of the Washakie Basin, southwestern Wyoming, preserves a diverse terrestrial fauna and associated flora from the late Paleocene (Clarkforkian Land Mammal Age; Cf1 or Cf2). Forty-one species of mammals have been documented at Big Multi Quarry, including 11 species of plesiadapiforms. Previously undescribed specimens of micromomyid plesiadapiforms extend the range of morphological variation known for the genera *Tinimomys* (n=36) and *Dryomomys* (n=12), and may represent new species.

Tinimomys sp. is similar to *T. graybulliensis* in possessing a continuous lingual cingulum on its upper molars, supporting an attribution to the genus. However, *Tinimomys* sp. is slightly smaller than *T. graybulliensis* in most tooth dimensions, and is more similar to *Chalicomomys antelucanus* in lacking a metacone and having a small protocone lobe on P3/. *Tinimomys* sp. further differs from *T. graybulliensis*, and is similar to *C. antelucanus* and *Micromomys fremdi,* in possessing a more exodaenodont parastyle on P4/ that is positioned lower relative to the paracone, resulting in a longer preparacrista slope when viewed buccally. Similarities to the most plesiomorphic species of micromomyid, *M. fremdi*, in both the relatively small protocone lobe of P3/ and long preparacrista on P4/, suggest that *Tinimomys* sp. is more primitive than *T. graybulliensis*.

The presence of *Dryomomys* at Big Multi Quarry extends the range of this genus temporally and geographically. Previously *Dryomomys* was only known from the late Clarkforkian (Cf3) of the Clarks Fork Basin, Wyoming, and only represented by the holotype of *D. szalayi*. *Dryomomys* sp. is similar in size to *D. szalayi*, but differs in possessing a significantly wider P/3, a distinct paraconid on M/1, a smaller P3/ with a less pronounced protocone and smaller protocone lobe, and a slightly longer, yet less lingually expansive P4/. Comparisons to other micromomyids suggest that these features may represent plesiomorphic retentions. These new specimens of *Tinimomys* and *Dryomomys* may serve to document evolutionary transitions among known taxa of micromomyids, helping to clarify relationships within the family.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 11:45

APPROACHING TRUE DIVERSITY IN FOSSIL COMMUNITIES USING A COMBINATION OF RAREFACTION METHODS AND THE PIE EVENNESS INDEX

CHEW, Amy, Western University of Health Sciences, Pomona, CA, USA

Ecological diversity consists of two inter-related components: richness (number of species) and evenness (species abundances). Richness is usually interpolated by rarefaction, which plots cumulative species richness as a function of number of individuals (*individual-based*) or average number of individuals per sample (*sample-based*). Evenness may be quantified by the Probability of Interspecific Encounter index (PIE). Richness tracks evenness: sample richness is higher in communities with high evenness and vice versa. I use both methods of rarefaction and PIE to test the long-term relationship between climate and the diversity of the early Eocene mammal fauna of the central Bighorn Basin, WY. Individual-based rarefaction provides a null richness hypothesis given a random distribution of species. Sample-based rarefaction richness estimates reflect non-randomness in species distributions. PIE indicates whether changes in richness are related to changes in community structure. More than 33,000 specimens from 161 species were grouped into 17 ~100Kyr intervals. Six of the intervals were during a cool period and the remaining intervals were during a subsequent warm period (5-8°C warmer mean annual temperature) divided into early (6 intervals) and late (5 intervals). Individual-based rarefaction interpolated significantly higher richness during the early warm period (80 *s*, where *s*=#species/3500 specimens) than during the cool or late warm periods (65 *s*), whereas there were no significant changes in sample-based rarefaction estimates (64, 66, and 59 *s* for cool, early warm and late warm, respectively). The difference between the estimates for the early warm period appears to be related to an underestimation bias in sample-based rarefaction with the increasing size of individual samples. PIE indicates that the late warm period had low evenness compared with the cool and early warm periods. However, this shift was only reflected in the sample-based rarefaction curves. These results suggest that 1) individual-based rarefaction is a better richness estimator in most situations; 2) sample-based rarefaction and PIE add important information to the interpretation of diversity.

Poster Session IV, (Wednesday)

THE EARLY MIOCENE RODENT FAUNA OF PAMPA CASTILLO, CHILE

CHICK, Jennifer, Case Western Reserve University, Cleveland, OH, USA; CROFT, Darin, Case Western Reserve University, Cleveland, OH, USA; DODSON, Holly, Sierra College, Rocklin, CA, USA; FLYNN, John, American Museum of Natural History, New York, NY, USA; WYSS, Andre, University of California at Santa Barbara, Santa Barbara, CA, USA

The early Miocene (Santacrucian) fauna of Pampa Castillo, Chile is a rich assemblage of 35 mammal species. Of these, the most abundant is a dasyproctid rodent, *Neoreomys australis*, which accounts for more than half of identified specimens. This rodent's hypsodont cheek teeth make identification challenging, since tooth dimensions and occlusal morphology

change drastically with wear. This large sample of *N. australis* permitted a detailed wear study, the goal of which was to describe morphological differences in occlusal structures that occur due to wear. We used both intact cheek teeth as well as transverse tooth sections. Up to seven wear stages were identified per tooth position, although some incongruence was evident between sectioned and intact teeth of the same position. This may be due to limitations of tooth sectioning in mimicking natural wear patterns, or individual variation. Regardless, this study clarified expectations of how morphology changes with wear in this species and better defined the range of variation for *N. australis*.

A second objective of this study was to refine previously published descriptions of the other rodents of the fauna. Two species of *Perimys* are abundant; also present is *Prolagostomus*, two genera of eocardiids (*Eocardia* and *Luantus*), *Eosteiromys* (Erethizontidae), the echimyids *Stichomys*, *Spaniomys*, and *Acarechimys*, and the octodontid *Sciamys*. Three species known previously only from the Pinturas Fm. of Argentina also were identified: *Luantus propheticus*, *Scleromys quadrangulatus*, and *Prostichomys bowni*. The presence of these species only in the lower and middle sequences ('Pinturan association') of the Pinturas Fm. suggests that Pampa Castillo may better correlate with these levels than typical Santacrucian faunas; however, like typical Santacrucian faunas, *N. australis* and chinchillids are abundant at Pampa Castillo. Additional study is needed to clarify the relative roles of habitat, geography, and time in determining these patterns of species distributions and abundances.

Technical Session I, Sunday 10:15

THE BONE MICROSTRUCTURE OF THE POLAR HADROSAURS FROM THE NORTH SLOPE OF ALASKA

CHINSAMY-TURAN, Anusuya, University of Cape Town, Cape Town, South Africa; TUMARKIN-DERATZIAN, Allison, Temple University, Philadelphia, PA, USA; THOMAS, Daniel, University of Cape Town, Cape Town, South Africa; FIORILLO, Anthony, Dallas Museum of Natural History, Dallas, TX, USA

The polar regions of the world today experience dramatic annual changes in temperature and light. Thus, one of the most pertinent questions with regard to dinosaurs recovered from high latitudinal deposits is how they survived in the polar regions of the Mesozoic. One of the richest high latitudinal dinosaur-bearing deposits is that of the Upper Cretaceous Prince Creek Formation of the North Slope of Alaska. Palaeoenvironmental analyses suggest that the environment at the time was dominated by a coniferous forest and the mean temperature is estimated to range from 2˚to 4˚ Celsius for the coldest monthly mean to 10˚ to 12˚ Celsius for the warmest monthly mean. The Prince Creek Formation localities in the North Slope of Alaska has yielded skeletal and track assemblages of a wide array of nonavian dinosaurs, including large- and small-bodied theropods, ceratopsians, pachycephalosaurs, hypsilophodontids, and hadrosaurs. The most abundant of these faunal remains are hadrosaurs of the genus cf. *Edmontosaurus,* which are represented by thousands of specimens.

Size dimensions of various long bones (e.g. femora, humeri, tibiae, fibulae) of the Alaskan specimens cf. *Edmontosaurus* suggests different growth stages among the individuals recovered, with the majority representative of juveniles. Different sized long bones were sampled for histological analysis. The bone microstructure revealed a well preserved bone tissue. The compacta of the bone wall is inundated with a large number of channels that suggest that the bone was well "vascularised" and was formed relatively quickly. Several of the young individuals show evidence of cycles of growth, and one large individual records eight cycles of growth. These growth cycles are unique in that the bone tissue within the alternating cycles both suggest rapid rates of bone deposition i.e. the tissues in both "cycles" are of the fibro-lamellar type, and differ only in terms of channel orientation. Details of the unusual bone microstructure of these high latitudinal hadrosaurs will be presented, and their possible lifestyle adaptations to living in the high latitudinal environment of the Alaskan North Slope will be discussed.

Technical Session XVII, Wednesday 3:15

ANALYSIS OF HOMOLOGY IN SERIALLY REPETITIVE MORPHOLOGICAL STRUCTURES: THE THEROPOD DIGIT PROBLEM

CHOINIERE, Jonah, George Washington University, Washington, DC, USA; DIMITROV, Dimitar, University of Copenhagen, Copenhagen, Denmark; ANTON-FERNANDEZ, Clara, Virginia Tech, Blacksburg, VA, USA; XING, Xu, Key Laboratory of Evolutionary Systematics of Vertebrates, Beijing, China; CLARK, James, George Washington University, Washington, DC, USA

The homology of repetitive structures is a longstanding problem in morphology, and the homology of the manual digits of theropods and extant birds has been particularly well-studied. Developmental studies indicate that the digits of birds are in the 2-3-4 position, while morphological comparisons of theropod digits indicate the 5th and then 4th digits were lost. The "frameshift hypothesis" sought to resolve this conflict by positing that the digits of tetanuran theropods underwent a homeotic change whereby morphology of the medial three digits of the ancestral theropod five-fingered manus were shifted laterally onto the positions of the second, third, and fourth digits in more derived theropods. The recent discovery of the Jurassic ceratosaur *Limusaurus,* with a vestigial digit I and enlarged digit II, prompted new debate on the "frameshift hypothesis". Analyzing different scenarios for a shift in digital identity requires the evaluation of alternative sets of primary homology hypotheses for digital correspondences across theropod taxa. These sets of primary homology hypotheses are analogous to different alignments produced from comparisons of homologous molecular sequences. Unfortunately, current alignment software is not designed to evaluate morphological correspondences. We devised new R scripts and coding strategies to utilize the phylogenetic software POY for analysis of morphological correspondences, and use this approach to test the position of the shift in digital position on the theropod tree. The results demonstrate input parameters such as gap costs and transformation costs have a large effect on the most parsimonious position for the shift in digital correspondence. Additionally, the inclusion of developmental data from extant theropods (i.e. *Gallus*) influences the position of the shift.

Technical Session VI, Monday 2:45

CONVERGENT MICROWEAR PATTERNS IN EXTANT METATHERIAN AND EUTHERIAN HERBIVORES: A PROXY FOR THE ANALYSIS OF MAMMALIAN DIET IN THE LATEST CRETACEOUS AND EARLY PALEOCENE

CHRISTENSEN, Hilary, The University of Chicago, Chicago, IL, USA

As a prerequisite to direct comparison of the metatherian and eutherian mammals that cohabited during the time period encompassing the K/T boundary, the degree to which compatibility of tooth wear in extant Australian marsupial and worldwide placental herbivores has been assessed. The aim of this study was to determine whether the microwear patterns recorded on their molars are indeed the same among animals of the same dietary niche, or whether the large difference in jaw architecture and chewing strokes between modern metatherians and eutherians has an effect on the signal—whether function or phylogeny determines microwear patterns.

Low-magnification microwear analysis has so far been shown to be effective in differentiating between grazers, browsers, and hard-object herbivores in extant ungulates, lemurs, notoungulates, xenarthrans, sciurids, and macropod marsupials. The present study includes members of the above with the addition of selected rodents and members of the Australidelphia superorder (in addition to the Macropodidae). Because the aim of the study was to examine the degree to which members of the same feeding guild have similar microwear patterns, species were chosen based on their being relatively specialized feeders belonging to grazing, browsing, and hard-object feeding niches; mixed feeders were excluded. No statistical difference between marsupial and placental mammals occupying the same feeding niche was found, providing strong evidence for functional convergence in these two groups. These results support the use of microwear as a dietary proxy across the metatherian and eutherian mammals in the fossil record.

Poster Session II, (Monday)

PRELIMINARY RESULTS OF A COMPREHENSIVE MORPHOLOGICAL PHYLOGENY OF THE PINNIPEDIA (MAMMALIA: CARNIVORA)

CHURCHILL, Morgan, University of Wyoming, Laramie, WY, USA; BOESSENECKER, Robert, Montana State University, Bozeman, MT, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

Pinnipeds (seals, sea lions, and walruses) are the second most diverse clade of marine mammals alive today (~36 species). Although knowledge of pinniped evolution has grown in recent decades, uncertainty still exists in the relationships of the three exant (Phocidae, Otariidae, and Odobenidae) and two extinct families (paraphyletic, early diverging "enaliarctidae", Miocene Desmatophocidae) to one another, as well as relationships within Otariidae. Molecular phylogenies support a sister group relationship between Odobenidae and Otariidae, and paraphyly of the sea lions (Otariinae). Morphology based studies in contrast have supported walruses as being either close to Phocidae, or to Otariidae, as well as monophyly of sea lions. However, many of these studies relied on small character sets, limited taxon sampling, and non-cladistic methodology. A further, more comprehensive examination of Pinnipedia is thus needed, in order to reconcile morphological and molecular analyses, as well as allow more accurate interpretation of changes in pinniped ecology through time.

We here report the preliminary results of a morphological study employing 51 taxa and 278 characters focused on examining the internal relationships within the Pinnipedia, which represents the largest study to date. Results so far find strong support for monophyly of Otariidae, Phocidae, and Odobenidae, as well as a *Pteronarctos* + Pinnipedia clade. A clade including *Pinnarctidion*, Desmatophocidae, Odobenidae, and Phocidae is recovered without strong support, and relationships within the clade are poorly resolved. A monophyletic Otariinae was recovered, with low support, however the fur seal genus *Arctocephalus* was found to be non-monophyletic. Further work will focus on continued revision of characters, addition of taxa and characters, and incorporation of molecular data to produce a total evidence phylogeny of the Pinnipedia.

Preparators' Session, Monday 11:45

RACING AGAINST DISASTER: THE DEMOLITION, REHABILITATION AND RECONSTRUCTION OF THE QUARRY VISITOR CENTER, CARNEGIE QUARRY, DINOSAUR NATIONAL MONUMENT

CHURE, Daniel, Dinosaur National Monument, Jensen, UT, USA

In August 1909, Earl Douglass, of the Carnegie Museum, discovered eight *Apatosaurus* caudal vertebrae in a sandstone layer of the Morrison Formation near Jensen, UT. This site, known as the Carnegie Quarry (CQ), proved to be one of the largest Jurassic dinosaur quarries ever found. Many taxa exhibited in the Carnegie Jurassic Hall are from the CQ (*Apatosaurus, Diplodocus*, *Camarasaurus*, *Stegosaurus*, *Dryosaurus*, *Camptosaurus*, *Marshosaurus*, *Hoplosuchus*, *Glyptops*). Between 1909 and 1924, excavations by the Carnegie

Museum, US National Museum, and University of Utah, recovered the remains of 500+ individuals, primarily dinosaurs. In 1915 Dinosaur National Monument was established to protect the CQ. In 1957-1958 the Quarry Visitor Center (QVC) was built and enclosed the unexcavated part of the CQ. Since then, 1500+ bones have been exposed and are preserved in-situ as a public exhibit. Unfortunately, the QVC was built on hydrophilic bentonitic mudstones and has been plagued by stability issues since its opening. Among these problems are heaving of the building, extensive cracking of exterior and interior walls, bulging walls, severely tilting floors, rhombohedral doorframes, huge glass walls hanging only by their welds, popping windows, floors pulled away from their joists, bowed vertical steel beams, degenerating foundations, and lack of structural integrity between different components of the building. By 2006 the building was deemed to be in danger of imminent collapse and condemned and closed with 48 hours notice. Construction to correct these problems began in Spring 2010. Partial demolition, and extensive removal, replacement, and reconstruction of building components will be done to stabilize the QVC. The major challenge is how to do this work without damaging the in-situ exhibit of bones. This will involve building a substructure within the QVC that will enclose and isolate the fossil resource from construction activities. It is expected that the refurbished QVC, with extensive new fossil exhibits, will be reopened to the public and scientific community in the Fall of 2011.

Technical Session XV, Wednesday 9:30

ANALYSIS OF CHONDRICHTHYAN FAMILIAL AND GENERIC RICHNESS, DIVERSIFICATION OF DENTAL MORPHOLOGIES, AND ECOSPACE DIVERSITY ACROSS THE PERMIAN-TRIASSIC AND CRETACEOUS-PALEOGENE BOUNDARIES

CIAMPAGLIO, Charles, Wright State University, Dayton, OH, USA; CLAYTON, Angela, Wright State Univeristy, Dayton, OH, USA

Chondrichthyans were one of the key taxonomic groups that survived both the end-Permian and end-Cretaceous mass extinctions. While chondrichthyan diversity decreased slightly after the Permo-Triassic extinction, morphological diversity was little altered, with many Paleozoic forms surviving well into the Early Mesozoic. Conversely, relatively rapid changes in tooth morphology occurred after the terminal Cretaceous event. In order to determine the pattern and processes of the Chondrichthyan response to both extinctions events, two types of analyses were performed. The first analysis focused on the pattern of extinction and recovery, by examining extinction and origination rates, and standing diversity at the family and genus taxonomic level, for both the geological epoch and geologic stage-increments. Because of the general lack of preservation of the cartilaginous elements composing the chondrichthyan skeleton, the study focused on fossil dentition, with a concentration on familial and generic taxonomic ranks due to intraspecies variation of tooth morphology. All data and faunal lists were acquired through an analysis of the literature. The second component of this project was to determine how tooth morphology, and hence, nutritional guilds changed after the extinction events and through the subsequent recovery and diversification. This was accomplished by examining chondrichthyan teeth from 20 well documented localities worldwide, that spanned the Devonian – Neogene periods. Once obtained, teeth were assigned to distinct morphological categories. In order to compare tooth types and numbers at each locality, the data was statistically analyzed using the Monte Carlo method of bootstrapping. The preliminary results from this study indicate that the number of tooth types increased after the Paleozoic Era and that novel morphologies enabled chondrichthyans to inhabit new feeding niches after the End-Permian extinction. Additionally, chondrichthyan feeding niches became more specialized after the End-Cretaceous extinction. Thus, it is possible that new tooth types may be responsible for greater diversity among chondrichthyans throughout the post-Paleozoic Era.

Technical Session XV, Wednesday 9:45

THE FIRST PHYLOGENY OF RAJIDAE TO INCLUDE EXTINCT AND EXTANT TAXA SIMULTANEOUSLY

CLAESON, Kerin, The University of Texas, Austin, TX, USA

†*Cyclobatis* is an extinct batoid known from the Cretaceous of Lebanon. It possesses a substantial amount of skeletal autapomorphies including a radially symmetric anterior disc and a sinuous articulation between the pectoral girdle and vertebral column. These traits among others have made it difficult to assess its relationship among other batoids, and this taxon has been shuffled among electric rays, stingrays, and skates since it was first described. In light of new evidence that supports the hypothesis that †*Cyclobatis* is a rajiform-batoid; I analyze this taxon in the context of the most recently proposed phylogeny of the clade Rajidae. I also propose and incorporate several new characters related to the vertebral column and pectoral girdle. As a result, I recover †*Cyclobatis* as the sister taxon to a clade formed by the extant members of Rajidae. It shares with extant members of Rajidae broad and oval nasal capsules and a suprascapular cartilage that is fused to the vertebral column. It also retains some plesiomorphic features, including hypobranchial cartilages that articulate with the basibranchial copula. †*Cyclobatis* shares several derived, homoplastic features with highly nested extant members of the crown group, such as a pelvic metapterygial cartilage with naked proximolateral margin. This is the first study to examine extinct and extant taxa of Rajidae simultaneously in a cladistic analysis. The well-supported placement of †*Cyclobatis* at the base of the skate tree also supports the evolutionary split of skates from guitarfish relatives in the Cretaceous. My results have implications for molecular clock calibration and estimation of rates of evolution within batoids.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 10:45

RIBCAGE ANATOMY, SKELETAL CONSTRAINT AND KINEMATICS IN EXTANT AND EXTINCT ARCHOSAURS

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The tetrapod trunk skeleton provides support and protection for the viscera, and acts as a structural framework to aid in the generation of movement for, or the dissipation of forces associated with for instance locomotion or aspiration breathing. Thoracic kinematics is complex, involving movement between and within metameric segments consisting of multiple skeletal elements. These elements are often interconnected via unicondylar joints with theoretically high degrees of freedom of movement. In the two extant archosaur groups, crocodylians and birds, the proximal vertebrocostal joints are bicapitate and possess a single axis of movement. In birds, the position of the parapophysis remains ventral to the diapophysis, whereas in crocodylians an abrupt dorsad shift in parapohyseal position occurs between thoracic vertebrae two and three. The avian thorax exhibits fewer degrees of freedom than the crocodylian thorax. Significantly, the bird thorax lacks intermediate ribs, and thus has one contralateral unicondylar joint per segment less than crocodylians. *In vivo* cineradiographic studies of respiratory kinematics in the American alligator and three basal bird taxa (emu, tinamou and Guinea fowl) demonstrates an increased lateral expansion of the caudal thorax in alligators during aspiration, in contrast to an increased ventrocaudal expansion of the thorax in birds. The observed kinematic patterns are consistent with joint morphology and the structural constraints observed in the avian thorax, and provide a framework to evaluate thoracic anatomy in extinct archosaurs. Basal archosaurs and crurotarsans exhibit a relatively abrupt shift in parapophyseal location similar to that observed in crocodylians. This shift is more gradual in theropods. In many theropods (e.g. tyrannosaurids), the position of the ligament scar for tubercular attachment to the vertebral transverse process allows the reconstruction of the rotational axis of the vertebral rib. Using a constraint-based approach, *in vivo* kinematic studies combined with detailed studies of thoracic joint morphology provide new insights into archosaur thoracic function and the evolution of respiratory mechanisms.

Poster Session II, (Monday)

A REEVALUATION OF EPIPARIETAL HOMOLOGY WITHIN CHASMOSAURINE CERATOPSIDS (ORNITHISCHIA) BASED ON NEWLY DISCOVERED TAXA

CLAYTON, Katherine, University of Utah, Salt Lake City, UT, USA; LOEWEN, Mark, Utah Museum of Natural History, Salt Lake City, UT, USA; FARKE, Andrew, 2Raymond M. Alf Museum of Paleontology, Claremont, CA, USA; SAMPSON, Scott, Utah Museum of Natural History, Salt Lake City, UT, USA

Unique combinations of hooks, spikes, horns, and other processes ornamenting the parietosquamosal frill of ceratopsid dinosaurs are often used to diagnose species and distinguish evolutionary relationships. These frill ornamentations develop from accessory ossifications along the margins of the squamosal and parietal (episquamosals and epiparietals, respectively). Although both chasmosaurine and centrosaurine ceratopsids have epiossifications, we suggest that it is presently impossible to homologize ossification positions between the two clades due to the lack of basal taxa for both. Thus, we propose a unique classification of chasmosaurine epiossifications as follows: epiparietals numbered sequentially from the midline (P1-Pn), with a midline process (when present) designated as P0. An epiossification crossing the parietosquamosal contact is EPS, and episquamosals are numbered (S1-Sn) from the parieto-squamosal contact. The latter is justified by the fact that the taxonomically most informative episquamosals occur caudally. All chasmosaurines have three epiparietals on each side, except for *Torosaurus latus* and *T. utahensis*, which have six. Several chasmosaurines have an epiossification crossing the parietosquamosal suture, including a new chasmosaurine from the Kaiparowits Formation of Utah, *Chasmosaurus irvinensis*, *Anchiceratops*, and *Triceratops*. *Triceratops* is the only chasmosaurine with a P0 midline epiparietal, a condition that likely evolved independently in some basal centrosaurines (*Avaceratops* and a new centrosaurine from the Kaiparowits Formation). The presence of P0 in *Triceratops* along with the disparity in the numbers of epiparietals (P1-3 and EPS in *Triceratops*; P1-6 in *Torosaurus*) suggests that *Torosaurus* is a valid taxon rather than the ultimate end member of *Triceratops* ontogeny. This contention is further supported by specimens of *Triceratops* that rival the size of *Torosaurus*, the existence of subadult specimens of *Torosaurus*, and the presence of *Torosaurus* in formations that lack *Triceratops*.

Poster Session IV, (Wednesday)

PRESERVATION OF BLOOD VESSELS IN A NEW SPECIMEN OF *BRACHYLOPHOSAURUS CANADENSIS*

CLELAND, Timothy, North Carolina State University, Raleigh, NC, USA; ZHENG, Wenxia, North Carolina State University, Raleigh, NC, USA; SCHWEITZER, Mary, North Carolina State University, Raleigh, NC, USA

The persistence of original protein fragments within the collagenous bone matrix of *Tyrannosaurus rex* (Museum of the Rockies, MOR, 1125) and *Brachylophosaurus canadensis* (MOR 2598) is supported by biomolecular assays and peptide sequences. A new specimen of *B. canadensis* (MOR 2967-B2-1) was collected from channel sandstone in the Judith River Formation, Montana, USA, using aseptic techniques and without preservatives, specifically for molecular analyses. Structures morphologically similar to blood vessels were collected from demineralized cortical bone fragments to determine if molecular preservation could be correlated to vessel morphology. Multiple immunological assays demonstrate positive

binding of antibodies against proteins associated with extant blood vessels, and sequences obtained by high-resolution, bottom up (i.e., digestion with trypsin) proteomic techniques support the preservation of original molecules consistent with extant vessel proteins. Furthermore, analytical transmission electron microscopy performed on vessels sectioned to 90 nm showed an intimate association between vessel walls and iron bearing minerals. We hypothesize that this iron-organic association provides a mechanism resulting in preservation.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 8:45

STABLE ISOTOPE EVIDENCE OF SEMIAQUATIC HABITS AND DIETARY NICHE DIFFERENCES FOR FOUR SYMPATRIC SPECIES OF ANTHRACOTHERIIDS FROM WADI MOGHRA, EARLY MIOCENE, EGYPT

CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; MILLER, Ellen, Wake Forest University, Winston-Salem, NC, USA; EL-BARKOOKY, Ahmed, Cairo University, Cairo, Egypt; HAMDAN, Mohamed, Cairo University, Cairo, Egypt; GAWAD, Mohamed Adbel, Cairo University, Cairo, Egypt

Wadi Moghra, Qattara Depression, Egypt, is an early Miocene fossil locality that preserves a diverse array of mammals (ca. 27 species). Anthracotheriids are especially abundant at this locality with at least four species identified so far (*Brachyodus depereti, Afromeryx africanus, Sivameryx moneyi*, and an unidentified species). This high diversity of anthracotheriids is unusual and suggests that the diet and habitat preferences of these species were sufficiently distinct as to reduce competition among them. These species may have accomplished this by adopting varying degrees of semiaquatic habits, which may have expanded the habitat space and dietary resources available to these species. Identification of semiaquatic species in the fossil record has largely been based on the morphological similarities with present-day hippopotamids, but these morphological characters may not always be diagnostic of aquatic habits. Here, we examine the stable isotope composition of tooth enamel carbonate ($\delta^{13}C_{CO3}$, $\delta^{18}O_{CO3}$) to define the ecological preferences and semiaquatic habits of each of these species of anthracotheriids.

Tooth material from anthracotheriids (n = 20) and associated fauna (n = 30) were sampled in order to reconstruct the ecological preferences of each as well as the paleoenvironmental conditions in which they lived. Using a linear regression developed from published hippo oxygen isotope data, the semi-aquatic habits for each species of anthracotheriid were evaluated and then combined with dietary evidence from enamel $\delta^{13}C$ values. Enamel $\delta^{18}O$ values for most species of anthracotheriids were consistent with semiaquatic habits though one species (*Afromeryx africanus*) had higher values that were indistinguishable from those of more terrestrial species in the fauna. No significant differences in enamel $\delta^{13}C$ values were detected among anthracotheriid species, suggesting that habitat preferences may have been a more important means of ecological separation of species.

Technical Session VIII, Monday 4:00

A NEW DEVONIAN FISH *LAGERSTATTE* FROM NEW YORK STATE: TAPHONOMY, PALEOENVIRONMENT AND PALEODIVERSITY

CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QB, Canada; POTVIN-LEDUC, Daniel, Université du Québec à Rimouski, Rimouski, QB, Canada; LANDING, Ed, New York State Museum, Albany, NY, USA; STEIN, William, Binghamton University, Binghamton, NY, USA; VANALLER HERNICK, Linda, New York State Museum, Albany, NY, USA

Since the mid-1800, numerous Devonian fish localities have been discovered in the northeastern USA. Most localities primarily yield disarticulated remains of Late Devonian chondrichthyans and placoderms associated with the Devonian Catskill Delta complex of the central Alleghanian basin. New Givetian fish horizons in a quarry in the Catskill Mountains region, southern New York State, form two taphonomic assemblages associated with a transitional paleoenvironment: Assemblage I is composed of ichthyoliths from ca. 15 species, whereas Assemblage II is composed primarily of articulated and slightly disarticulated specimens belonging to eight species. In both assemblages, placoderms and chondrichthyans are most abundant, whereas acanthodians, actinopterygians and sarcopterygians are scarce. Both assemblages are nearly contemporaneous but correspond to different depositional settings. Assemblage I is a thanatocoenosis of isolated ichthyoliths mainly distributed along a hydrodynamic gradient preserved in a "bone bed" above a thin, dysoxic/anoxic black mudstone. Assemblage II has been mapped on a bedding surface of ca. 850 m^2. This main fish horizon corresponds to one biocoenosis event (composed of two successive mass-mortality events) that took place on an estuary bank with lignophyte and cladoxylopsid root systems. The mass mortalities are represented by a few hundred complete specimens of placoderms (three species), chondrichthyans (two species) and acanthodians (one species). A muddy flood event carried the fish over the estuary bank, and buried numerous individuals trapped along the roots (first mortality). A few surviving fish eventually died in isolated temporary pools (second mortality). In terms of exceptional preservation, complete squamation patterns are preserved for the ptyctodont placoderms and antarctilamnid chondrichthyans. Assemblage II is a *Konzentrat-* and *Konservat-Lagerstätte.* The richness of the new Fossil-*Lagerstätte* is higher than the average richness for Devonian fish localities worldwide.

Technical Session VIII, Monday 2:30

ABOUT THE EARS: *ACANTHODES* RE-EXAMINED AND GNATHOSTOME ORIGIN RE-ANALYZED

COATES, Michael, University of Chicago, Chicago, IL, USA; DAVIS, Samuel, private individual, Stang Korven, France

Discoveries of Devonian and Silurian osteichthyans and chondrichthyans have refocused attention on the base of the gnathostome crown, and the memberships of their respective stem groups. *Acanthodes bronni* from the Lower Permian of Germany has been re-examined because conditions in this exceptionally well-preserved taxon (relative to knowledge of other 'acanthodians') influence early gnathostome tree topologies. New silicone rubber peels expose existing reconstructions as incomplete and in need of considerable revision. *Acanthodes* skeletal anatomy is unexpectedly shark-like: the braincase roof has a central ridge and endolymphatic fossa; otic capsule and semicircular canal arrangements resemble those of *Cladodoides*; there is a prominent lateral otic ridge; the hyomandibula articulates with the otic capsule rear; the palatoquadrate articulates with the postorbital process; there is no passage through the otic capsule for the glossopharyngeal nerve. The combined presence of these features suggests that *Acanthodes* might, in fact, be a stem-chondrichthyan. However, the results of a new, large-scale phylogenetic analysis signal otherwise: *Acanthodes* branches from the base of the osteichthyan stem group. Furthermore, these data and this analysis deliver a new hypothesis of anatomical conditions close to the gnathostome crown-node. Cranial characters of early osteichthyans and chondrichthyans are re-polarized, and the new phylogeny provides further means for exploring 'placoderm' and 'acanthodian' paraphyly. Of perhaps broader relevance, this study also highlights the reorganization of the gnathostome head after the origin of jaws but before the origin of the crown group. This provides a new phylogenetic framework for understanding the diversity of otic capsule related conditions across the basic divisions of all extant gnathostomes.

Poster Session II, (Monday)

MORPHOLOGICAL EXAMINATION OF AN ARTICULATED CARNIVORE ANKLE USING VIRTUAL PREPARATION AND DISARTICULATION OF THE SPECIMEN

COLLINS, Kerri-Ann, Institute for Human Evolution; Bernard Price Institute, Johannesburg, South Africa; CARLSON, Kristian , Institute for Human Evolution, Johannesburg, South Africa; KUHN, Brian, Institute for Human Evolution, Johannesburg, South Africa; BERGER, Lee, Institute for Human Evolution, Johannesburg, South Africa

Malapa is a recently discovered Plio-Pleistocene hominin bearing site in the Cradle of Humankind, South Africa. In addition to its well-preserved, articulated and associated hominin fossils, it has produced numerous equally well-preserved, articulated fauna. Here we show the results of a morphological study of an articulated carnivore ankle and mid-foot discovered during preparation of one of the calcified clastic sediment blocks from the site. Using this technology, we provide a taxonomic assignment of the specimen as well as make some inference to body size and functional morphology. Instead of traditional mechanical or chemical preparation techniques, which might damage the intimately articulated joint surfaces, we use computed tomography scanning and commercial software (e.g., Avizo 6.1) to virtually deconstruct the specimen. After segmenting individual elements and producing 3D renderings of each, we used standard osteometric measurements as a basis for a traditional comparative morphological analysis. We tentatively assign the specimen to the genus *Dinofelis,* primarily based on morphological analyses and comparative analysis with existing southern African *Dinofelis* specimens. We also demonstrate that a virtual approach can be applied successfully in order to describe fossils and assign taxonomic affiliations. Achieving this has allowed us to study each bone and its association individually, without risking damage to this rare articulated specimen. An approach such as this is will be of certain use in future studies involving similar fossils where traditional preparation is not desirable.

Technical Session IV, Sunday 3:45

A FOSSIL JESUS LIZARD (SQUAMATA, CORYTOPHANIDAE) FROM THE EOCENE OF NORTH AMERICA

CONRAD, Jack, Stony Brook University, Stony Brook, NY, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA

Corytophanidae (basilisks/Jesus lizards and casquehead lizards) is a small clade of lizards from Central America and northern South America. Modern forms are notable for their cranial and axial crests and their ability to run across the surface of water. We describe the first North American corytophanid--the oldest known member of the clade. The new specimen comes from the Bridger Formation (Eocene) of Wyoming and consists of an incomplete skull (lacking premaxilla, frontal, parietal, and supraoccipital) with articulated lower jaws and atlas-axis complex. An initial morphological phylogenetic analysis of 451 lepidosauromorphs coded for 701 characters, and a follow-up combined-evidence analysis of 42 pleurodontan iguanians, 424 morphological characters, and 1838 molecular characters demonstrate a sister-group relationship between *Basiliscus* and the new form (supported by nasal and splenial morphology). Our analysis recovers polyphyly of 'messelosaurines' (e.g., *Geiseltaliellus*, *Cadurciguana*, *Cypressaurus*, *Holmanisaurus*) and non-corytophanid status for *Suzanniwana* (supported by open Meckel's canal, placement of the pineal foramen, and absence of a prefrontal-lacrimal groove). *Geiseltaliellus* (Eocene of Germany) and the new form are the only fossil squamates with demonstrable corytophanid affinity. The distribu-

tion of extant lizards conforms to the latitudinal diversity gradient commonly observed for many extant organisms, with observed diversity increasing towards the equator. Although the geologic antiquity of this pattern is poorly understood, the fossil record documents terrestrial animals that are currently confined to the tropics in the mid-to-high latitudes during warm periods in Earth history. The Eocene corytophanids document the tropical fauna present during greenhouse conditions in the northern mid-latitudes during the early Eocene. Although extant corytophanids are strictly tropical, they ranged much farther northward during the Eocene, supporting the hypothesis that the modern latitudinal diversity gradient is steepened by relatively recent range movements toward the tropics in response to climatic shifts.

Poster Session I, (Sunday)

ESTIMATED AGE AND SIZE OF THE LATE CRETACEOUS SHARK *ARCHAEOLAMNA KOPINGENSIS*

COOK, Todd, University of Alberta, Edmonton, AB, Canada; NEWBREY, Michael, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; MURRAY, Alison, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada; SHIMADA, Kenshu, DePaul University, Chicago, IL, USA

Previous descriptions of the lamniform shark *Archaeolamna kopingensis* consisted only of isolated teeth, but the exact dental pattern for the species remained controversial, and the adult size of the shark was not known. A partial skeleton of this species in the Natural History Museum of Los Angeles County was recovered from the Sharon Springs Formation of the Pierre Shale Group, early middle Campanian, of western Kansas. The fossil includes portions of the upper and lower jaws with articulated teeth, revealing a large section of the dental pattern of this species. Also recovered was a portion of the neurocranium as well as multiple vertebral centra. A sagittal section through a centrum shows that this adult shark had reached an estimated age of 18 years. Although an accurate estimation of total length of this specimen is not possible because the total number of vertebrae is unknown, the recovered upper jaw allows us to infer the approximate size of this shark. Using measurements obtained from the partially complete palatoquadrate and comparing with jaw circumference values for modern lamniform sharks, we suggest this specimen had a jaw circumference larger than that of a 3.2 m *Isurus oxyrinchus* (shortfin mako) and a 3.8 m *Isurus paucus* (longfin mako). The largest tooth from the jaws of the specimen is approximately 83% the height of the largest tooth reported for this species, suggesting an even larger size was reached by some individuals.

Romer Prize Session, Monday 8:00

THE EVOLUTION AND DEVELOPMENT OF HYPERPHALANGY AND HYDROFOILS IN CETACEANS

COOPER, Lisa, University of Illinois, Urbana, IL, USA

The evolution of aquatic cetaceans (whales, dolphins and porpoises) from a terrestrial ancestor involved dramatic changes to the standard mammalian limb during the Paleogene. Cetaceans are the only mammals in evolutionary history to increase the number of phalanges per finger (hyperphalangy). In dolphins, the standard number of three phalanges per finger form during early embryonic development, but this process persists into the fetal period until between nine and thirteen phalanges are generated in some digits. Developmental data indicate that dolphins continue synthesizing those proteins that allow for digit elongation (Fgf) and joint formation (Wnt) into the fetal period via a recapitulation of signaling, while other mammals terminate phalanx formation during the embryonic period. Like many marine mammals, cetaceans also encase the digits with a soft tissue flipper. Computed tomography and experimental data generated in a windtunnel showed that a cambered cetacean flipper is shaped like a hydrofoil and functions to generate lift and counteract body torque. Developmental evidence also showed that cetaceans recruit two proteins that typically function in digit and limb formation (Fgf, Gremlin) to act within the interdigital tissues and stop programmed cell death, thereby creating a soft-tissue flipper. Asymmetric signaling in the ectoderm and interdigital mesenchyme generated the cambered hydrofoil essential for aquatic locomotion. Molecular evidence shows dolphins alter duration (heterochrony) and location (heterotopy) of proteins essential to mammalian limb development. Combined molecular and fossil evidence lays the foundation for pinpointing when in geological time these novel developmental patterns evolved, and that the appearance of a soft-tissue flipper may have been a necessary precursor to the origin of cetacean hyperphalangy.

Poster Session I, (Sunday)

FIRST RECORD OF A VALANGINIAN (EARLY CRETACEOUS) DINOSAUR ASSOCIATION FROM SOUTH AMERICA

CORIA, Rodolfo, CONICET-Museo Carmen Funes-IIPG, UNRN, Plaza Huincul, Neuquén, Argentina; CURRIE, Philip, University of Alberta, Edmonton, Alberta, Canada; KOPPELHUS, Eva, University of Alberta, Edmonton, Alberta, Canada; BRAUN, Andreas, Gondwana - Das Praehistorium, Schiffveiler, Saarland, Germany; CERDA, Ignacio, CONICET-Museo Paleontología UNCOMA, Neuquen, Neuquen, Argentina

A new and varied dinosaur association, represented by ornithopod, theropod and sauropod remains, has been discovered in the coarse, terrestrial sandstones of the Mulichinco Formation (Upper Valanginian, Early Cretaceous) exposed in Neuquén Province, Patagonia, Argentina. All skeletal remains come from a single stratum with sedimentologic characteristics that suggest it represents a catastrophic alluvial event. Two semi-articulated skeletons already-have beencollected, and several more have been located for future collection. Some of the fossils have been heavily weathered by dissolution action of plant roots. However, in certain areas, the fossil remains are well preserved in hard, cemented, concretionary sandstones. Associated fossil plants include conifers and ferns. This new locality brings information about a key moment of the evolution of the Cretaceous dinosaur faunas of Patagonia. Despite information from the terminal levels of the Jurassic and the rich dinosaur associations identified in different levels of the post-Hauterivian Cretaceous, the diversity of Valanginian dinosaurs was completely unknown in South America, and is scarce worldwide. Certain anatomical features of the collected specimens suggest abelisaur affinities in the theropods, advanced hadrosauroid conditions in the ornithopods, and basal titanosauromorph characters for the sauropods. So far, none of the identified specimens is particularly large, in comparison with the giant theropods and sauropods that subsequently dominated this region. Although preliminary taxonomic identification of both theropods and sauropods matches with what could be expected, the presence of an hadrosauroid ornithopod more advanced than those recorded in younger levels, encourage revisiting the phylogeny of this clade as well as reviewing current hypothesis about their paleogeography.

Poster Session III, (Tuesday)

FIRST DROMAEOSAUR TRACKWAYS FROM NORTH AMERICA: NEW EVIDENCE FROM A LARGE SITE IN THE CEDAR MOUNTAIN FORMATION (EARLY CRETACEOUS), EASTERN UTAH

COWAN, John, Moab Institute for Mesozoic Studies, Moab, UT, USA; LOCKLEY, Martin, University of Colorado Denver, Denver, CO, USA; GIERLINSKI, Gerard, Polish Geological Institute, Warsaw, Poland

Although six small dinosaur tracksites have been reported from the Cedar Mountain Formation, most reveal very little useful information. The newly discovered site reported herein, is much larger than any previously reported, covering an area of several acres, already partly excavated or under very thin overburden. Most tracks are exceptionally-well preserved and indicate a diverse dinosaur-dominated fauna representing at least three theropod, one sauropod and two ornithischian trackmakers. Additional traces are tentatively attributable to crocodilians. These well-preserved footprints occur in clear, recognizable trackways including two distinctive tridactyl theropod morphotypes (cf. *Irenisauripus*, and a new ichnotaxon indicating a short metatarsal IV). A distinctive didactyl dromaeosaurid trackway (cf. *Dromaeopdus*) is the first reported from North America. The site also reveals well preserved manus- only sauropod trackways which show a prominent postero-lateral trace in the presumed position of digit V. This morphology may also indicate a new ichnotaxon. Ornithopod trackways indicate an iguanodon-size trackmaker, and *Apuliosaurpus*-like trackways suggest an ankylosaurian trackmaker. Enigmatic traces tentatively attributed to swimming vertebrates, probably crocodilians, include presumed manus, pes and body or tail traces. The paleoenvironment indicates a pond, or small lake setting, with undulating, irregular topography. Most trackways indicate walking progression on an emergent but wet (or very shallow, subaqueous) substrate. Manus only sauropod trackways, probably represent penetration of footprints from a higher layer, not swimming. However, probable crocodile traces and a high incidence of enigmatic ‘slide’ marks could indicate vertebrate activity in shallow water, or in a slurry-like medium overlying the main track bearing surface.

Poster Session I, (Sunday)

VERTEBRATE FAUNAL ANALYSIS OF THE LATE CRETACEOUS BLACK CREEK GROUP, BLADEN COUNTY, NORTH CAROLINA

CRANE, Cynthia, East Carolina University, Greenville, NC, USA; RIGSBY, Catherine, East Carolina University, Greenville, NC, USA; CULVER, Stephen, East Carolina University, Greenville, NC, USA; RUSSELL, Dale, North Carolina State Museum of Natural Sciences and Department of Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, NC, USA

Research on the late Cretaceous (Campanian) vertebrate fauna of the Black Creek Group in North Carolina has a long but sporadic history. A local- and regional-scale understanding of this fauna can be derived from a new vertebrate site near Elizabethtown, Bladen County, North Carolina. Bulk sampling was conducted at this locality and a faunal analysis was performed. Specimens were identified to the family and, where possible, to the genus level. This new site has produced a wealth of Campanian vertebrate fossils that reveals new taxonomic, paleoecologic, and biogeographic information about the Black Creek Group. The Elizabethtown fauna is dominated, in order of decreasing abundance, by chondrichthyans, chelonians, crocodylians, and osteichthyans; it also contains dinosaurian, squamate, and amphibian material. The Elizabethtown fauna is similar in taxonomic composition to vertebrate faunas from other Campanian age localities such as the Black Creek Group at Phoebus Landing, North Carolina, the Aguja Formation in Big Bend, Texas and the Marshalltown Formation of New Jersey.

Poster Session III, (Tuesday)

BUILDING A COMPARATIVE MORPHOLOGICAL ATLAS FOR LUNGFISH: NEW INFORMATION ON THE SKELETAL ANATOMY OF *TRANODIS CASTRENSIS*

CRISWELL, Katharine, The University of Texas at Austin, Austin , TX, USA

The evolutionary relationships of lungfish have long been a subject of debate. To provide more data for use in phylogenetic analyses, I developed a comparative atlas to document the morphology of extant lungfish. Here, I extended the scope of my atlas to incorporate an extinct taxon, *Tranodis castrensis*. *Tranodis* is an Upper Mississippian lungfish that is known from the Buffalo Wallow Formation in Hancock County, Kentucky, and is the oldest lungfish taxon known in which specimens were found preserved inside their burrows. *Tranodis* is represented at other sites from pectoral elements and skull roofing material; however, many elements are still unknown, and the intracranial anatomy is unstudied. I scanned Cincinnati Museum Center (CMC) specimen 8297 using High Resolution X-Ray Computed Tomography (HRXCT). The HRXCT scan has a total of 1125 slices and a 0.0836 slice thickness and interslice spacing. This skull previously was mechanically prepared, leaving many of the skull roof and orbital bones visible. The operculum, pterygoid and prearticular tooth plates, vomerine teeth, and remaining mandibular elements were also exposed. Many elements, however, are only partially visible from the exterior of the fossil. In order to study the bones embedded in matrix, I isolated each recognizable skull bone and digitally disarticulated the skull. This method of preparation eliminated the uncertainty of additional manual preparation, and left the specimen intact for future study. I examined the articulations of the pterygoids and prearticulars within the skull as well as the inner surfaces of the skull roof bones. Previously unknown elements that I examined include the ceratohyal and cranial rib. The ceratohyal has a similar morphology to those of the Permo-Carboniferous lungfish *Sagenodus* but possesses a distinct notch in the posterior margin. The cranial rib is more uniform in thickness than in other taxa and flares less at either end. By studying elements of *Tranodis* that were digitally prepared with HRXCT data, I added valuable morphological data to a growing comparative atlas of lungfish skeletal anatomy that I used to elucidate relationships of extant lungfish.

Technical Session XIII, Tuesday 1:45

MORPHOLOGICAL DIVERSITY IN EXTINCT SOUTH AMERICAN SPARASSODONTS (MAMMALIA: METATHERIA)

CROFT, Darin, Case Western Reserve University, Cleveland, OH, USA; DOLGUSHINA, Tatiana, Case Western Reserve University, Cleveland, OH, USA; WESLEY-HUNT, Gina, Montgomery College, Rockville, MD, USA

The distinctiveness of South America's Tertiary mammal communities has been recognized for well over a century. Not only was the plant-eating guild filled exclusively by endemic groups for most of this interval, so too was the meat-eating one; a clade of metatherians known as sparassodonts (borhyaenoids) were the primary carnivores. Despite their lock on the mammalian predatory niche for 50+ million years, sparassodonts apparently never were as successful as members of the Carnivora on other continents in terms of number of species (taxonomic diversity) or abundance (commonness in the fossil record). Proposed explanations for this include competition with crocodilians and/or large, terrestrial, carnivorous birds (phorusrhacids, also known as terror birds), and developmental constraints on metatherian dentitions. To test these explanations, we compared morphological diversity of South American sparassodonts to North American carnivorans and creodonts over the same interval, based on a data set of estimated body masses plus 16 discrete, taxon-independent characters summarizing functional aspects of the dentition. We included all currently recognized Eocene (Itaboraian South American Land Mammal 'Age') and younger sparassodonts. Taxa were coded primarily based on the literature. Morphological diversity was assessed using: (1) mean pairwise dissimilarity between species, and (2) volume of occupied morphospace. We predicted that: (1) sparassodonts would be less disparate morphologically than carnivorans if constraint were a significant factor; and (2) sparassodonts would mostly plot outside of hypercarnivore morphospace if competition with non-mammalian meat-eaters (generally assumed to be hypercarnivores) were a significant factor. Our results support the constraint hypothesis and do not support the competition hypothesis. Assuming our taxon-independent characters apply as well to sparassodonts as to carnivorans and creodonts, these results suggest that habitat may have been a more important factor in dietary partitioning among Tertiary South American meat-eaters than diversity of food resources and/or percentage of meat in the diet.

Romer Prize Session, Monday 8:15

COMPETITIVE RELEASE OR ECOLOGICAL RETREAT: ECOLOGICAL RAMIFICATIONS OF EXTINCTION AND HABITAT TRANSFORMATION FOR MADAGASCAR'S LEMURS

CROWLEY, Brooke, University of Toronto, Toronto, ON, Canada

Lemurs are a unique and ecologically-crucial part of Madagascar's faunal diversity. In the last 2000 years, at least 17 species have become extinct and the future of the remaining taxa is uncertain. Competitive release may have allowed extant taxa to fill niches left vacant by extinct species. Alternatively, vacated niches may have remained unfilled or have disappeared entirely, or surviving lemurs may have shifted to new niches in response to anthropogenic or climate impacts. Here I use stable isotope biogeochemistry to test among these hypotheses for three extant taxa from the Spiny Thicket Ecoregion in southwestern Madagascar. Stable isotopic ratios reflect both the diet and habitat of an individual. In Madagascar, different types of plants (e.g. C_3 and CAM) have dramatically different carbon isotope ratios, and a negative relationship exists between rainfall and lemur isotope ratios. Accordingly, I use carbon and nitrogen isotope ratios in lemur bone to determine if lemurs lived in drier or moister habitat, and whether or not they fed on predominantly C_3 or CAM plants. I find weak evidence for competitive release in *Propithecus verreauxi*, and no evidence for release in *Lemur catta* or *Lepilemur* spp. Instead I find a dramatic contraction in the isotopic niche breadth of the entire lemur community following the decline and disappearance of now-extinct species, a pattern that is suggestive of ecological retreat. Additionally, I find that modern lemurs from a protected riparian reserve have significantly lower carbon and nitrogen isotope ratios than any subfossil individual, extinct or extant. This finding may have important conservation and management implications. The majority of reserves dedicated to the protection of extant species in southwestern Madagascar are riparian habitat, yet growing evidence suggests that lemurs (particularly *L. catta*) living in riparian reserves can experience health problems. My results suggest that lemurs used to frequent very dry habitats such as dry forest and spiny scrub. These arid habitats are under-protected, and what little habitat remains is disturbed and severely fragmented.

Poster Session IV, (Wednesday)

EIMER'S ORGANS IN MOLES AND THE RESOLUTION OF OSTEOLOGICAL EVIDENCE FOR SOMATOSENSATION

CRUMPTON, Nicholas, University of Cambridge, Cambridge, United Kingdom

The Eulipotyphla family Talpidae consists of the moles, shrew moles and desmans and are found throughout Europe, Asia and North America. These small insectivorous mammals express a range of behavioural, environmental and dietary preferences, however nearly all members of the Talpidae rely on a highly developed somatosensation system facilitated by Eimer's organs. These complex sensory organs are found exclusively in the nasal epidermis of talpids and their density on the rhinarium of species has been utilized in this study as an index of somatosensory sensitivity. The current research aimed to ascertain the resolution to which the talpid skull records variation in somatosensation between species. This was achieved via investigation of the caliber of the infraorbital foramina (IOF). This foramenis known to scale isometrically with the cross sectional area of the 2nd partition of the trigeminal nerve and this was supported by histological samples of available species. A comparative analysis of IOF size recorded between a large sample of 29 species of talpids (n=205) indicates that foramen size correlates with Eimer's organ quantity on the rhinarium and is related to behavioural and environmental preferences independent of phylogenetic relatedness. Osteological cranial morphology has been extensively used as evidence for the development of nervous tissue and, by proxy, sensory adaptation in both living and fossil mammals and this new research indicates that even fine scale differences in the sensitivity of closely related, fossorial/semiaquatic mammals are detectable within the bony anatomy.

Technical Session XVII, Wednesday 1:45

BEING A THEROPOD ON AN ISLAND: A PECULIAR DROMAEOSAURID FROM THE MAASTRICHTIAN OF THE TRANSYLVANIAN BASIN, ROMANIA

CSIKI, Zoltan, Department of Geology and Paleontology, University of Bucharest, Bucharest, Romania; BRUSATTE, Stephen, American Museum of Natural History, New York, NY, USA; VREMIR, Matyas, Transylvanian Museum Society, Cluj-Napoca, Romania; NORELL, Mark, American Museum of Natural History, New York, NY, USA

Islands faunas are frequently characterized by highly unusual taxa, which are often endemic, relictual, and/or substantially larger or smaller than mainland relatives (the "island rule"). The fossil assemblage of the Maastrichtian 'Hateg Island' (Romania) has long been considered an abnormal island fauna, based on the occurrence of basal turtles and cimolodontan multituberculates, the presence of dwarfed and basal dinosaurs, and high overall endemicity. However, little is known about the predatory dinosaurs that inhabited this island, and it is unclear whether theropods were also affected by the island rule. We describe an articulated partial skeleton representing a new dromaeosaurid from the uppermost Cretaceous deposits of the Transylvanian Basin, which allows, for the first time, a detailed understanding of the anatomy and phylogenetic relationships of an island-dwelling theropod. The new taxon is highly autapomorphic and characterized by over 20 peculiar morphological traits, including extensive fusion in the manus and hindlimb, a shortened distal hindlimb, a stocky pelvis with increased femoral extensor muscle insertions, and a modified foot with two hyperextensive claws, as the result of an enlarged, fully functional first digit. Phylogenetic analysis places the new taxon as a derived velociraptorine dromaeosaurid, closely related to contemporary Laurasian taxa such as *Velociraptor*, its sister taxon. Sauropod and ornithopod dinosaurs from the Hateg island, on the contrary, usually occupy basal positions within their respective clades, and their closest relatives are often considerably older taxa. The close relationship between the new taxon and Asian dromaeosaurids suggests that faunal interchange between Asia and the European islands persisted late into the Cretaceous, contrary to previous suggestions of marked isolation of the European faunas. Finally, as shown by slightly larger referred specimens from the Hateg Basin, the new taxon is approximately the same size as its close relatives. In sum, the new taxon indicates that some island-dwelling dinosaurian predators were morphologically aberrant, but not dwarfed, primitive, or geographically endemic.

Technical Session XVI, Wednesday 3:00

NON-DIETARY ABRASIVES AND THE DENTAL EVOLUTION OF PLIO-PLEISTOCENE SUIDAE (ARTIODACTYLA: MAMMALIA)

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Hypotheses concerning morphological differences in the dentitions of suid genera, as well as other ungulates, usually invoke differences in either dietary composition or the quality and properties of food. Recent work on living herbivores suggests that non-dietary abrasives from ingested exogenous grit play an important role in excess tooth wear and thereby constitute a potential selective agent in the evolution of tooth morphology. We suggest that to prolong the functional longevity of teeth subject to excess tooth wear, suids responded in several ways including the evolution of hypsodonty and increasing the crown area of molar teeth. We hypothesize that: (1) if non-dietary mineral grit selects for the structural properties of teeth to better resist abrasion, and if a larger molar crown tooth area is a means by which suids resist tooth wear, then the marine record of the changing intensity of soil erosion should correlate with a change in the rate of the evolution of molar tooth size and (2) non-dietary abrasives in the form of mineral grit directly influence the evolution of enamel volume on tooth crowns. From the literature, we collected M_3 tooth size measures (n= 545) from Plio-Pleistocene suid genera (*Nyanzachoerus*, *Notochoerus*, *Metridiochoerus*, and *Kolpochoerus*) and aeolian dust data from the Arabian sea floor. Using time series analysis, we compare plots of M_3 area with aeolian dust by constructing smoothing spline fits at various lambda values. We find temporal coincidence between accelerations of evolutionary rates in suid M_3 crown area and peaks in the export of aeolian dust to the Arabian Sea floor. Results of this study demonstrate that non-dietary abrasives may have played a significant role as a directional selective agent in the dental evolution of Plio-Pleistocene suids.

Poster Session III, (Tuesday)

DESCRIPTION OF THE FIRST ORNITHOMIMID (DINOSAURIA) BONEBED FROM NORTH AMERICA WITH IMPLICATIONS FOR THE DISCRIMINATION, ONTOGENY AND BEHAVIOR OF ORNITHOMIMIDS

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Bonebeds can provide important anatomical, taphonomic, and ontogenetic information about relatively poorly known taxa, and provide evidence for behavioral inferences. Such accumulations of large vertebrates are well-documented in the Late Cretaceous fossil record, but theropod bonebeds are rare, with less than 10 being known worldwide. Three partial postcrania from the Upper Cretaceous Horseshoe Canyon Formation of Alberta, Canada, represent the first known bonebed of ornithomimids in North America, and only the third documented ornithomimid bonebed in the world, the others being found in China. The specimens were collected in 1926 from a partially eroded locality that may have once been larger and contained more individuals; it is now believed to have been completely eroded away. The three individuals recovered are in varying stages of completeness, with little material preserved anterior to the pelvic girdle (probably lost through erosion). All three specimens are morphologically similar, with one being 7% larger and close to the size of the largest ornithomimids recovered from the formation. Although no cranial or manual elements were preserved, the material probably represents either *Struthiomimus* or *Ornithomimus*; both genera have been recovered from the formation as skeletons with skulls, and individual elements, especially numerous pedal phalanges. The pes of two individuals are well preserved. Selected pedal elements from these and other ornithomimid taxa were used in a limited principle component analysis, but were not found to vary significantly between taxa, confirming that pedal phalanges have limited taxonomic utility for this group. Histological analyses from the fibulae of the largest and one of the smaller specimens gave putative ages of 4 and 3 years, respectively. This suggests that, similar to the Chinese bonebeds, this site preserves subadult-sized specimens, and that other large ornithomimid specimens from the formation may not be fully grown or mature. Sedimentological and taphonomic evidence from the locality suggests that the bonebed represents the first record of gregarious behavior in ornithomimids in North America.

Poster Session I, (Sunday)

MID-CENOMANIAN VERTEBRATE FAUNAS OF THE NORTH AMERICAN WESTERN INTERIOR SEAWAY

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Recent studies of Cenomanian vertebrate faunas, particularly from lag deposits (bonebeds and calcarenites) in Canada and the United States, have significantly altered the previous picture of the overall biodiversity and biogeography of the Western Interior Seaway (WIS) during the 'mid-Cretaceous.'The five mid-Cenomanian regional 'localities' highlighted in this study, Alberta, Saskatchewan, the Black Hills region, Kansas, and Colorado,are separated by as much as 18 degrees latitude, a north-south distance of more than 2,300 km. Our compilation of faunas indicates that at least 70 vertebrate taxa are recorded from these localities. The faunas include at least 41 chondrichthyans, 21 non-tetrapod osteichthyans, 10 non-avian tetrapods (marine turtles and plesiosaurs), and five avian taxa (hesperornithiforms and ichthyornithiforms). Although there are differences attributable to particular paleoenvironmental conditions (e.g., water depth), these faunas also demonstrate some clinal trends, such as more diverse faunas of benthic chondrichthyans mixed with dolichosaurid lizards to the south, and a more diverse fauna of birds to the north. However, the faunas overall show strong taxonomic homogeneity, particularly among many chondrichthyans that were cosmopolitan, indicating that passage throughout the seaway as well as to both the Boreal and Tethys oceans was utilized. These faunas also demonstrate high osteichthyan diversity in the northern waters of the WIS, which were once thought to have supported only a depauperate, cold-adapted fauna. Because a number of fish species are also recognized in chronologically later faunas typified by the vertebrate assemblage of the Niobrara Formation (Upper Coniacian - Lower Campanian) in western Kansas, mid-Cenomanian time can also be characterized as the onset of the 'Niobrara-type fauna', marked by an increase inchondrichthyan and osteichthyan diversity, when ichthyosaurs had already become extinct and mosasaurs had not yet appeared. The surprisingly great diversity in vertebrate taxa indicates that ecosystem structure and dynamics of the WIS during the mid-Cenomanian was unquestionably complex.

Poster Session IV, (Wednesday)

TITANOSAUR OSTEODERM ONTOGENY, ANATOMY AND FUNCTION: NEW DATA FROM *RAPETOSAURUS KRAUSEI* (MAEVARANO FORMATION, MADAGASCAR)

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At least 10 species of titanosaur sauropods are known to have possessed osteoderms. Because titanosaur osteoderms are typically recovered in isolation and disarticulation, their anatomy and functional/phylogenetic significance remains unresolved. Here we report on two osteoderms that occur with associated and articulated skeletons of *Rapetosaurus krausei*, a titanosaur from the Upper Cretaceous Maevarano Formation of Madagascar. The specimens are significant because they allow referral of two osteoderm morphotypes to *R. krausei* and because they provide insight on the ontogeny, anatomy, and potential functions of titanosaur osteoderms.Two distinctive bonebeds preserve the remains of *R. krausei* and its associated osteoderms. The first preserves a single skeleton of an adult (femur length = 146 cm) that includes the most massive sauropod osteoderm yet discovered. It is ellipsoid, exhibits a characteristic bulb and root morphology, and measures 57 x 26.7 x 19.2 cm. In addition to interesting external textures (e.g., cross-hatched internal surface typical of other vertebrate osteoderms), it is also comprised of metaplastic bone. The second preserves a subadult skeleton of *R. krausei* that exhibits no duplication of elements and some instances of articulation (e.g., foot, ribs, hindlimb, and forelimb in anatomical position), as well as direct association with an osteoderm. The osteoderm measures 14 x 9 x 8 cm, and is characterized by thin, disorganized bony spicules externally and cancellous bone with deep excavations for the transmission of vascular canals internally. Vascular canals in this specimen can be traced from internal surface to external surface via CT scans.

These specimens, particularly in light of the debris-flow depositional setting in the Maevarano Formation, indicate that *Rapetosaurus* likely possessed only a few osteoderms in its skin. Osteoderm morphology is related to anatomical location and/or ontogeny. Large osteoderms may result from the fusion of multiple, smaller dermal elements. External morphology, bone histological analysis and CT-scans help restrain possible functional interpretations for osteoderms in *Rapetosaurus.*

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 9:15

THE ROLE AND FUNCTION FOR CRANIAL SUTURES IN REPTILES: A FINITE ELEMENT ANALYSIS OF THE SKULL OF *SPHENODON* (DIAPSIDA: LEPIDOSAURIA: RHYNCHOCEPHALIA)

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The skull comprises numerous bones united by sutures, and although still a topic of discussion, it is generally thought that these bone junctions allow the skull to grow. However, in many taxa cranial sutures remain open in adults, suggesting that they still play a role in skull function during feeding and other everyday activities. Strain gauging experiments can provide some information on the role of sutures, but this information is limited to select, localised regions of the skull and direct measurement is not possible in extinct taxa. An alternative approach involves computational modelling in which deformations, stresses, and strains within the skull can be predicted. Here we perform such a study on the skull of the extant *Sphenodon* (Rhynchocephalia), where bite, joint, and muscle force data are derived from a multibody dynamics analysis and applied to a finite element model of the same skull. This extant taxon was chosen because the model can be validated using previously obtained muscle activity data, and because in some respects (no obvious kinesis, extensive quadrate-pterygoid overlap) the skull architecture is somewhat analogous to the plesiomorphic condition for diapsid reptiles. Understanding the function of this relatively 'rigid' skull will provide a foundation onto which hypotheses relating to other, more kinetic skulls can be tested. Results show that localised, peak strains are reduced in some areas of the skull, possibly preventing bone damage under specific bites, but the strains predicted over multiple

bites do not support the general rule that sutures reduce strain. Thus it appears that sutures do not reduce strains within the skull, as is often suggested, but instead distribute strains more uniformly over the entire skull. A larger proportion of the skull therefore experiences a moderate level of strain from each bite position. This has important implications with regard to our understanding of how bone adaptation, remodelling, and overall skull shape are influenced by loads due to feeding in other diapsids and possibly amniotes in general.

Poster Session II, (Monday)

NEW INFORMATION ON THE CRANIAL ANATOMY OF A JUVENILE ICHTHYOPTERYGIAN FROM THE VEGA-PHROSO SILTSTONE MEMBER (EARLY TRIASSIC) OF BRITISH COLUMBIA, CANADA

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Tetrapoda underwent a broad radiation in the Triassic that gave rise to many new clades. One of the most notable was the secondarily aquatic Ichthyopterygia that diversified to occupy a broad paleogeographic range by the Early (E.) Triassic. Fossil material collected from these regions is fragmentary and poorly preserved, but phylogenetically significant. TMP 89.127.3 represents a relatively well-preserved ichthyopterygian collected from the Vega-Phroso Siltstone Member (E. Triassic) of British Columbia, Canada. The presence of rounded, well-spaced carpals identifies this specimen as osteologically immature. Based on shared geologic occurrence and similar forefin morphology, TMP 89.127.3 was interpreted previously to be *Parvinatator wapitiensis*. The nearly complete skull (~87 mm long) is newly available for study and preserved in lateral and dorsal views. The left maxilla is rotated into a horizontal plane, but remains in contact with an external naris that is visible in dorsal aspect. The left nasal is separated from contact with the postfrontal and parietal by the frontal that partially forms the dorsal orbital margin. It is not possible to calculate a reliable tooth size to skull width ratio, but general dental observations reveal that the anterior teeth are slender, with the exposed crowns at least five times taller than wide in labial aspect; the posterior teeth are conical and robust, with the more visible maxillary crowns ~1 to 1.5 times taller than wide in labial aspect and ending in broad, blunt tips; and the bases of the well-exposed maxillary crowns are closely spaced (<1 mm apart) and occur in different planes, providing evidence for multiple maxillary tooth rows. Based on these new data, TMP 89.127.3 is tentatively reidentified as a grippidian ichthyopterygian closely related to *Grippia* and *Chaohusaurus*. This marks the first Canadian occurrence of Grippidia, expanding the known palaeogeographic range of the clade that had been limited to Svalbard and China. This shows grippidians had achieved a far broader distribution by the E. Triassic than previously thought, and adds new data to understanding the early evolutionary history of Ichthyopterygia.

Poster Session IV, (Wednesday)

A MESODONT DIPODID RODENT FROM THE MIDDLE MIOCENE OF THE GREAT BASIN OF NORTH AMERICA

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Jumping mice (Dipodidae) are a Holarctic group of rodents spanning the Eocene to Holocene. At least nine genera are known from the Miocene in Eurasia. However, dipodid diversity in North America is more modest, with only five Miocene genera in two subfamilies, Sicistinae and Zapodinae, all of which have brachydont molars. Not until the Pliocene and Pleistocene do two of the North American genera of Zapodinae (*Zapus* and *Javazapus*) exhibit mesodont molars. Our screenwashing efforts in the Mud Hills outcrops of the middle Miocene Barstow Formation near the town of Barstow, California, yielded a small new mesodont dipodid, the first recorded occurrence of the family in the formation. The new taxon is known by a single m1 from a single early Barstovian (Ba1) locality, so no assessment of variability is possible yet. Nevertheless, the molar is distinctive in several characteristics including its relative hypsodonty, cuspidate cusps with a lack of accessory lophs, strong anteroconid and hypoconulid, lack of a mesoconid and posterior cingulid, and strong mesostylid. We suggest that the species' relatively tall cuspidate tooth is in contrast with the general dipodoid trend for lophodonty and might reflect increased insectivory in its diet.

Poster Session IV, (Wednesday)

AUGMENTATION OF THE HOLOTYPE OF *NEUQUENSAURUS AUSTRALIS*: IMPLICATIONS FOR THE TAXONOMY OF SALTASAURINE SAUROPOD DINOSAURS

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Titanosaur sauropods radiated in the Cretaceous to become the predominant herbivores in many ecosystems. Our understanding of this radiation is hindered by a currently labile phylogeny for the group, which is partially due to taxonomic problems with many genera. For example, the Late Cretaceous South American saltasaurine titanosaurs *Neuquensaurus australis* and *Saltasaurus loricatus* are represented by well-preserved and abundant material whose hypodigms span most of the skeleton, but whose holotypic materials are limited to a few bones that do not overlap between the taxa. Both taxa were found within bonebeds for which demarcation of individuals is difficult, complicating referrals of bones to the holotypes from other regions of the skeleton. We present a collections-based discovery that enables us to augment the holotype of *Neuquensaurus australis* with a partial sacrum that was preserved in articulation with one of the original holotypic caudal vertebrae, but not recognized as such at the time. We document this association via the presence of a broken crescent of bone on the posteriormost sacral vertebral centrum that has a snap-fit onto the rim of the condyle of the holotypic biconvex vertebra. Based on comparisons with a more complete sacrum and ilium of a referred specimen of *Neuquensaurus australis*, we interpret this biconvex vertebra to be the seventh sacral vertebra. The situation in *Neuquensaurus australis* raises the possibility that the biconvex "first caudal" vertebra of other titanosaurs may be part of the sacrum as well. Augmentation of the *Neuquensaurus australis* holotype to include a sacrum makes it comparable to the holotype of *Saltasaurus loricatus*. Morphological differences in the number, shape and proportion of sacral vertebrae allow discrimination between *Neuquensaurus* and *Saltasaurus*, confirming their generic separation. The El Brete quarry, which preserves the holotypic sacrum and abundant referred specimens of *Saltasaurus loricatus*, also preserves a sacrum consisting of seven vertebrae that closely resembles that of *Neuquensaurus australis*, suggesting that these two saltasaurines coexisted in the Late Cretaceous of South America.

Technical Session XV, Wednesday 12:00

INVESTIGATING THE DIET OF EXTANT AND FOSSIL FISHES THROUGH MICROTEXTURAL ANALYSIS OF TEETH

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Hypotheses of diet and feeding in fossil fishes rely heavily on anatomical comparison and mechanical modelling. However, recent evidence indicates that in some species of fishes level dietary specializations in feeding structures correlate poorly with diet, and that diet can differ between morphologically similar populations within a species. These observations undermine the assumptions of the functional morphology approach. Here we adopt an engineering approach to quantification of tooth microwear based on microtextural analysis of high-resolution three-dimensional data. Data were acquired with a focus variation microscope (Alicona IFM) and tooth surface roughness was quantified through several industry standard amplitude, volume and texture parameters. These data allow statistical comparison of textures developed on molariform teeth of extant herbivorous, durophagous and specialised shell-crushing populations of fishes (*Archosargus probatocephalus* and *Anarhichas lupus*, Teleostei), and comparison with teeth from fossil and modern fishes. Analysis of extant taxa reveals that dental microtextures reflect differences in diet both within- and between-species. Results were validated through blind testing of data from pharyngeal jaw teeth of cichlids (*Astatoreochromis alluaudi*) with known diets. Application of microtextural analysis to molariform teeth from fossil pycnodontid fishes, assumed to be specialised shell-crushers, shows that previous dietary hypotheses, based primarily on functional morphology, are incorrect. Microtextural analysis therefore offers a new and powerful tool to test hypotheses of the diet in both extant and fossil organisms.

Technical Session X, Tuesday 10:15

3-D SKELETAL KINEMATICS OF WING-ASSISTED INCLINE RUNNING (WAIR) IN ADULT CHUKAR PARTRIDGES (*ALECTORIS CHUKAR*): LINKING SKELETAL MORPHOLOGY AND THE WING STROKE

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How did forelimbs of avian ancestors begin to develop an aerodynamic function? New fossil discoveries continue to supply rich information on morphological changes on the line to birds. Additionally, kinematic studies of living birds have yielded a plethora of new data on the function and development of the flight stroke. Linking the wing stroke of living birds to the morphologies of extinct avian relatives would greatly benefit from detailed kinematics of the skeleton. Previous studies measuring the kinematics of WAIR and other behaviors in birds have relied on surface markers to track wing movements. Bending of flexible feather shafts and skin movement relative to bones obscures underlying skeletal motion. Herein, we present an analysis of the first 3-D skeletal kinematics of chukar partridges (*Alectoris chukar*) during WAIR using XROMM (X-ray Reconstruction of Moving Morphology). As a first step towards elucidating the kinematics during different flight behaviors, dual high-speed fluoroscopic video was collected during WAIR up a 70 degree ramp and during ascending flight (AF) along the same trajectory. Digital models of the shoulder girdle and wing elements were positioned and oriented to match the two video views to measure shoulder, elbow and wrist joint motion. The humerus is similarly positioned at the top of upstroke in both AF and WAIR. During AF, glenohumeral depression, protraction and pronation are greater than during WAIR. Wrist flexion and extension are also greater during AF. The elbow flexes and extends similarly during both behaviors with minor differences in adduction/abduction. These data offer a detailed measure of joint interactions in vivo, ultimately providing a foundation for understanding the joint mechanics during different behaviors.

Poster Session II, (Monday)

POLYTETRAFLUOROETHYLENE (PLUMBER'S) TAPE, TISSUE AND PLASTER BANDAGE USED AS A REMOVABLE SUPPORT FOR FOSSIL PREPARATION

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Polytetrafluoroethylene (PTFE) films, widely available as plumber's or Teflon® tapes, are soft, smooth, thin, stretchy and pliable. They are also chemically inert, nonabsorbent and nonstick. These properties have made PTFE films useful in ethnographic and archaeological conservation as non-abrasive liners and wraps for storage, as isolating membranes for gap-filling and as temporary markers. Here, common half-inch plumber's tape was used to support a delicate, palm-sized specimen in loosely cemented sandstone. The tape was gently packed around the specimen with a soft, dry brush. A quarter-inch layer of toilet tissue was packed over the tape with a wet brush. Then two layers of plaster surgical bandage were applied over the tissue to encase everything in a thin shell. The soft cushioning and minimal shell provided just enough support to allow the specimen to be grasped, flipped and prepared from the other side. Unlike rigid support systems using Carbowax or cyclododecane, this method cannot take much force from an airscribe or needle. For this particular specimen such rigidity was not necessary and plumber's tape could: 1) conform without adhering, 2) protect the specimen from the wet tissue and plaster bandage, 3) easily be plucked, cut away or pushed down as matrix was removed, 4) resist sticking to the Butvar B-98 consolidant used during preparation, 5) easily be removed if necessary, 6) resist deterioration if retained for storage. PTFE plumber's tape is an inexpensive, universally available material that may be equally useful for other aspects of fossil preparation.

Preparators' Session, Monday 11:00

A SIMPLE MICROVERTEBRATE MOLDING AND CASTING TECHNIQUE: A 20-YEAR RETROSPECTIVE

DAVIES, Kyle, Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA; CIFELLI, Richard, Sam Noble Oklahoma Museum of Natural History, Norman, OK, USA; DAVIS, Brian, University of Oklahoma, Norman, OK, USA; GORDON, Cynthia, University of Oklahoma, Norman, OK, USA

Molding and casting of microvertebrate fossils (such as mammal teeth) has become increasingly common with the advent of silicone molding compounds and a variety of new, high-resolution casting resins. Obvious advantages to the methods include deposition of replicates at sister institutions and distribution to researchers lacking easy access to the original fossil(s), archival backup in the event of damage or loss, ease of study, and safeguarding of delicate original fossils. Moreover, casts made with modern materials show sufficiently high fidelity to be studied and photographed at high magnification under light microscopy or SEM, even showing such features as wear striations.Given the large numbers of specimens and the fact that many replicates are made of each, mass production and standardization of procedures are essential. Clay platforms are cut from rolled-out plastalina clay using appropriately-sized vials from series used by museums, yielding uniform bases of standard sizes. Microvertebrates are commonly mounted on pins for study and storage; an advantage of the technique is that dismounting is unnecessary: pins can simply be stuck into the platforms. Specimen data are inscribed into bases using a needle; the setup is then walled with rolled clay and filled with catalyzed silicone. Completed molds are partly filled with casting resin, centrifuged, and subsequently filled. Molds and replicates are flat-bottomed, allowing easy storage in trays. In the past 20 years, we have used this technique to safely and successfully mold and cast over ten thousand microvertebrate fossils, mostly belonging to mammals and many of which are extremely delicate, ranging downward to less than 1 mm in maximum dimension.

Physical Drivers and Marine Tetrapod Evolution, Monday 11:00

USING THE HIGH FIDELITY OF CETACEAN STRANDINGS TO REVEAL THE SPATIOTEMPORAL SCALES OF CETACEAN MACROECOLOGY

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Stranded cetaceans have intrigued naturalists for centuries. For coastlines with archived stranding records, these occurrences have been generally interpreted through the lens of population-level events (e.g., disease, climatic and oceanographic changes). Recently, paleoecologists have interpreted strandings as a death assemblage, and comparisons between strandings and live surveys, over the same spatiotemporal scales, have revealed a high fidelity of both richness and abundance. In terrestrial communities, such high fidelities have led to the discovery that species accumulate through time and space in similar ways, allowing for the substitution of sampling regimes in time or space. Here we used a refined dataset of the cetacean stranding record from the US Pacific Coast to determine if the cetacean stranding record similarly samples space and time in commensurate ways. Specifically, our analyses plotted stranding occurrences (resolved to the county-level, n = 44 counties) against a time-space axis, to resolve averaging effects of sampling diversity across the time series (n = 15 years). We also took into account various biases, including: latitudinal gradients in cetacean diversity; periodic oceanographic changes; and human population changes, which serve as a proxy for observer effort. Our analyses revealed that decadal-scale sampling regimes (>10 years) across medium-large counties (>140 km coastline) accumulate higher richnesses than a single year sampling across the entire US Pacific coast (~2300 km). Thus, temporal and spatial sampling in the cetacean stranding record are not related in a simple linear fashion: time is more important than space for sampling richness. Coupled with the high fidelity of the cetacean stranding record, these results imply that: 1) such fossil assemblages sample ecologically relevant features of community structure; and 2) the stranding record provides a baseline for measuring cetacean diversity in fossil assemblages, where temporal sampling often exceeds spatial sampling.

Poster Session II, (Monday)

ESTIMATING DIVERGENCE TIMES OF LIZARDFISHES AND THEIR ALLIES (EUTELEOSTEI: AULOPIFORMES) AND THE TIMING OF DEEP-SEA ADAPTATIONS

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The order Aulopiformes (Euteleostei: Cyclosquamata) includes 44 genera and approximately 236 species of lizardfishes and their allies. Taxa within the order include predatory marine fishes that range in habitat from inshore coastal systems to the deep sea. Aulopiform fishes have evolved fascinating deep-sea evolutionary adaptations including a number of highly specialized anatomical eye modifications and a reproductive strategy of simultaneous hermaphroditism, one of the rarest methods of reproduction among vertebrate taxa. The fossil record for aulopiform fishes is robust with extinct taxa described from two of the three suborders, the Aulopoidei and the Alepisauroidei. The majority of fossil taxa are associated with the crown aulopiform clade of alepisauroids (Lancetfishes) from Late Cretaceous deposits. Hypotheses of aulopiform divergence times have never been explored with molecular data from a robust dataset with comprehensive aulopiform taxonomic sampling. In this contribution we estimate the divergence times of Aulopiformes utilizing a Bayesian approach in combination with knowledge of the fossil record of teleosts, including lizardfishes. In addition the timing and character evolution of deep-sea evolutionary adaptations is explored. Specifically we investigate the divergence times of: (1) the common ancestor of aulopiforms, (2) the major aulopiform lineages, and (3) the evolutionary history of two aulopiform deep-sea adaptations, eye specializations and simultaneous hermaphroditism. Estimating the divergence times of aulopiform fishes is important to our understanding of the evolutionary history of one of the most diverse deep-sea vertebrate lineages, including the timing and evolution of deep-sea adaptations.

Poster Session II, (Monday)

NEW DATA ON THE SMALL ARCTOCYONID *PROLATIDENS WAUDRUAE* FROM THE EARLY PALEOCENE OF HAININ, BELGIUM, AND ITS RELATIONSHIPS WITH NORTH AMERICAN OXYCLAENINES

DE BAST, Eric, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SIGÉ, Bernard, Université Claude Bernard, Lyon, France; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

One of the few species described from the early Paleocene of Hainin, Belgium is the very small arctocyonid *Prolatidens waudruae*. The species was described soon after the discovery of the deposit, based on only 3 lower molars. New material from Hainin, including premolars and upper teeth, allow us better comparison with the North American taxa. *Prolatidens waudruae* seems particularly primitive in its small size and tooth morphology. The paraconid is well-developed and occupies a lingual position; the crown is moderately low, with cusps bulbous but sharp; the enamel is smooth, unlike in many arctocyonids. The p4 has a more specific morphology with no paraconid, posterior cristae delimiting a relatively deep gutter on the lingual side and a much reduced metaconid. The P4 is also simple, relatively short due to the much reduced paracone, and with a large protocone. The subfamily Arctocyoninae (including *Arctocyon*, *Arctocyonides*, *Colpoclaenus*, *Anacodon* and *Mentaclaenodon*) differs from *Prolatidens* in almost all its derived characters. In *Prolatidens* indeed the enamel is not crenulated, the paraconid of the lower molars is not fused to the metaconid and the crown is higher than in most genera of the subfamily. The loxolophine arctocyonids, generally considered as a subfamily (including *Loxolophus*, *Mimotricentes*, *Baioconodon*, *Deuterogonodon*, *Desmatoclaenus* and *Lambertocyon*), also differ from *Prolatidens* in their shared derived characters such as the hypoconulid-entoconid closeness. The oxyclaenine arctocyonids regroup the so-called "primitive" genera (*Oxyprimus*, *Protungulatum*, *Chriacus*, *Prothryptacodon*, *Thryptacodon* and *Oxyclaenus*). Among these genera, *Oxyprimus* was suggested as the closest arctocyonid species to *Prolatidens*. However the shape of p4 is very different with a large paraconid, well separated protoconid and metaconid and a single posterior crest. *Prothryptacodon* from the Torrejonian compares the best with *Prolatidens*. The simple molar morphology, and the posterior gutter and absence of paraconid on p4 are shared characters that bring these genera together. Differences mainly consist in higher crown and more secant morphology in *Prothryptacodon*.

Romer Prize Session, Monday 8:30

THE EFFECTS OF PHYLOGENY, FUNCTION AND PHYSIOLOGY ON BONE MICROSTRUCTURE

DE BOEF MIARA, Maria, Harvard University, Cambridge, MA, USA

The study of bone microstructure is both common and valuable to the field of vertebrate paleontology. The structure of bone on the microscopic scale is often astoundingly well preserved and science is quickly demonstrating that there is a great wealth of information this structure can give us. It has been established that bone microstructure is influenced by both the physiological and functional demands placed upon an organism as well as the organism's

evolutionary history. Because of this, an examination of fossil bone microstructure may help us understand the physiology, biomechanics and phylogenetic history of extinct organisms. These three factors do not act independently however. The influence of interactions between the three factors further shapes bone microstructure and makes interpreting fossil data more challenging. In this study, I endeavored to use living species to determine the importance of these three factors and their interactions on shaping bone microstructure. A variety of bone microstructure characteristics from seven living species of the Order *Carnivora* were quantified. Data regarding the physiology, biomechanics and phylogenetic relationships of these seven species were collected. Then, using a variance partitioning method, the variances in the bone microstructure characteristics were then partitioned among the three influencing factors – physiology, biomechanics and phylogenetic relationships. This gives a measure of the relative effects of these three factors on the shaping of bone microstructure. As expected, it was found that all three factors had a significant effect on bone microstructure. However, what was more surprising was the degree to which this effect was through interactions. In all cases interactions between two or all three of the factors explained more of the variance than any one factor alone. In general, of the three, phylogenetic history explained the greatest proportion of the variance either alone or through interactions with the other two factors. These results emphasize the complexity of this system and suggest that future studies that study any one factor also consider the confounding effects of the other two.

Poster Session I, (Sunday)

DINOSAUR FOSSIL SITES INSIDE INCISED CHANNELS. AN EXAMPLE FROM THE ARCILLAS DE MORELLA FORMATION (LOWER CRETACEOUS, SPAIN)

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The Arcillas de Morella Formation (Lower Cretaceous) is widely known by specialists because it has delivered an abundant and diverse collection of dinosaur remains. This formation forms part of the Maestrat Basin. The Maestrat Mesozoic basin was part of the northern margin of the Tethys and was placed in the eastern sector of the Iberian plate during the Lower Cretaceous. The Arcillas de Morella Formation has a maximum thickness of 90 meters and it is early to middle Aptian in age. It is formed by red clays, sandstones, conglomerates, green marls, and limestones. These red clays have intercalations of green marls forming cycles of marine (marls) and continental (red clays) materials. The sandstones are present in large channel bodies or form laterally extensive units. The latter adapt to erosion surfaces. The channels are 700 meters in cross section and up to 25 meters in depth. In them, besides the sandstones, there are conglomerates, green marls, and carbonates that contain a marine fauna (foraminifers, oysters, and echinoids) and remains of tree trunks with marine bivalve borings. Locally the channels include very thin laminate facies, with alternations of silt and dark grey lime, rich in organic matter without bioturbation traces.

Most of the localities with dinosaur fossils in this formation are in the infilling parts of the channels. In these sites remains in anatomical connection have been discovered, but also sites with reworked bones that, in some cases, also contain autochthonous marine fauna.

Due to the presence of dinosaur footprints in the deposits of the base of the marine infill we suggest that the incision of these channels was developed under subaerial conditions, and that later they became flooded to settle down in estuarine environments. Rare earth elements studies in dinosaur bones placed in the marine deposits indicate that in some locations there are mixtures of bones of different origins. Only some remains found among the materials with estuarine facies, in the upper part of the infilling sequence of the channels, are of organisms contemporary with the formation of the fossil sites.

Technical Session I, Sunday 12:00

MODELLING AND RECONSTRUCTION OF THE FEEDING BIOMECHANICS OF THE BASAL CERATOPSIAN *PSITTACOSAURUS GOBIENSIS* AND ITS IMPLICATIONS FOR CERATOPSIAN EVOLUTION

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The ceratopsian clade of dinosaurs (Ceratopsia) is a diverse clade with the earliest members belonging to the diverse 'parrot beaked' *Psittacosaurus* genus of the late Barremian-Albian of the middle Cretaceous of central Asia. A biomechanical reconstruction of the cranial mandibular adductor musculature was done on the new ceratopsian species *Psittacosaurus gobiensis* to further investigate the chewing mechanics of the akinetic skull present in psittacosaur dinosaurs. The skull was CT scanned, modeled in the computer program Amira and the reconstruction of the musculature was performed using the Strand7 finite element analysis software. The adductor musculature was modeled utilizing osteological correlates present on the skull and through morphological comparison to extant phylogentically close taxa. A novel extension of the *adductor mandibulae externus ventralis* was modeled as a 'pseudo-masseter muscle similar to that seen in modern parrots. *Psittacosaurus gobiensis* was found to be capable of producing remarkably high bites forces in excess of 400N in both unilateral and bilateral biting. These forces are quite large when compared to values found for similar small bodied herbivores. This total bite force is more than three times the force calculated for *Heterdontosaurus,* with the bite force of *Psittacosaurus gobiensis* found to be closer to those seen in extant taxa such as smaller crocodilians, omnivorous mammals and small bodied carnivores. As *Psittacosaurus* is known to be an herbivorous dinosaur, this large bite force was most likely necessary to process plant material which was too tough to be consumed by leaf-eating taxa. This specialized mode of herbivory is supported by the oblique wear facets present on the tooth crowns which are similar to those found in larger herbivorous dinosaurs with highly kinetic skulls. The early specialization in dietary habit present in *Psittacosaurus* could well have been a key morphological catalyst for the evolution and diversification of the ceratopsian clade.

Poster Session IV, (Wednesday)

A NEW ENANTIORNITHINE (THEROPODA, AVIALAE) FROM THE UPPER CRETACEOUS LA COLONIA FORMATION OF PATAGONIA, ARGENTINA

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Enantiornithes is a geographically widespread and diverse Mesozoic bird clade originally described from the Upper Cretaceous sediments of South America. Despite extensive subsequent global discoveries of Mesozoic birds, only four South American localities have produced enantiornithine taxa. Here, we report an enantiornithine specimen, MPEF-PV 2359, from a new locality in the Upper Cretaceous La Colonia Formation of Patagonia, Argentina. Whereas mammals and other vertebrate fossils have been reported from this locality, the new specimen is the first avialan. The specimen, from deposits assessed to be Maastrichtian in age, is the uncrushed distal end of a right humerus with well preserved muscle scars. Based on the weakly developed strap-like distal condyles it is referred to Enantiornithes, while the following characters support its placement with the proposed subclade Euenantiornithes: (1) a dorsal condyle oriented at a high angle with respect to the humeral shaft; (2) the anterio-posterior compression of the humerus; and (3) a wide olecranon fossa with inconspicuous scapulotricipital and humerotricipital grooves. The specimen is differentiated from most other Enantiornithes by the development of a ridge on the dorsal edge of the ventral condyle, which extends across the distal surface of the humerus, and a thin crest on the ventral margin of the humerus that is interpreted as a raised margin of the m. brachialis insertion. The ridge present on the edge of the ventral condyle is proposed to be possibly synapomorphic of a Euenantiornithine subclade while the position and demarcation of the *m. brachialis* scar by the thin ventral crest is recognized as a potential autapomorphy. The new specimen expands our understanding of South American Enantiornithine diversity and, with recovery of new material, may be recognized as a new species. The unique position of the m. brachialis attachment in this specimen is strikingly reminiscent of the condition seen in extant Passeriformes and may have potential functional implications.

Poster Session II, (Monday)

DEVELOPING A PILOT PALEONTOLOGICAL RESOURCE MONITORING PROGRAM FOR THE NATIONAL PARK SERVICE AT GLEN CANYON NATIONAL RECREATION AREA, UTAH

DEBLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT, USA; SANTUCCI, Vincent, National Park Service, McLean, VA, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA; MADSEN, Scott, Utah Geological Survey, Salt Lake City, UT, USA; MADSEN, Margaret, Utah Geological Survey, Salt Lake City, UT, USA

Through the enactment of the Paleontological Resource Preservation Act (PRPA) of 2009, the United States Congress directed the National Park Service (NPS) to manage and protect paleontological resources using scientific principles and expertise and establish appropriate plans for the inventory, monitoring, and scientific and educational use of paleontological resources. In 2009, the Utah Geological Survey partnered with the NPS to develop a pilot paleontological resource monitoring program targeting fossiliferous exposures along the shores of Lake Powell in Glen Canyon National Recreation Area (GLCA). Initial fieldwork focused on Upper Triassic through Lower Jurassic strata in GLCA because these rocks are highly fossiliferous and accessible to the public, and therefore fossil sites are subject to theft, vandalism, and inadvertent damage. Also, these rocks are exposed to accelerated erosion by being subjected to wave action and repeated submersion and desiccation as water levels fluctuate seasonally along the shore of Lake Powell. The Upper Triassic Chinle Formation has the greatest potential to produce scientifically significant body fossils (bones, petrified wood, etc.) and the Lower Jurassic Glen Canyon Group has previously documented, scientifically significant trace fossils (tracks and burrows). We systematically collected data using protocols developed by us and others working on public lands to formulate a strategy for long-term monitoring of *in situ* fossils at GLCA. We chose, as a test monitoring site, an area having several localities in the Navajo Sandstone with vertebrate tracks and trackways identified as *Anchisauropus, Anomoepus*, and *Grallator* preserved in tabular, carbonate-cemented sandstone beds, interpreted as a playa deposit. Our methods include repeat photography using easily relocated "permanent" natural or man-made landmarks (such as stakes), placement of stakes to monitor erosion rates, placement of crack monitors to evaluate displacement, rock sampling and analysis to determine the amount of carbonate cement leaching by water, constructing site packets for use by later monitors, and developing a database for managing monitoring data.

Technical Session XIV, Wednesday 11:30

A RE-ANALYSIS OF THE "COELUROSAURIAN PIT-BULL" *YIXIANOSAURUS LONGIMANUS* WITH IMPLICATIONS FOR THE THEROPOD DINOSAUR DIVERSITY OF THE JEHOL BIOTA

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The theropod diversity of the Lower Cretaceous Jehol Group of Liaoning Province in northeastern China consists primarily of small bodied, lightly built feathered coelurosaurs. However the Jehol theropod *Yixianosaurus longimanus*, though known only from a partial skeleton, shows a combination of primitive (e.g. expansion of the distal scapula, posterolaterally directed glenoid, undivided proximal surface of ulna) and derived (e.g. scapula shorter than humerus, large contour feathers) coelurosaurian pectoral and limb characters thus making its phylogenetic affinities important to resolving the evolutionary history of the maniraptoran forelimb. Here we offer a re-analysis of the type specimen, focusing on its phylogenetic position and the ecological implications of its unique morphology. Purported affinities to either Deinonychosauria or Scansoriopterygidae are not supported, and results indicate a more basal position for *Yixianosaurus*. Allometric analysis indicates that *Yixianosaurus* was a small to medium sized theropod (estimated snout to vent length (SVL) between 410-450 mm) possessing forelimbs that were both long and robust, though not as elongated as in paravians. The manus is large, relative to both humeral length and SVL, and possesses one of the highest phalangeal index values known in theropods, indicating highly developed grasping ability. The combination of thick limb elements and an elongated yet robust manus with large raptorial claws showing enlarged flexor turbercles indicates that *Yixianosaurus* was a powerful animal. The phylogenetic placement of *Yixianosaurus* indicates that limb elongation occurred multiple times within Coelurosauria, while the differences in limb structure between *Yixianosaurus* and other Jehol theropods, in terms of both element robustness and intra-limb proportions, hints at potential niche separation.

Poster Session I, (Sunday)

AMPHIBIANS INDICATE ECOSYSTEM INSTABILITY PRIOR TO AND AFTER THE K-PG BOUNDARY: FOSSIL EVIDENCE FROM GARFIELD COUNTY, NE MONTANA

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The Hell Creek and Tullock Formations of Garfield County, NE Montana represent an ideal study system for investigating trends in vertebrate evolution, extinction, and recovery across the Cretaceous-Paleogene (K-Pg) boundary. From this study system, we assembled a fossil database of >1800 amphibian specimens (exclusive of Anura) from a temporally-constrained sequence of well-sampled vertebrate microfossil localities from the Hell Creek and lowermost Tullock Formations. Using this database, we documented high-resolution temporal patterns in amphibian taxonomic diversity, community structure, and survivorship during the K-Pg interval. Ten salamander and salamander-like amphibian species, representing the Batrachosauroididae, Scapherpetontidae, Sirenidae, and Albanerpetontidae, were recognized in the local section. We recorded the occurrence of *Habrosaurus prodilatus*, a temporal and paleobiogeographic range extension for the taxon, as well as a new genus and species of salamander from the Hell Creek Formation based on several distinctive atlantes. Preliminary results indicate that amphibian richness is relatively stable preceding the K-Pg boundary; whereas relative abundances of the most common taxa (*Opisthotriton*, *Scapherpeton*) undergo significant fluctuations. Heterogeneity values are high in the lower part of the Hell Creek Formation and much lower in the middle of the formation. The decrease in heterogeneity and the apparent local extinction of *H. prodilatus* occurred ~700-600 kyr before the K-Pg boundary, possibly coincident with a cooling trend that preceded the Late Maastrichtian warming event. In the upper part of the Hell Creek Formation, heterogeneity returns to prior levels only to decrease significantly across the K-Pg boundary. Likewise, amphibians suffered local extinction of ~30% of species at or near the K-Pg boundary. The earliest Paleocene survival fauna is numerically dominated by the 'bloom taxon' *Opisthotriton*, which represents ~85% of all individuals. The high-temporal resolution and quantitative approach of this study sheds new light on patterns of amphibian extinction and survivorship across the K-Pg boundary.

Technical Session V, Sunday 3:30

A DENSELY CONCENTRATED EARLY PLIOCENE MAMMALIAN FAUNA FROM THE LINXIA BASIN IN GANSU, CHINA

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The lower Pliocene of the Linxia Basin in Gansu Province is one of only a few representative sections for the early Pliocene sedimentary records in northern China, and even in East Asia. Recently, a 45 m long fossil lens was discovered from the red clays of the early Pliocene Hewangjia Formation at Duikang in Guanghe County within this basin. The whole lens was successively excavated by cutting it into many 1 meter longblocks. Previously, Pliocene mammals were sparsely found in China, and most were collected from fluvial and lacustrine deposits in the eastern Loess Plateau. Mammals from the widely distributed Pliocene *Hipparion* red clays are less in number. The known fossils from Duikang include 20 species, such as *Hystrix gansuensis*, *Alilepus* sp., *Sinictis dolichognathus*, *Parataxidea sinensis*, *Hyaenictitherium wongii*, *Adcrocuta eximia*, *Chasmaporthetes kani*, *Felis* sp., *Hipparion hippidiodus*, *H. platyodus*, *H. licenti*, *H.* (*Proboscidipparion*) *pater*, *Shansirhinus ringstroemi*, *Hesperotherium* sp., *Ancylotherium* sp., *Cervavitus novorossiae*, *Palaeotragus microdon*, *Samotherium* sp., *Sinotragus* sp., and *Gazella blacki*. Their faunal components are similar to that of the early Pliocene Gaozhuang fauna from Yushe, Shanxi. On the other hand, some taxa from Duikang have not been found in the Gaozhuang fauna, are slightly more primitive in evolutionary level, and known mainly in the late Miocene. As a result, the age of the Duikang fossils may be slightly earlier than that of the Gaozhuang fauna and closer to the lower boundary of the Pliocene. The Duikang fossiliferous bed is 0.8 m above the top of the late Miocene Liushu Formation, and the first occurrence of the three-toed horse *Hipparion pater* can be regarded as a biostratigraphical marker of the Miocene/Pliocene boundary. In conclusion, Duikang is an ideal candidate locality to establish as the stratotype for the lower boundary of the Chinese terrestrial Pliocene. Two giraffids and two chalicotheres were found from Duikang. All of these herbivores are typical browsers. The components of the Duikang fossils indicate that the environment of the Linxia Basin was a subarid steppe during the early Pliocene.

Poster Session II, (Monday)

A NEW STAGODONTID METATHERIAN FROM THE CAMPANIAN OF NEW JERSEY, AND ITS IMPLICATIONS FOR A LACK OF EAST-WEST DISPERSAL ROUTES IN THE LATE CRETACEOUS OF NORTH AMERICA

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The Ellisdale Site of New Jersey has produced the most diverse assemblage of terrestrial vertebrates from the Cretaceous of Eastern North America, including anuran and caudatan amphibians, squamates, avian and non-avian dinosaurs, and mammals. Preliminary studies of the Ellisdale land fauna suggested strong taxonomic affinities with the Campanian assemblages of the western interior of North America; however subsequent comparisons have indicated a high degree of endemism among nearly every element of the Ellisdale terrestrial assemblage identifiable to the generic level.Three mammalian taxa were initially recognized at Ellisdale: a cimolodontid and possible cimolomyid multituberculate, and a metatherian based on an isolated M3 which was described as identical to *Alphadon* (*Protalphadon*) *lulli*, a characteristic taxon of the Judithian fauna of western NA. Subsequent collection obtained other metatherian teeth that exhibited possible stagodontid affinities.

More recent analysis has now demonstrated that the M3 originally ascribed to *A. lulli* may belong to a previously undescribed taxon of stagodontid. The Ellisdale stagodontid appears to be more advanced than *Pariadens* of the Cenomanian of Utah; however is less derived than the stagodontid taxa *Eodelphis* and *Didelphis* from the Campanian and Maastrichtian of western North America.It has been purported that land animals may have dispersed across eastern North America, and possibly into Europe, throughout the Late Cretaceous; however the presence of an endemic "Ellisdalean" land fauna does not support this hypothesis. The Ellisdale fauna together with geological data suggest that eastern North America was an isolated continent from the Turonian onward, and thus became a refugium for relatively underived Early Cretaceous taxa that underwent vicariant speciation. If dispersal to the European archipelago did take place via a North Atlantic route, it could not have happened until the latest Maastrichtian, based on paleogeographic and paleontologic studies.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 10:30

THE COMBINED USE OF STABLE ISOTOPES AND DENTAL MICROWEAR TEXTURE ANALYSIS TO DECIPHER THE PALEOECOLOGY OF AUSTRALIAN MARSUPIALS

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Clarifying the paleoecology of Australian marsupials has primarily focused on traditional morphological methods with an increasing number of stable isotope studies. Recently, stable isotopes and 3-D dental microwear texture analysis (DMTA) have been combined to assess the paleoecology of Pleistocene kangaroos. The independent use of carbon isotopes can be used to infer the consumption of C_3 vs. C_4 vegetation while DMTA can assess the consumption of browse vs. grass, in addition to other dietary categories (e.g., bone consumption). The integration of these tools allows herbivorous marsupials to be identified as C_3 browsers, C_3 grazers, C_4 browsers, and/or C_4 grazers. Regions where C_3 grasses and/or C_4 browse are prevalent (e.g., Australia) require the use of multiple paleoecological methods. Here, we present two case studies that highlight: 1) the use of DMTA to infer relative bone consumption in the marsupial lion *Thylacoleo carnifex,* and 2) the combined use of stable isotopes and DMTA to assess dietary resource partitioning in a population of Pleistocene kangaroos (*Macropus titan*, *Procoptodon goliah*, *Procoptodon pusio, Procoptodon ralpha*). Specifically, *T. carnifex* was compared to carnivorous taxa ranging from the bone avoiding cheetah (*Acinonyx jubatus*), the generalist African lion (*Panthera leo*), and the opportunistic bone consuming spotted hyena (*Crucuta crocuta*). Most notably, *T. carnifex* is significantly different from *A. jubatus* in anisotropy and *C. crocuta* in complexity. These data indicate that *T. carnifex* may be more similar to its convergent namesake the African lion, in bone consumption. Next, the combined use of stable isotopes and DMTA in Pleistocene kangaroos reveals that the taxa with the greatest complexity also have the greatest and most variable $\delta^{13}C$ val-

ues, indicating the inclusion of C_4 browse in the diets of *P. pusio* and *P. goliah*. The converse is also true, with *M. titan* and *P. ralpha* indicating the consumption of primarily C_3 grasses. Collectively, the integration of geochemical and DMTA tools can clarify the paleoecology of Australian marsupials and taxa in regions with complex vegetation and/or prior to the expansion of C_4 grasslands.

Technical Session XVIII, Wednesday 1:45

FIRST RECORD OF CHIGUTISAURIDS (STEREOSPONDYLI, TREMATOSAURIA) IN THE SANTA MARIA FORMATION (UPPER TRIASSIC OF SOUTHERN BRAZIL)

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Chigutisauridae is the longest-lived trematosaurian clade (from Early Triassic to Early Cretaceous). They were reported in Argentina, Australia, India, and South Africa. This contribution reports a new chigutisaurid in the Carnian of southern Brazil (Santa Maria Formation, Paraná Basin). The material comprises two skull fragments, a mandibular fragment, a clavicular blade and a humerus. Ontogenetic features, such as thin dermal skull bones and wide open sutures, point to an early developmental stage of the specimen. The presence of a long, straight and pointed tabular horn, which runs parallel to the skull midline towards its tip, and a distinctive projection in the posterior border of the postparietal suggest a close relationship of the Brazilian chigutisaurid with the Indian *Compsocerops cosgriffi*. Three distinctive characters, however, show that the Brazilian chigutisaurid is a different taxon: presence of an alar process of the jugal in the ventral margin of the orbit; jugal does not extend well beyond the anterior margin of the orbit; and tabular does not contact the parietal (this last character is shared with the other Indian chigutisaurid, *Kuttycephalus triangularis*). Argentinean and Indian occurrences are dated as Norian, so the presence of a Carnian chigutisaurid in southern Brazil suggest that western Gondwana chigutisaurids have first occupied the Paraná Basin and later migrated towards west (to Argentina) and east (India). However, the presence of ghost chigutisaurid taxa cannot be dismissed, because their long temporal range contrasts with their still short (in comparison to other temnospondyls) geographic distribution. Hence, they might have been more geographically widespread than their fossil record suggests.

Poster Session III, (Tuesday)

DENTAL EMERGENCE SEQUENCES IN THE EUARCHONTA AND A POTENTIAL SYNAPOMORPHY OF EUPRIMATES

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Phylogenetic relationships within the Euarchonta remain contentious, but recent molecular evidence suggests that the Dermoptera are the sister group to Primates, corroborating the monophyly of the Primatomorpha. Much of the basic biology of the colugo remains unknown, however. The sequence of dental emergence can be an important character in both phylogenetic and life history reconstruction and although dental emergence sequences are available for some tree shrews, plesiadapiforms, and primates, information on dental emergence in the colugo is lacking. In this study, we determined the sequence of dental emergence in the Malayan colugo, *Galeopterus variegatus*, and compared it to published sequences for plesiadapiforms, tree shrews, and primates. We also re-examined published specimens of *Plesiadapis fodinatus*, *Notharctus tenebrosus*, as well as the extant pen-tailed tree shrew, *Ptilocercus lowii*. Twelve juvenile colugo specimens were seriated and teeth scored as a fraction of erupted crown height to determine the emergence sequence. Four *G. variegatus* specimens and one *P. lowii* were CT scanned to determine the state of development in the premolars. The sequence of emergence in the maxilla of *Galeopterus variegatus* is (DP4 = DP3 = M1)-DI2-(DI3=DC1=M2)-M3-C1-I2-P3-P4-I3 and in the mandible it is di1-di2-(dp3=dp4=m1)-(dc1=m2=di3)-i1-(i2=p3=p4)-c1-i3. Premolar emergence appears to be almost simultaneous, but in one specimen of the colugo, P3 was in occlusion, while P4 had not yet reached the occlusal plane. CT scans also suggest simultaneous development of p3 and p4. In plesiadapiforms, the third premolar precedes the fourth in emergence. The emergence of the fourth premolar before the third may be a synapomorphy of Euprimates, as this is the sequence in those Eocene primates for which information is available, as well as tarsiids, lorisids, galagids, most lemuroids, and some platyrrhines. In tree shrews, p4 precedes p3 in *Tupaia glis,* but in the more plesiomorphic *Ptilocercus*, p3 precedes p4, suggesting that any resemblance of tupaiids to Euprimates is convergent.

Poster Session III, (Tuesday)

RECORD OF THE EARLY AND MIDDLE MIOCENE CLIMATIC EVENTS ON MAMMALIAN TOOTH ENAMEL $\delta^{13}C$ VALUES FROM EUROPE

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The Miocene witnessed two important global climatic events: the Miocene Climatic Optimum (MCO; 17–15 Ma), characterized by high temperatures and an enhancement in humidity; followed by the Mid Miocene Cooling (MMC; 15–13.5 Ma) characterized by a sudden drop in global temperatures and an increase in the aridity, linked to the reestablishment of the ice cap in the East Antarctica. Our study tracks the shift from a more humid period during the MCO towards drier conditions in the MMC, pinpointed in four European terrestrial paleontological sites (Sandelzhausen, Somosaguas, Steinheim, Paçalar) spanning a range of time from 16.5–16.0 Ma to 13.6–13.0 Ma, by comparing $\delta^{13}C$ values analyzed in the tooth enamel from herbivorous mammals. The Sandelzhausen site shows the lowest $\delta^{13}C$ values (-11.4 ± 1.0‰ VPDB) agreeing with its age coinciding with the humid MCO. The Somosaguas site records the MMC trend and its mammalian tooth enamel shows significantly higher $\delta^{13}C$ values (mean= -9.9 ± 1.2‰ VPDB) when compared to the other sites ($F = 24.718$, $p < 0.001$), indicative of the increase in aridity patterns. Tooth enamel from the Steinheim site furnished $\delta^{13}C$ values (-11.1 ± 1.1‰ VPDB) resembling those supplied by Sandelzhausen, despite its age being similar to the one showed by Somosaguas and thus, coinciding with the arid MMC period. This fact, supported by palynological and paleoecological studies, may be explained by the existence of a strong latitudinal gradient in precipitation during the Middle Miocene when considering a west Mediterranean South-North transect. At the end of the sudden cooling when a change towards more humid conditions occurred, the Paçalar site displays $\delta^{13}C$ values (-11.2 ± 1.0‰ VPDB) statistically indistinguishable from Sandelzhausen and Steinheim. A subtropical forested landscape has been deduced for the Paçalar site, which supports the appearance of two hominoid species. Our results offer a preliminary view of the distribution of the isotopic values in different environments in western Eurasia during these important periods of the Miocene. Higher resolution isotopic studies on European fossil sites will enhance the understanding of these climatic events.

Evolution of the Modern African Fauna, Wednesday 9:00

A REVIEW OF THE AFRICAN FOSSIL SIRENIA

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The African fossil record of the Order Sirenia is best known from the middle Eocene to early Oligocene of North Africa, where the families Protosirenidae (two species of *Protosiren* and an unnamed genus and species) and Dugongidae (four species of *Eotheroides* and possibly four of *Eosiren*) are recorded. Another middle Eocene *Eotheroides* is also known from Madagascar. In the North African Miocene, the dugongids *Rytiodus* and *Metaxytherium* have been identified. Indeterminate Eocene to Miocene sirenian remains are recorded from several other parts of the continent. Reports of *Halitherium* in Africa and Madagascar have not been substantiated. The latest African Tertiary sirenian, a supposed "*Felsinotherium*" from the Pliocene of Morocco, may actually represent a dugongine of New World affinities. The living sirenians found in Africa (*Trichechus senegalensis* and *Dugong dugon*) have no fossil record there, and may both be Pliocene or later immigrants from the New World also.Sirenians evidently arose along the shores of the Tethyan Seaway, probably in the Old World; but whether they and the other Paenungulata belong phyletically with the Ungulata or the Afrotheria remains unsettled. Present evidence suggests that Eocene sirenian faunas on the north and south shores of Tethys were distinct at the generic level. Although the African sirenian record provides some of the best fossils to document the reduction and loss of hind limbs of Eocene marine mammals following their return to the sea, the later evolutionary history of the group must for now be traced mostly on other continents. Fossil Sirenia from Africa have been collected from shallow marine, lagoonal, estuarine, deltaic, and riverine environments. The African landmass was changing during the early and middle Cenozoic; the closure of the Tethyan Sea in the north, compression and formation of the Syrian Arc in the northeast, and opening of the Red Sea in the east, undoubtedly produced a diversity of ecological settings that supported a notable diversity of African (Tethyan) sirenian lineages.

Technical Session XVIII, Wednesday 3:00

A STEM-GROUP ANURAN FROM THE LOWER CRETACEOUS OF WESTERN LIAONING, CHINA

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A nearly complete skeleton of a new archaic anuran is described from the Early Cretaceous Yixian Formation, western Liaoning Province, China. This is the third frog from the Sihetun locality, where *Callobatrachus sanyanensis* and *Liaobatrachus graubai* are found. The skull of the new frog is wide and the quadratojugal is present to complete the maxillary arch. It has nine presacral vertebrae with three pairs of free ribs on the second to fourth presacrals, and their centra are amphicoelous probably with an incoherent notochordal canal. The urostyle with one pair of transverse process is monocondylar. Like in *Callobatrachus sanyanensis*, the anterior end of the scapula is overlain by the clavicle, and the ilium has weak dorsal crest and no dorsal protuberance. The tibiofibula is longer than the femur as in *Mesophyne beipiaoensis*. However, the new taxon differs from the other Mesozoic anurans from China by the following combination of characters: maxilla with no contact with squamosal, amphicoelous presacral centra, the anterior presacrals with free ribs, moncondylar sacro-uostylar

articulation, no intermedium, and the proximal end of the coracoid larger than the distal one. A phylogenetic analysis with the inclusion of all reported Mesozoic anurans from China is presented here, and the result suggests that the new anuran is a primitive archaeobatrachian more basal than *Mesophyne beipiaoensis,* which is the sister taxon of crown-group anurans.

Poster Session II, (Monday)

NEW LATEST CRETACEOUS MAMMALS FROM THE LANCE FORMATION NEAR BLACK BUTTE STATION, SOUTHWESTERN WYOMING

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The Cretaceous-Paleogene (K-Pg) mass extinction event was one of the most critical points in the evolutionary history of mammals. In North America, it is represented by fossil localities spanning the Lancian and Puercan land mammal 'ages,' which occur largely in continental deposits of the northern Great Plains region. These deposits represent coastal lowland paleoenvironments, adjacent to the Western Interior Seaway. The early Puercan faunas contain a small number of local survivors of the K-Pg extinction event, as well as a substantial influx of immigrants that seed the ensuing recovery and radiation of mammals. The immigrants have been proposed to originate from exotic areas, such as Asia and Baja California, and from upland refugia. Due to sparse fossil data, testing of these hypotheses has been limited. Here, we present a preliminary systematic paleontological study of more than 200 mammalian fossils from a Lancian-age local fauna from the Lance Formation of southwestern Wyoming. The specimens are from two independent collections made in the 1970s by the University of California Museum of Paleontology and the University of Wyoming Geological Museum. Deposits of the Lance Formation in this region are on the eastern flank of the Rock Springs Uplift near Black Butte Station; thus, this local fauna was farther west and paleoenvironmentally distinct from most other known Lancian local faunas. Preliminary analysis of the assemblages indicates that the Black Butte Station local fauna includes some common Lancian mammalian taxa as well as several new multituberculate taxa. These results suggest that explorations in under sampled regions and paleoenvironments are critical to a more complete understanding of the K-Pg transition.

Poster Session IV, (Wednesday)

PRELIMINARY BIOGEOGRAPHICAL AND SYSTEMATIC ANALYSIS OF AN EARLY PLEISTOCENE AVIFAUNA IN THE ROLLING PLAINS REGION OF WEST TEXAS

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The Plio-Pleistocene is characterized by extreme climatic oscillations producing intermittent glacial conditions in North America. This climatic variability is responsible for the periodic restructuring of affected ecosystems resulting in modern avian biodiversity and biogeographical distribution patterns seen today. These Pleistocene glaciation events reduces species diversity from a Pliocene peak of over 20,000 to fewer than 10,000. At present, North American avian systematics and biogeography lacks resolution due to a paucity of relevant data in the form of described avifaunal assemblages. This research is focused on a systematic and paleoenvironmental analysis of the avifaunal component of a fossil assemblage from the Roland Springs Ranch of Snyder, Texas. This locality, RSR1, is in the Rolling Plains region of West Texas. Overall, the entire fauna from this locality is diverse. Coupled with characteristic stratigraphic features, this compositional diversity indicates a lack of taphonomic bias suggesting that deposition occurred in a low-energy fluvial environment. Preliminary biostratigraphic dating using non-avian taxa suggests this assemblage represents a transitional period between the Blancan and Irvingtonian North American Land Mammal Ages (ca. 1.8 mya). If this assessment is accurate, the composition of the RSR1 avifauna should differ significantly from published Blancan-age, as well as Irvingtonian-age North American avifaunas. This avifaunal assemblage numbers over 100 specimens and consists of various elements representing at least six orders. This assemblage fills an important spatial gap in the avifaunal record and will help to resolve avian systematic and biogeographical issues from the important period just prior to the Pleistocene.

Poster Session IV, (Wednesday)

THE INFLUENCE OF BONE HISTOLOGY ON FOSSILIZATION: INSIGHTS FROM LASER ABLATION ANALYSES OF LATE EOCENE BRONTOTHERES

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Three associated brontothere (Perissodactyl) bones (metapodial, distal femur, and rib) were collected from an overbank mudstone in the Peanut Peak Member of the Late Eocene Chadron Formation (White River Group) near Crawford, Nebraska. The three bones were analyzed for lanthanide (REE) and other trace elements (TE) using conventional solution inductively-coupled plasma-mass spectrometry (ICP-MS) and Laser-Ablation-ICP-MS (LA-ICP-MS) to detect REE and TE variations within bones, compare results of the two methods, and determine whether biomechanical or histological factors affect post mortem uptake of REE and TE. Concentrations of most REE and TE were highest at the bone surface and decreased with depth into the trabecular bone. REE signatures from the outer circumferential layer (OCL) and the uppermost 1-2 mm of cortical layers of the three bones were light-REE enriched whereas signatures from deeper cortical and trabecular bone were middle-REE depleted. The bones were from a single locality, and should have the same REE signatures. Averaged REE signatures from LA-ICP-MS analyses of the OCL and outer cortical layers of the three bones were very similar; more similar than in previous solution ICP-MS analyses, possibly due to addition of bone from deeper cortical layers in solution ICP-MS samples. Preliminary data suggest that biomechanical functions of bone have little to no effect on the incorporation of REEs. However, bone histology may affect incorporation. REE concentrations in individual osteons are greater than surrounding bone but decrease toward the center of the osteon, which should have been an open channel prior to fossilization. Uranium gradients are used to calculate fossilization durations. However, U concentrations in two of the bones increased with depth into the inner cortical bone, possibly due to remobilization or redox variations, hindering its usefulness for interpreting fossilization time. REE signatures have also been used to determine fossil provenance and combat fossil poaching. These results suggest that LA-ICP-MS analyses provide higher quality data for REE comparisons to determine provenance.

Poster Session II, (Monday)

AN UPPER TRIASSIC (NORIAN) ICHTHYOSAUR WITH GUT CONTENTS FROM THE OTUK FORMATION, WESTERN BROOKS RANGE, ALASKA

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The partial skeleton of a large ichthyosaur, discovered in 1950 and collected in 2002, is the first specimen of this clade documented in Alaska. The specimen was collected in the western Brooks Range, approximately 55 kilometers northwest of Howard Pass. The ichthyosaur was discovered within the Limestone Member of the Otuk Formation, although its stratigraphic position within the member was not precisely documented. The Otuk Formation ranges in age from Early Triassic to Early Jurassic and consists of the Shale, Chert, Limestone and the Blankenship members. The Limestone Member is Norian in age and consists dominantly of rhythmically interbedded siliceous lime mudstone, shale, and chert. All are laminated to thin bedded, with a paucity of sedimentary structures and most body fossils indicating deposition below storm wave base in an outer neritic to inner bathyal setting.The preserved portion of the semi-articulated skeleton measures four meters representing approximately one-third to one-half total body length. The specimen includes fragments of the skull, most of the dorsal ribs and gastralia, portions of the pectoral and pelvic girdle, three proximal forelimb elements, and a nearly complete femur. Significantly, the presence of numerous small (less than one centimeter maximum dimension) bone and invertebrate fragments in the abdominal region are interpreted to be partially digested food remains within the alimentary canal. Based on its stratigraphic occurrence, large size, and available skeletal remains, the specimen is tentatively referred to the Shastasauridae, a clade of large (up to 20 meters) ichthyosaurs well known in the Middle to Late Triassic successions of western North America. The Howard Pass ichthyosaur is the most complete ichthyosaur known from Alaska and considerably extends northward the geographic range of this clade in North America.

Technical Session VII, Monday 4:00

OPPORTUNISM, ACOUSTICS AND MASS: EXAPTATION AND PATTERNS OF MIDDLE-EAR EXPANSION IN ARCHOSAURIA

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Archosaurs generally have large middle-ear volumes. In some lineages (crocodylomorphs, pterosaurs, theropods), this expanding volume results in extensive intraosseus pneumaticity, whereas other groups (*Psittacosaurus*, some sauropods) exhibit apomorphic extraosseus pneumatic expansions. Adaptive hypotheses (mass reduction, acoustic performance) have been advanced to explain this middle-ear expansion. We mapped expanded middle ears onto a phylogenetic framework and suggest instead that non-adaptive opportunistic expansion is the plesiomorphic backdrop on which the exaptation of apomorphic functions could occur. We also observe that, in some clades, constructional constraints (jaw-muscle conformation, brain volume) govern the manner in which middle-ear expansion proceeds. Lineages that exhibit extensive intraosseus pneumaticity generally had basal members occupying the small-bodied predator niche. Lightly built, fast moving predators with intraosseus pneumaticity would have had the exapted benefit of reduced head mass, decreasing inertial momentum and allowing for higher turning velocities and improved prey tracking and pursuit. A trend in crocodylomorphs toward increased jaw adductor muscle mass led to a more robust palatoquadrate complex,which in turn, constrained the middle-ear space such that any expansion would intersect and excavate the bones of the suspensorium and braincase. In theropods, small size in concert with trends for increasing brain volume led to the intersection of the middle-ear space with the bones of the braincase; selection for decreased head mass, coupled with opportunistic expansion, led to extensive pneumatization of the braincase. Taxa with expanded extraosseus middle-ear pneumaticity, such as some sauropods, may have been exapted for either mass-reduction or acoustic performance or both. The bullar-like structure seen in *Psittacosaurus* may have had an exapted acoustic function. Non-adaptive opportunistic expansion of the middle ear due to some intrinsic mechanism seems to have been the rule for archosaurs. Constructional constraints govern the style of pneumatic expansion, which in turn may influence the exaptive potential.

Poster Session II, (Monday)

EVOLUTION OF EARLY EOCENE *PALAEOSINOPA* (MAMMALIA, PANTOLESTIDAE) IN THE BIGHORN BASIN, WYOMING

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Palaeosinopa is a late Paleocene to early Eocene Holarctic genus belonging to the semi-aquatic, phylogenetically enigmatic family Pantolestidae. Pantolestids are usually grouped with cimolestans or with leptictids and palaeanodonts. At least six species of *Palaeosinopa* have been recognized during the early Eocene in North America, four of which have been reported from the Willwood Formation in the Bighorn Basin. Historically, the systematics of *Palaeosinopa* have been complicated due to small sample sizes and the primitive dental morphology of the genus, as well as the inadequacy of some holotypes. Continuing field work in the Bighorn Basin has resulted in a significantly improved sample of *Palaeosinopa*, which allows a reassessment of dental variation in a stratigraphic context. Based on this new sample (n=146), we confirm the presence of at least three and possibly four species of *Palaeosinopa* in the Bighorn Basin: *P. lutreola*, *P. veterrima*, a new species, and possibly *P. incerta*. *P. didelphoides* is distinct from *P. veterrima* based on minor differences in paraconid morphology and, as maintained by previous researchers, occurs in the Wind River Basin but not the Bighorn Basin. *P. incerta* is problematic and may comprise specimens from the extremes of *P. lutreola* and *P. veterrima* size distributions. *P. veterrima* is the most common species of *Palaeosinopa* in the Willwood Formation. Its molar morphology evolves from the more "crestiform" type (in earlier Wasatchian strata) that resembles other species of *Palaeosinopa* to a more bunodont morphology (the new species) characterized by exodaenodonty, a cuspate paraconid, and a wider, more open talonid in later Wasatchian strata. This change suggests a shift in diet and possibly ecology. While the oldest specimens of the *P. veterrima* lineage can be readily distinguished from the youngest specimens, stratigraphically intermediate individuals are also morphologically intermediate, making allocation to one or the other group difficult. The new sample thus provides evidence for gradual evolution within the genus *Palaeosinopa*, as has been documented in other lineages of mammals from the Bighorn Basin.

Poster Session III, (Tuesday)

PALEOECOLOGY OF A LATE MIOCENE HOMINID LOCALITY IN NORTHERN CENTRAL HUNGARY: PRELIMINARY STABLE ISOTOPE ANALYSIS OF THE RUDABANYA FAUNA

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In Europe, the Vallesian Crisis marks the extinction of many mammalian taxa characteristic of previous Middle Miocene faunas, including most of the hominids that settled successfully in Europe during the Middle and early Late Miocene. It is suggested that the extinction of Late Miocene Western and Central European hominids was not related to the spread of open environments, but to a significant increase in climatic seasonality and subsequently the deciduous component of the vegetation. Both the morphology and life history pattern of *Rudapithecus hungaricu*s, a large-bodied frugivorous hominid, considered to be closely related to the last common ancestor of living African great apes and humans, suggest it would have been susceptible to habitat change. A diverse assemblage of Late Miocene mammalian fauna has been recovered over the last 40 years of excavation at series of four localities near the town of Rudabánya in northern central Hungary. Current paleoenvironmental reconstructions for these localities suggest a predominantly closed forest-environment. To further evaluate the environmental context of *Rudapithecus*, we combined rare earth element (REE) and bulk and serial stable isotope (δ^{13C} and δ^{18O}) analyses in a sample of tooth enamel from five different ungulate species contemporaneous with *Rudapithecus*. The sampled ungulate taxa include *Hippotherium intrans, Miotragocerus* sp., *Lucentia* aff. *pierensis*, *Micromeryx flourensianus*, and *Aceratherium incisivum*. Relatively flat REE patterns in the tooth enamel suggest that diagenesis has not erased the original geochemical signal. Preliminary δ^{13C} values indicate that all mammals fed on C3 plants. δ^{13C} and δ^{18O} values of *Miotragocerus, Micromeryx,* and *Aceratherium* are more negative and indicate feeding in a forested environment, while the isotopic values for *Hippotherium* and *Lucentia* are more positive, indicating feeding in a more open environment. Isotopic values also suggest resource partitioning among the sampled ungulates. These results provide insight into the paleoecology of Rudabánya and help to evaluate the impact of environmental change on the evolution and dispersal of Late Miocene hominids.

Technical Session IV, Sunday 3:15

FOURIER TRANSFORM INFRARED SPECTROSCOPY (FTIR) OF SOFT-TISSUE PRESERVATION FROM THE EOCENE GREEN RIVER FORMATION (COLORADO, USA)

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Many geochemical and biological analytical techniques have been employed in the identification and quantification of soft-tissues in the fossil record, such as mass spectrometry, the polymerase chain reaction, scanning electron microscopy and electron microprobe analysis. However, many of these techniques require destructive sampling and are unable to provide information regarding large scale spatial distribution of chemistry, including organic molecules within fossil organisms. This research takes a multiple-technique approach to examine a range of fossilised and modern organisms in order to map and compare the chemistry of soft-tissue regions. Two of these techniques are relatively new to paleontological studies, synchrotron rapid scanning x-ray fluorescence (SRS-XRF) and Fourier Transform Infrared (FTIR) spectroscopy. SRS-XRF non-destructively provides highly sensitive, in-situ and large scale 2D elemental maps, which reveals the distribution of elements present in concentrations below the detection limits of conventional techniques. SRS-XRF is rarely used in paleontology as the greater expense and limited number of synchrotrons in existence restricts accessibility. FTIR spectroscopy is also relatively new to paleontological studies, and is useful as it can identify and spatially map the presence of organic functional groups by detecting their diagnostic infrared spectra. Key results from this study represent comparative FTIR analysis of an extant gecko skin moult and fossilised lizard skin from the Eocene Green River Formation (Colorado, USA). The maps produced from extant skin show that protein functional groups (amide I and II) are present within individual scale structures. Comparable maps produced from fossilised skin show the presence of the same functional groups also within each individually preserved scale. These remarkable spatial correlations suggest that these are not modern contamination but the remnants of organic compounds that were present in the living organism. This is an unprecedented result that shows endogenous organic molecules can be preserved in-situ for over 50 million years.

Poster Session I, (Sunday)

CLIMATIC AND FLORAL LATITUDINAL GRADIENTS BETWEEN LATE CRETACEOUS SOUTH AMERICA AND ANTARCTICA: PALEOBIOGEOGRAPHICAL IMPLICATIONS FOR SOUTHERNMOST GONDWANA

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Extensive exposures of Cretaceous (144-65 Ma) strata in Argentina have yielded most of the known dinosaur taxa from the Southern Hemisphere. However, little is known about their environment. The Pari Aike Formation, in southern-most Patagonia (Argentina), yields unique dinosaurian (*Talenkauen santacrucensis, Puertasaurus reuili, Orkoraptor burkei*and an unnamed Titanosaur), elasmobranch (*Cretalamna appendiculata*), testudine, and dipnoan fauna.The Pari Aike Formation is notable because it is the southernmost Late Cretaceous site with both floral and faunal components preserved. Throughout the Cretaceous, South America and the Antarctic Peninsula shared a continental-continental plate boundary. It is not clear whether this connection was subaerial, covered by an epeiric sea, or whether it alternated between these states. Limited terrestrial vertebrate data is available to examine the paleobiogeographic relationship between Late Cretaceous Antarctica and South America. However, fossil wood spans both of these locations and provides a potentially useful tool for understanding vertebrate paleoenvironments and paleobiogeography.

To assess the usefulness of fossil wood, we collected and sectioned samples from the Pari Aike Formation (Argentina). All of the fossil wood samples have distinct growth rings, providing strong evidence for seasonal growth regimes. The relative abundance of gymnosperm wood is 73% versus 20% for angiosperms. The closest published Late Cretaceous locality is in the Antarctic Peninsula. Putatively coeval floras from the Antarctic Peninsula have distinctly different relative abundances: ~25% gymnosperm wood versus ~75% angiosperm wood. These differences suggest that these two regions, notwithstanding their close proximity, did not share a homogeneous flora. Despite the equable Late Cretaceous climate, this research points to the possibility of climatic and floral latitudinal gradients along the relatively short continental connection between South America and Antarctica. Floristic differences between the regions could have favored endemism and/or migratory behavior among the southern Gondwanan Late Cretaceous fauna.

Poster Session II, (Monday)

NEW AMPHICYONID (MAMMALIA: CARNIVORA) FROM THE LOWER IRRAWADDY SEDIMENTS (MYANMAR) WITH COMMENTS ON *AMPHICYON* SPECIES FROM THE MIOCENE OF ASIA

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We report a discovery of an amphicyonid from the lower part of Irrawaddy Sediments in central Myanmar. The age of the fauna has been estimated as the late Miocene based on a biostratigraphic correlation with the Siwalik fauna. The materials consist of a maxillary fragment with P^4-M^2 and two mandibular fragments with incomplete M_{1-2}. The Irrawaddy amphicyonid is similar to *Amphicyon* in enlarged second molars relative to first ones, a crenulated lingual cingulum that surrounds the protocone, a wide talonid on M_{1-2}, and a vestigial paraconid on M_2. Its size is within the size range of *Amphicyon major*, alarge European amphicyonid. However, it differs from other *Amphicyon* species and other amphicyonines ina relatively large protocone lobe on P^4,an oval-shaped outline of M^2,a relatively small para-

conid on M_1, anda buccolingually wide m_1, indicating that it belongs to a new genus of the subfamily. Fossil records of amphicyonids in the Miocene of Asia have been scanty. Only three records, one from the early Miocene of Vietnam and two from the middle Miocene of Thailand, were the previously known amphicyonids from Southeast Asia. The present specimen confirms that the family survived until the late Miocene in Southeast Asia, similar to the condition in China and Siwalik. Most of Asian amphicyonids have been assigned to the genus *Amphicyon*, although they have been suggested to belong to different lineages from the *Amphicyon* species from other continents (Europe, North America, and Africa). Our reexamination of Asian "*Amphicyon*" suggests that some of the Chinese and Siwalik forms may relate more closely to other amphicyonine genera such as *Yisengrinia* than to *Amphicyon*. On the other hand, the Irrawaddy amphicyonid shows more similarities to European and North American *Amphicyon* species and one of the Siwalik "*Amphicyon*", suggesting that some of Asian amphicyonids actually have an origin in the *Amphicyon* lineage. Although most of Asian amphicyonid materials are fragmentary, our reappraisal revealed their taxonomical diversity, which seems to have resulted from multiple immigration events from other continents and endemism in each part of Asia.

Technical Session XV, Wednesday 10:30

MACROEVOLUTION OF LARGE BODY SIZE IN MEGATOOTHED (LAMNIFORMES: OTODONTIDAE) SHARKS

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Sharks in the family Otodontidae (i.e. *Otodus* and *Carcharocles*) include some of the largest selachian species to have ever lived. Based mainly on tooth dimensions, it has long been reported that total length (TL) of these related species has increased throughout the Cenozoic. It is generally accepted that *Otodus obliquus* gave rise to the genus *Carcharocles*, which includes *Carcharocles megalodon*, during the early to middle Eocene. Total length estimates for *O. obliquus* are comparable to if not larger than adult modern white sharks (*Carcharodon carcharias*), which can attain lengths up to 7 meters. Meanwhile, published total length estimates for *Carcharocles megalodon* are upwards of 18 meters. Using a heterochrony model, we should expect *C. megalodon* to exhibit one of two modes of growth to attain its large size: 1) an accelerated growth rate compared to *O. obliquus* to become large relatively quickly or 2) a growth rate similar to but maintained longer than *O. obliquus*. The vertebral centra of these species can be found on rare occasions and can preserve a record of ontogeny in growth bands or "annuli", which are truly annular in many species of modern lamniform sharks. Vertebral centra were sampled from numerous otodontid sharks including: *O. obliquus* from the early Eocene of Morocco, *Carcharocles auriculatus* from the Eocene of Belgium, *Carcharocles angustidens* from the Oligocene of Belgium, and *C. megalodon* from the Miocene of Belgium. Growth bands were analyzed using a combination of x-radiography and high resolution x-ray computed tomography (CT) scans to avoid specimen destruction. Centrum diameter at birth increased in each species through time with *Otodus* specimens being the smallest falling into the range of the extant white shark (~16 – 20 mm). All species of *Carcharocles* had centrum diameters at birth that were larger than *C. carcharias*, with the largest being *C. megalodon* at 31.9 mm. Growth rates for *O. obliquus* samples appear to be equal to or slightly greater than *C. auriculatus*. However, growth rates for *C. angustidens* and *C. megalodon* appear to accelerate through time suggesting an early ontogenetic increase in body size.

Technical Session XVI, Wednesday 4:00

PHYLOGENETIC IMPLICATIONS OF THE PETROTYMPANIC COMPLEX OF BALEEN WHALES (CETACEA, MYSTICETI)

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We compare the anatomy of the petrotympanic complex (petrosal bone plus tympanic bulla) across 14 species of extant mysticetes in order to explore the phylogenetic significance of the region. Although the petrotympanic complex is a common source of phylogenetic information for extinct and extant cetaceans, there are few anatomical studies comparing the complex across a broad range of mysticete taxa (as exists for odontocetes). We identify 48 characters from the region and employ them in parsimony analyses of mysticetes using different data partitions including and excluding petrotympanic characters from combined morphological data sets.Our results confirm that the ear region is an important source of phylogenetic characters in mysticetes. Using petrotympanic characters alone, monophyly of major groups (Balaenopteroidea, Balaenopteridae, and Balaenidae) are recovered with strong support. The same groups are recovered by morphologic analyses excluding all petrotympanic characters (although resolution is reduced within *Balaenoptera*), and by previous molecular analyses. Contrary to results consistently obtained from molecular data, *B. musculus* and *B. physalus* within *Balaenoptera* are united, and *Caperea marginata* groups with balaenids within a monophyletic Balaenoidea. Monophyly of Balaenoidea is consistent with other morphologic results, but differs from molecular analyses, which place *C. marginata* on the balaenopteroid lineage. Within *Balaenoptera*, *B. borealis* and *B. edeni* are grouped together when only petrotympanic characters are included, which is consistent with molecular analyses, but differs from morphologic studies. The relationship between those taxa is lost when the petrotympanic characters are combined with morphologic data from other regions of the skeleton. Given the phylogenetic importance of the petrotympanic complex, which preserves well in the fossil record,future studies will focus on the ear region of mysticetes in order to elucidate relationships among extinct taxa, as well as discrepancies between morphologic and molecular results.

Poster Session I, (Sunday)

CTENACANTHIFORM SHARKS FROM THE PERMIAN KAIBAB FORMATION, NORTHERN ARIZONA

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The Middle Permian (Guadalupian) Kaibab Formation is a sequence of limestones and sandy limestones deposited during the eastward transgression of a shallow sea and is now found across much of northern Arizona, southern Utah, and southeastern Nevada. Despite a considerable amount of work on the invertebrates, related to stratigraphic studies, very little emphasis has been placed on the vertebrates, only two taxa having been described, the giant petalodont shark *Megactenopetalus kaibabanus* and an unnamed phyllodont. Recent collecting from the Kaibab in northern Arizona has yielded approximately 28 shark fin spine and tooth taxa, of which only the ctenacanthiform sharks are reported on here. Five tooth taxa are recognized, of which four appear to be new. Within the family Ctenacanthidae is one new species of *Saivodus*, together with a new related species. The three other taxa represent an indeterminate family of ctenacanthiform sharks: *Glikmanius myachkovensis*; a large *Glikmanius*-like taxon representing a new genus and species; and a small *Glikmanius*-like taxon. The range in tooth types suggests predator partitioning within the ctenacanths of the Kaibab Formation. The new *Saivodus* species, the related taxon, and *Glikmanius myachkovensis* had puncturing and grasping teeth best suited for securing smaller prey to be swallowed whole. The small *Glikmanius*-like species had teeth for grasping and cutting, while the large *Glikmanius*-like taxon had teeth adapted for feeding on larger prey and may represent the apex predator of the Kaibab Sea.Ctenacanthids are rare in the Permian world-wide, although they are more common in the Pennsylvanian. Thus, this fauna extends the range of the family upwards. The Kaibab fauna may be related to faunas in eastern Greenland, Wyoming, and Australia that also contain ctenacanths but those faunas are currently in need of revision.

Technical Session VII, Monday 2:45

A COMPLETE SKULL AND SKELETON OF A LONG-NECKED PLEURODIRE (PLEURODIRA: ARARIPEMYDIDAE) FROM NIGER

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A well preserved, articulated skull and postcranial skeleton of a small pleurodire was discovered beneath a skeleton of the spinosaurid dinosaur *Suchomimus tenerensis* in the Elrhaz Formation (Aptian-Albian) in Niger. CT scans of the skull documents the morphology of the endocranium and the course of basicranial circulatory canals. Many features distinguish the Nigerienne turtle as a new taxon. Skull length is twice its width, and the sagittal crest is particularly long. The cheek emargination is deep and bordered distally by a maxillary prong. The peripheral series reaches the boomerang-shaped nuchal plate. Other distinctions include a ventrally curved dentary ramus with squared chin, unfused postzygapophyses on cervical vertebra 8, an incomplete neural series that does not contact the suprapygal, lack of carapacial vacuities, a reduced mesoplastron, and a divergent distal condyle on the first metacarpal. The Nigerienne turtle is closely related to the unusual pelomedusid *Araripemys barretoi* from similar age sediments in the Santana Formation of northeast Brazil, exhibiting all synapomorphies that characterize *Araripemys*, such as the posterior extension of the internal carotid canal, elongate cervical vertebrae with postzygapophyses on cervical vertebrae 2-7 that join in the midline, a flat carapace with a granular sculptured texture, anteriorly prominent epiplastra, and three plastral vacuities. The new araripemyid may help to resolve the affinities of *Araripemys* and, thus, basal divergences within Pleurodira. Primitive character states such as reduction in the relative size of the mesoplastra suggest a basal relationship of the African species to the Pelomedusoides. Conversely, derived characters such as an incomplete neural series may place the African species higher within Pelomedusoides. The presence of closely related species in Brazil and Niger in sediments of approximately 110 Ma provides additional evidence of prolonged faunal exchange between South America and Africa prior to the opening of the Atlantic Ocean.

Technical Session VI, Monday 3:00

CHANGES IN MOLAR FUNCTIONAL MORPHOLOGY OF EARLY HIPPOMORPHA

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During the well documented evolution of Hippomorpha a significant change from brachydont to hypsodont teeth occurred. The change in the brachydont teeth from bunodont to lophodont in the Eocene and Oligocene represents an essential modification in mastication and diet. Measurements on 3D surface models of upper tooth rows demonstrate that in both Equidae and Palaeotheriidae the efficiency of cutting and shearing is increased on the buccal side, whereas on the lingual side two different functional paths are taken. In the primitive genera *Hyracotherium* and *Propalaeotherium* cutting and shearing on the buccal side is slightly increased compared to the functional precursor *Phenacodus* and this tendency is even more strongly expressed in the more derived *Anchitherium* and *Palaeotherium*. The inclination angle of the developing mesostyle is steepening, displaying an enhanced efficiency for cutting and shearing. The relative surface of the buccal facets and length of buccal shearing edges increase and apical wear decreases. On the lingual side, *Anchitherium* exhibits a proceeding specialisation for cutting and shearing. Lingual facets are distinct and steep, in contrast to the classical phase II facets, which are almost not detectable. Due to the

steep inclination of the facets the shearing forces can be drained off diagonally and no high lingual tooth base is needed. *Anchitherium* apparently has a one phase power stroke, such as the modern horses with hypsodont cheek teeth, and has a well expressed shearing and cutting function buccally and lingually. *Palaeotherium* has no lingual facets, but classical phase II facets that are relatively flat, indicating a two phase power stroke. *Palaeotherium* and *Phenacodus* have a high lingual tooth base, capable to absorb high vertical forces that occur in crushing. *Anchitherium* probably mainly fed on food that could be processed by cutting and shearing such as leaves. In contrast to *Anchitherium*, *Palaeotherium* was able to break up harder food items, such as hard fruits. Therefore it can be deduced, that *Palaeotherium* had a wider diet breadth, but was not as efficient in cutting and shearing as *Anchitherium*.

Poster Session IV, (Wednesday)

A PORTUGUESE SPECIMEN OF *CAMPTOSAURUS APHANOECETES* (ORNITHOPODA: CAMPTOSAURIDAE) INCREASES THE DINOSAURIAN SIMILARITY AMONG THE UPPER JURASSIC ALCOBACA AND MORRISON FORMATIONS

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The ornithopod dinosaur fauna from the Upper Jurassic Lusitanian Basin (Central-West Portugal) is poorly known and mainly represented by isolated bones and teeth. At present, just occasionally, some partial skeletons are found, but the incompleteness of the available specimens does not allow a robust interpretation of the composition of the ornithopod assemblages from these ecosystems. In this context, the discovery of a new and, so far unknown ornithopod species is noteworthy for the European record. The specimen consists of a partial skeleton from the upper Kimmeridgian beds of the Alcobaça Formation in Praia da Corva's cliffs (Torres Vedras Municipality). The possession of a slightly arched scapula with the distal end of the blade posteroventrally sloped, and a humerus with a low and rounded humeral deltopectoral crest, are some of the features exclusively shared, among the camptosaurids, by *Camptosaurus aphanoecetes*, previously recognized in the North American Morrison Formation. The extension of this North American camptosaurid to southwestern Europe corroborates the high similarity between the dinosaur fauna of these two coeval Laurasian landmasses. That indicates some degree of geographical relationships and ecological similarity between them. Prior to this discovery, the Alcobaça Formation had already yielded remains of three dinosaur species, the plated dinosaur *Stegosaurus armatus* and the carnivorous *Allosaurus fragilis* and *Torvosaurus tanneri*. Thus, the Portuguese Alcobaça Formation contains a unique Upper Jurassic European record of four intercontinental dinosaur species.

Technical Session IX, Tuesday 8:00

RAPID EVOLUTIONARY RATES OVER GEOLOGICAL TIMESCALES IN MAMMALS

EVANS, Alistair, Monash University, Melbourne, Australia; JONES, David, Monash University, Melbourne, Australia; IMPPS RCN: INTEGRATING MACROECOLOGICAL PATTERN AND PROCESSES ACROSS SCALES, University of New Mexico, Albuquerque, NM, USA

Quantifying evolutionary rate is fundamental to understanding the processes underlying evolution. Most recent work has focussed on calculating evolutionary rates on short timescales (<100 years or generations). These studies have demonstrated that evolution can proceed relatively rapidly over such brief intervals. Fewer studies have quantified evolutionary rate in fossil organisms, and the perception remains that evolution over geological timescales is always very slow: published measurements of mammal evolution over longer than 10^6 years or generations tend to reveal very low rates ($<10^{-5.5}$ haldanes, $<10^{0.5}$ lnSD change, <1 darwins, <1 factors of e). Previous rate estimates focused on analysing the central tendency of single lineages, which will underestimate the maximum potential rate of evolution. Instead we calculate rates for clade maxima rather than the means of single lineages. We compiled the maximum body size within 28 mammal orders on the four largest continents (Africa, Eurasia, and North and South America) and the ocean basins for all sub-epochs during the last 70 million years, covering the well-documented mammal radiation following the K-Pg mass extinction. Here we show that rates of macroevolution (over $>10^6$ years or generations) can be an order of magnitude faster than previously reported: in the mammal radiation following the K-Pg mass extinction, body size evolved at up to $10^{-4.5}$ haldanes or $10^{1.5}$ SD change over 10^6-10^7 generations. This demonstrates the presence of sustained directional selection upon component lineages of the mammal clade over very long timescales.

Technical Session I, Sunday 10:30

A SANTONIAN-AGED PACHYCEPHALOSAURID FROM NORTH AMERICA AND THE EVOLUTION AND DIVERSITY OF PACHYCEPHALOSAURIA

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Pachycephalosauria (Ornithischia: Marginocephalia) is a clade of small- to medium-sized herbivorous dinosaurs characterized by a prominent thickening of the skull roof. The evolutionary history of the group is one of the most poorly understood aspects of dinosaurian evolution due to limited knowledge of their anatomy and their poor fossil record. New frontoparietals from the Santonian-aged Milk River Formation of Alberta reveal the anatomy of the earliest known North American pachycephalosaurid. This material includes a complete well-preserved frontoparietal that is remarkable for having a fully developed dome. The morphological distinctiveness of the new taxon was tested quantitatively using bivariate and multivariate landmarked-based morphometric analyses performed on a dataset of 15 complete pachycephalosaurid domes representing most named taxa. Bivariate plots reveal that the new taxon is distinct in the proportion of its large supraorbitals, and its oblong, highly inflated dome is separable from all other taxa in the principal component analysis. This taxon demonstrates that several distinctive cranial features of pachycephalosaurs, including the full incorporation of the anterior peripheral elements into the dome, loss of supratemporal fenestrae, and loss of a prominent parietosquamosal shelf, predate the Campanian and the occurrence of named putatively basal flat-headed and incompletely domed taxa. A species-level phylogenetic analysis of Pachycephalosauria using a new character matrix results in a strict consensus tree in which the new Milk River taxon occurs in an unresolved polytomy with *Prenocephale* and pachycephalosaurines. Phylogenetic diversity metrics, calculated through time calibration of the phylogenetic results, suggest considerable undiscovered pachycephalosaur diversity in the Late Cretaceous. Furthermore, the sister-group relationship between Pachycephalosauria and Ceratopsia posits a 70 million year ghost lineage that suggests most of the evolutionary history of pachycephalosaurs remains unknown, and emphasizes the incompleteness of the dinosaur fossil record.

Poster Session IV, (Wednesday)

THE USE OF SEARCH AND RESCUE AND TECHNICAL (ROPE) RESCUE TECHNIQUES IN THE AID OF PALEONTOLOGICAL FIELDWORK

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Working in steep terrain or moving heavy jackets are common hazards and difficulties encountered during paleontological fieldwork. Normally these conditions are accepted and a brute force approach to overcoming them is adopted, even though this often exposes personnel and fossils to hazardous conditions. The search and rescue (SAR) community has developed techniques that can be used to overcome the hazards of steep terrain and moving a heavy fragile package (injured person) over rough terrain efficiently and safely. Consequently SAR methods can be used to solve some problems faced by paleontologists in the field. Presented here will be an overview of basic SAR techniques that can be used to access, excavate, and move heavy fragile fossils.Described and illustrated here will be the capabilities of single rope technique and rope rescue methods, how they can benefit the professional paleontologist, and the approximate limits of rope use. The methods described are relatively fast, inexpensive, gentile, and can be free if trained volunteers are used. Generally seven functions can be performed by ropes: Equipment transport, work safety, work positioning, rope access, raises, lowers, and lateral movement. Equipment transport is simple and involves minimal training, while work safety and work positioning are methods of protecting an investigator from potential fall when working around steep or rugged terrain. Rope access allows the investigator to access locations that would otherwise not be accessible without ropes (cliffs, etc.) Raises, lowers, and traverses are ways of moving large fragile masses over terrain features, doing so safely, gently, and efficiently. These techniques require significantly more training, but are more useful. All methods will be illustrated diagrammatically and with pictures in training or practice, when possible.This presentation is not intended as a rope techniques or rope rescue training course, so the depicted methods should not be used without training or the use of trained volunteers. Consequently, information concerning where to gain training will be provided as well as initial contact information for sources of trained volunteers.

Poster Session IV, (Wednesday)

CHEWING MOVEMENT AND TOOTH FUNCTION IN *BASILOSAURUS ISIS* (MAMMALIA, CETACEA) BASED ON DIGITAL ANALYSIS OF WEAR FACETS

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Modern whales swallow their prey whole (Odontoceti) or filter-feed (Mysticeti), but they evolved from Eocene Archaeoceti that have complex cheek teeth with wear facets that indicate chewing movements. To determine jaw movement and tooth function in archaeocetes, we analyzed the orientation of wear facets and striations in *Basilosaurus isis*, one of the best known archaeocete species. Cranial remains studied here are part of a virtually complete skeleton, WH-74, collected from the late Eocene Birket Qarun Formation of Wadi Hitan, Egypt. We constructed a 3D surface model of the skull and mandibles from CT scans, and recalculated the surface of the plastically deformed skull to remove twisting and shearing deformation. High-resolution surface scans of individual teeth were digitally aligned to the retrodeformed skull model. We marked the wear facets and measured the inclination angles and dip directions of their best-fit planes with respect to standard XY, XZ, and YZ reference planes of the skull. Three types of wear facets are recognized on the upper cheek teeth. 1) Steeply inclined shearing facets on the lingual sides result from direct tooth-tooth contact. Striations on these imply an orthal or upward as well as a retractional or anterior-to-posterior movement of the jaws relative to the skull. 2) Flatter facets at the apices of the central cusps

and flanking cuspules were likely caused by forceful tooth-food contact during orthal crushing, which resulted in breakage of the apices. 3) Large flakes of enamel and dentine were spalled from both lateral sides of the cheek teeth, probably also due to high forces applied to the tips. This explains areas of open dentine exposed on the buccal sides of the upper cheek teeth. These areas were further eroded by tooth-food contact. Left molars and premolars are worn more heavily than right ones in WH-74 and show different patterns of facet orientation, implying an individual preference for chewing on the left side. Further quantification of striation directions combined with facet data of upper and lower cheek teeth will yield precise information on the directions and distances of jaw movement throughout the chewing cycle.

Technical Session XVI, Wednesday 2:00

THE FOSSIL RECORD OF EXTINCTION: THE DEMISE OF THE BLUE ANTELOPE (*HIPPOTRAGUS LEUCOPHAEUS*) IN SOUTHERN AFRICA

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The extinction of southern Africa's blue antelope (*Hippotragus leucophaeus*) in the early 19th century marks the first large African mammal to become extinct in historic times. Because the blue antelope disappeared before scientists could observe live populations, the fossil record is the primary source of information regarding the ecology of the blue antelope and the processes responsible for its demise. This study provides new data on the blue antelope's fossil history and evaluates the causes of its extinction.Examination of fossil occurrences over time shows that blue antelope became increasingly rare within a steadily shrinking geographic range since the terminal Pleistocene (24-12 ka). Revised specimen counts from Nelson Bay Cave (NBC) show this trend to be associated with declining abundances of grazing ungulates, suggesting that suitable grasslands were disappearing. The demographic structure of the NBC blue antelope, reconstructed from dental crown height, shows a reduction in median and maximum age not seen in other ungulates. This age profile is consistent with increased mortality rates and declining population densities.Previously proposed extinction mechanisms include resource competition and habitat degradation associated with the arrival of pastoralists 2,000 years ago and overhunting by European settlers. However, the observed time-depth of the decline in blue antelope range and abundance predates the arrival of both by thousands of years. Although they may have been incidental contributors to the extinction, they are unlikely to have been the primary drivers. Rather, the extinction of the blue antelope is best explained as the result of long-term environmental change operating through the Holocene.Southern Africa's late Quaternary extinctions have been previously characterized as a synchronous event taking place at the Pleistocene/Holocene transition. Recent evidence, however, shows the extinction chronology to be increasingly complex, with a number of extinct ungulates surviving well into the Holocene. The extinction of the blue antelope can be viewed as the most recent of a long-term extinction process spanning the last 18,000 years.

Poster Session I, (Sunday)

MUDDYING THE WATER: TRACK FEATURES TYPICAL OF LIMB KINEMATICS FORMED THROUGH NORMAL SUBSTRATE DEFORMATION, AS SHOWN BY FINITE ELEMENT ANALYSIS EXPERIMENTATION

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The fossilized tracks of vertebrates present the only direct evidence of locomotor mechanics and other aspects of the paleobiology of extinct animals available from the fossil record. Track morphology, specifically variations in track depth and features associated with the base of the track, has traditionally been used to infer peak under-foot pressures or varying ground reaction force vectors associated with limb kinematics (e.g. touch down, weight bearing, and kick off phases). However, a track represents the interface between animal and substrate, resulting from the effects of both biomechanics and soil mechanics. Virtual experiments carried out using finite element analysis have shown that features at the base of a track, superficially similar to those hypothesised to result from limb kinematics, can be formed through pure substrate mechanics irrespective of the limb motion or loading. Displacement of substrate beneath a vertically loaded indenter can create medio-lateral ridges (typically thought to represent three-phase limb movement) in undertracks. Asymmetric indenters, such as those used here to represent theropod pedes, produce tracks deeper at the posterior when loaded vertically and uniformly. These experiments show the importance in fully characterising a substrate, and reproducing tracks in the lab experimentally, before interpreting limb kinematics from fossil tracks.

Poster Session IV, (Wednesday)

A COMPARISON OF THE TAXONOMIC COMPOSITON OF MEDIAL MIOCENE EQUIDS (MAMMALIA: PERISSODACTYLA) FROM THE MISSION PIT, SOUTH DAKOTA AND ASHFALL FOSSIL BEDS, NEBRASKA

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The Mission Pit locality (SDSM V5314), near Mission, South Dakota, has produced a large collection of equid teeth obtained from the Miocene Thin Elk (Ash Hollow) Formation. Ashfall Fossil Beds (UNSM Ap-116), near Royal, Nebraska, has yielded an extensive collection of equid cranial elements and teeth derived from the Cap Rock Member, Ash Hollow Formation. The two sites are interpreted to be Clarendonian in age [12.5 to 9.0 Ma], but may contain faunal assemblages from differing Clarendonian subages.

The two sites exhibit a notably similar composition of equid genera, including the tribes Equini (*Pliohippus*, *Calippus*, and *Protohippus*), and Hipparionini (*Cormohipparion*, *Neohipparion*, and *Pseudhipparion*). Both sites share the same proportion of the equid tribes Hipparionini and Equini. Approximately seventy-five percent of the equids at both sites are members of the Hipparionini tribe, whereas twenty-five percent are of the Equini tribe. The comparative composition within the Equini tribe between the two sites is nearly identical. Only slight differences are observed in the composition of genera within the Hipparionini tribe between the two sites, with the Mission Pit containing a higher percentage of *Neohipparion*. The striking taxonomic similarity between the two sites is not only unique but rare, suggesting a correlative relationship within the early to medial Clarendonian (Cl1 or Cl2). This similarity also suggests unique paleoecological relationships among equids and has a potential for insight into plant ecology and equid niche partitioning during this time interval.

Technical Session I, Sunday 11:15

A NEW CENTROSAURINE CERATOPSID FROM THE BELLY RIVER GROUP (UPPER CRETACEOUS) OF ALBERTA, CANADA AND THE EVOLUTION OF PARIETAL ORNAMENTATION

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In 1916, a centrosaurine dinosaur bonebed was excavated within the Campanian-aged deposits of what is now Dinosaur Provincial Park, Alberta, Canada. From this now-lost quarry, two parietals, a squamosal, a skull missing the frill, and an incomplete dentary were deposited at the Natural History Museum, London. The material was recently reprepared and identified as a previously unknown taxon. Based upon extant locality data and paleopalynology, the quarry is in either the upper part of the Oldman Formation or the lower part of the Dinosaur Park Formation. The facial region of the partial skull is similar to putative mature specimens of *Centrosaurus* spp. and *Styracosaurus albertensis*, with short, rounded postorbital horncores and a large, erect nasal horncore. The squamosal is typical of centrosaurines. Parietal ornamentation is consistent between both known parietals and unique among ceratopsids. Bilateral, procurved parietal hooks occupy the P1 (medial-most) position on the dorsal surface of the parietal, very similar to those seen in *Centrosaurus apertus*. Epiparietals in the P2 position (lateral to P1) manifest as extremely elongated, posteriorly-directed spikes, unlike the condition in *C. apertus*, *S. albertensis*, or any other "derived" centrosaurine. Assuming this non-traditional configuration, a phylogenetic analysis suggests that the new taxon is closely related to *C. apertus*. Historically, based upon *Styracosaurus* and related centrosaurines, it was assumed that the medial-most spikes on centrosaurine parietals correspond to the P3 epiparietal position. The exception illustrated in the new taxon suggests that homologies of epiparietals between basal centrosaurines (e.g., *Albertaceratops* and *Diabloceratops*) and derived centrosaurines (e.g., *Styracosaurus* and "pachyrhinosaurs") should be reconsidered. The medially-placed, posteriorly-directed "P3" process of basal centrosaurines may in fact be homologous with P2.

Poster Session IV, (Wednesday)

NEW FOSSIL BIRDS FROM THE DESEADAN (LATE OLIGOCENE) OF ARGENTINA

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The Cabeza Blanca locality (Sarmiento Formation) in Chubut Province, Argentina, is one of the most productive fossil-bearing localities of Oligocene age in Argentina. The fossiliferous Deseadan-age (29-21 Ma) unit of the formation represents channel-fill deposits. Several mammalian clades have been recovered to date, including a number of rodent, palaeothentid marsupial, and notoungulate taxa. The fossils described herein provide a glimpse of the Cabeza Blanca avifauna and include several isolated, fragmentary limb elements. Nonetheless, character information contained within the preserved morphology allows for preliminary referrals to certain neognathe clades. A tarsometatarsus characterized by the absence of a distinct trochlear sulcus on MT II, a shallow collateral fovea on MT II, and a distinct fossa supratrochlearis plantaris is here referred to Galloanserae. A coracoid is characterized by an acrocoracoid process that is coplanar with the craniocaudal axis of the coracoid and a deep, cuplike scapular cotyle. These features suggest affinities with Procellariiformes. If this referral is supported, it represents the oldest member of the clade known from South America. Although based on limited material, the Cabeza Blanca avifauna provides new insight into the distribution of avians during the Paleogene and critical data on an important constituent group of the ecosystem. Increased predation and competition associated with mammalian diversification in South America during the Paleogene is hypothesized to have severely affected avian diversity. Testing such hypotheses requires the characterization of avian and mammalian faunas, such as those preserved at Cabeza Blanca.

Poster Session III, (Tuesday)

A METRIORHYNCHID CROCODYLIFORM BRAINCASE FROM NORTHERN CHILE

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Metriorhynchids were a group of Mesozoic crocodyliforms completely adapted to a marine lifestyle. Although there are a large number of metriorhynchid skulls, mainly from the Middle and Upper Jurassic from the European margins of the Western Tethys, most of them have collapsed into a single layer. This has confounded accurate braincase descriptions. A three-dimensional metriorhynchid braincase of *Metriorhynchus* cf. *westermanni* from the Oxfordian of northern Chile has excellent preservation and shows details of the sutures. X-ray computed tomographic (CT) scanning provides internal anatomical details. The general pattern of the orbitotemporal region is consistent with that described by other authors in the basal thalattosuchian *Pelagosaurus typus*. The specimen from northern Chile shares with other metriorhynchids (*Cricosaurus araucanensis, Metriorhynchus westermanni, M. casamiquelai* and *Dakosaurus andiniensis*) a dorsally exposed laterosphenoid, a laterosphenoid-prootic suture that forms a blunt crest separating the dorsotemporal fenestra into two muscular fossae, and a quadrate that is incompletely sutured to the braincase. The main difference in the orbitotemporal region is that in the Chilean specimen, and the other metriorhynchids examined, the trigeminal fossa is mainly positioned caudal to the trigeminal foramen, whereas in *Pelagosaurus typus* it is rostral and caudal to the trigeminal foramen. The CT scans reveal the presence of enlarged dorsal dural venous sinuses overlying the brain, a paired tube-like cavities connecting the cranioquadrate passage to the dorsal dural venous sinus, and a well developed sinus within the quadrate. The large foramen ventrolateral to the occipital condyle, characteristic for metriorhynchids, is confirmed as the opening for the internal carotid artery.

Poster Session II, (Monday)

THE FIRST TERTIARY POSTCRANIAL CARNIVORE SKELETON FROM SOUTH CENTRAL MEXICO: DESCRIPTION AND PALEOBIOLOGICAL SIGNIFICANCE

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A nearly complete postcranial skeleton was recovered from the Arroyo Atopoltitlan, ~6.6 km south of Tehuitzingo, Puebla (north-central Sierra Madre del Sur Morphotectonic Province). The bearing strata belong to the Tehuitzingo Formation, a ~40 m thick, 15°-20° NE dipping fluvio-lacustrine sequence, which records clastic sedimentation in a narrow (~15 km wide) basin (graben?) developed on the Early Paleozoic Acatlán Complex. Estimates on the former unit's age vary from Late Miocene to Pleistocene, however its structural dip and the carnivore it bears date it as pre-Pleistocene.

The specimen, a fairly complete, articulated skeleton includes the vertebral column, eight right ribs, both right and left fore and hind limbs, and several small, disarticulated fragments. The apendicular skeleton is that of a cursorial, ~45-50 cm shoulders, high mammal. The manus and pes are fully digitigrade, *i.e.*, with long and slender metacarpals/metarsals and phalanges, the third ones are acute and clawed; the well developed sesamoid bones are related to an effective toe flexion system, common in fast running digitigrade carnivores.

The skeleton is that of a generalized mammal, save the manus and pes which are remarkably like those of canids, a fact used to refer the fossil to this family. Further, the lack of an entepicondylar foramen in the humerus, the relatively long radius/tibia compared to the humerus/femur, and metatarsal I respect to metatarsal II, within the Caninae. Most North American Caninae are known from the Late Miocene onward.

Taphonomically, this canine probably died on or close to an edge shore of a flood plain, got adrift, thus avoiding scavenging, rotted there, and became inflated by decomposition gases; the head being heavier became separated from the carcass, whose limbs eventually adopted unusual flexing position, and eventually come to rest on the bottom, becoming buried by subsequent fine clastics sedimentation. Much later on, erosion uncovered the burial place, and partly "peneplained" the specimen, thus eliminating most of the thorax left half, exposing only a series of small spool-shaped whitish squares that contrasted with the pale red embedding rock.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

THE MECHANICAL DESIGN OF RORQUAL MANDIBLES: IMPLICATIONS FOR LUNGE-FEEDING FROM QUANTITATIVE COMPUTED TOMOGRAPHY

FIELD, Daniel, Yale University, New Haven, CT, USA

Rorqual whales (Mysticeti: Balaenopteridae) lunge at high speeds with mouths open up to 80 degrees in order to engulf large volumes of prey-laden water. In doing so, the floor of the mouth encounters high drag, and the mandibles are consequently exposed to dorsoventral bending forces. Quantitative computed tomography (QCT) was used to investigate the internal morphology and densitometry of a pair of sub-adult humpback whale (*Megaptera novaeangliae*) mandibles, to test the hypothesis that they exhibit a mechanical design that enables them to withstand high drag without experiencing high strain. QCT data indicated a significant increase in mineral density and cross-sectional area from the mandibular symphysis to the coronoid process. This arrangement, similar to what would be expected for bending resistance in a cantilever beam, is optimized to resist the bending forces encountered during lunge-feeding. The northern right whale (*Eubalaena glacialis*), which is not a lunge-feeder, exhibits the opposite caudorostral mandibular density distribution to that of rorquals, suggesting that a gradient of high caudal mandibular flexural rigidity and lower rostral flexural rigidity may be a good predictor of lunge-feeding behavior in mysticetes. This comparison indicates that adaptive bone remodeling is a significant factor contributing to the establishment of mandibular bone density distributions of rorquals, and has implications for inferring feeding mode in extinct mysticetes.

Poster Session I, (Sunday)

AN EXAMPLE OF *UNDICHNA*, THE FISH SWIMMING TRACE, FROM THE DEVONIAN CATSKILL FORMATION, EASTERN PENNSYLVANIA

FILLMORE, David, Kutztown University, Kutztown, PA, USA; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM, USA; SIMPSON, Edward, Kutztown University, Kutztown, PA, USA; SZAJNA, Michael, State Museum of Pennsylvania, Harrisburg, PA, USA

We document the first record of *Undichna* from the Catskill Formation in eastern Pennsylvania, strata of Devonian age near Trout Run, Lycoming County, Pennsylvania. Reports of *Undichna* specimens from the Devonian are rare, and we are aware of only four such reports from Europe and the British Isles. Therefore, these *Undichna* trails are the oldest reported examples from North America.The *Undichna* specimens are preserved in concave hyporelief (part and counterpart were recovered) on a fine-grained mudstone. This record of *Undichna* from the fluvial deposits of the Catskill Formation occurs on the crests of mud-draped ripple bedforms, in association with a diverse assemblage of other lithologic features, including fossil fish remains (bones, scales), invertebrate ichnotraces (e.g., *Diplichinites*, *Planolites*), sedimentary exposure features (raindrop impressions, mudcracks), and frequent examples of fluvial ripples. The *Undichna* traces consist of isolated, solitary, well-defined, narrowly incised, sinusoidal wave lines that have a wave length of 28 mm, wave amplitude of 5.0 mm, and a wave line width of approximately 0.1 mm.The ichnogenus *Undichna* is the swimming trace of a fish that usually consists of a series of sinusoidal waves made on soft sediment at the bottom of standing water by the fins of a fish swimming by anguilliform locomotion. The single sinusoidal waves of the Catskill Formation specimens justify assignment to the ichnospecies *U. unisulca* Gilbert et al. 1999. The Catskill Formation record of *Undichna* indicates the presence of a small fish with a caudal fin that touched the sediment during periods when subaerial surfaces were subaqueous. The length of the fish is estimated at 2.0 cm (4 times the wave amplitude of the trail).

Poster Session III, (Tuesday)

DIVERSIFICATION OF MIOCENE MAMMALS IN NORTH AMERICA, WITH RESPECT TO TECTONIC AND CLIMATIC HISTORY

FINARELLI, John, University of Michigan, Ann Arbor, MI, USA; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, USA

Modern biodiversity displays striking regional- to continental-scale geographic gradients in species richness. One such gradient is the increase in species richness in topographically complex regions (e.g., active tectonic provinces) as compared to tectonically passive lowlands. Ecological mechanisms that could potentially explain higher richness in topographically complex regions include niche partitioning among heterogeneous habitats across elevational gradients, which would increase potential species accommodation and, consequently, regional diversity. Here, we investigated evolutionary processes contributing to the elevational diversity gradient.If topographic complexity is responsible for increased regional diversity, then we should observe greater species richness in the fossil records of tectonically active regions than of tectonically passive settings. We analyzed 418 rodent species from fossil localities in western North America spanning 25 to 5 Ma, comparing diversification histories for the tectonically active montane West and quiescent Great Plains. Although diversification histories did differ between regions, neither per million-year species richness, origination rates, nor extinction rates were systematically biased over this interval. Rather, there were periods during the Miocene, when species richness in either region was greater than in the other. In addition, instances occurred in which rates of origination, extinction and net diversification for either region were significantly greater than the other. This pattern suggests that the modern elevational diversity gradient is a transient feature, arising during particular episodes of Earth history.In the montane region, the greatest increase in both originations and species richness coincided with a Middle Miocene episode of intensi-

fied tectonic activity and global warming. Subsequent global cooling resulted in dramatic species-richness decline in the montane region and increased richness on the Great Plains. These results suggest that an interaction between tectonic activity and climate change was mediating mammal diversification.

Poster Session II, (Monday)

BLOCK 124: A LOOK INTO THE HISTORY OF A 100-YEAR-OLD FIELD JACKET FROM THE CARNEGIE QUARRY, DINOSAUR NATIONAL MONUMENT, UT

FINLAYSON, Heather, Utah Field House of Natural History State Park Museum, Vernal, UT, USA; TEMME IV, Thomas, SWCA, Vernal, UT, USA; GRAY, Dale, Utah Field House of Natural History State Park Museum, Vernal, UT, USA

The Utah Field House of Natural History State Park Museum has had in storage for 30 years, a field jacket (Block 124) from the original Carnegie Museum excavation at Dinosaur National Monument, UT. Upon the 100th anniversary of Earl Douglass' 1909 discovery of the monument, staff at the Utah Field House decided it would be appropriate to open Block 124, to see what lay within. After preparation, a *Stegosaurus* caudal vertebra was revealed. The fossil was wrapped in layers of plaster and burlap bandages, however, no separator between the bandages and bone was used. This jacketing technique is still used today with little variation. It has proven over time to be a tried and true method for protecting fossils as indicated by the condition of Block 124 after 100 years. Working on this fossil prompted several questions: Who was the first paleontologist to use plaster jacketing as a way to package fossils and who was the first person to use toilet paper or other paper products as a separator? These and many other questions prompted the bigger question: How have fossil excavation techniques evolved throughout the history of paleontology and what techniques were used during the excavation of the Carnegie Quarry? Using mainly hammers, chisels, shovels and picks, the removal of over 350 tons of fossils and rock from the quarry occurred from 1909 to 1924. All of the bones, including Block 124, were shipped in wooden crates via horse-drawn wagons and trains back to the Carnegie museum. Because technology lagged behind out west, the low-tech but dependable method of jacketing allowed these valuable resources to be transported safely back east where the proper resources existed to prepare and display these fossils. Today, in addition to using the same tools and techniques as the paleontologists of the past, we now use tools like hammer drills and jackhammers powered by gas and smaller pneumatic tools run on compressed air to facilitate excavation and fossil preparation. Furthermore, new methods and techniques are constantly being developed and tested to further improve the safe recovery of fossils.

Poster Session I, (Sunday)

A NEW DINOSAUR ICHNOFAUNA FROM THE LATE CRETACEOUS OF WRANGELL-ST. ELIAS NATIONAL PARK AND PRESERVE, ALASKA

FIORILLO, Anthony, Museum of Nature and Science, Dallas, TX, USA; ADAMS, Thomas, Southern Methodist University, Dallas, TX, USA; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan

An unnamed nonmarine sedimentary package of rocks in southeastern Alaska in Wrangell-St. Elias National Park and Preserve, the largest national park in the United States, has provided the first evidence of dinosaurs for this vast region. The rock unit is contained within the Wrangellia Terrane and exposures are of limited geographic extent. Sections are overwhelmingly dominated by intraformational conglomerates. Fine to medium grained light colored sandstones are common and medium gray shales occur as minor components to the sections. Field parties found evidence of a small theropod and ornithopods. The theropod impression is approximately 12 cm long and 10 cm wide. Attribution to the Theropoda was based on the sinusoidal shape of the impression of the middle digit. Ornithopod impressions, identified by clearly blunt and rounded digit impressions, are approximately 21-28 cm long and 23-30 cm wide. All impressions were undertracks. Pollen samples failed to produce diagnostic pollen but kerogen and charcoal were abundant. The abundance of charcoal suggests that fire was prevalent in this ancient ecosystem. The abundance of conglomerate and sandstone in the sections, combined with the abundance of charcoal suggest that this area during deposition was tectonically dynamic and prone to ecological disturbance. Megafloral specimens indicate an abundance of horsetails, ferns and gymnosperm wood. The rock unit is mapped as Late Cretaceous in age, which ranges from approximately 99 Ma to 65 Ma. The lack of angiosperm pollen and megafloral remains suggest that fossil flora composition is most consistent with the floral composition of the Campanian/Maastrichtian Prince Creek Formation of northern Alaska rather than the underlying, older Nanushuk Formation. The megafloral record suggests that this unnamed rock unit may be of youngest Cretaceous age.

Poster Session I, (Sunday)

THE TRIASSIC MADYGEN LAKE ENVIRONMENT - A SHARK NURSERY GROUND?

FISCHER, Jan, TU Bergakademie Freiberg, Freiberg, Germany; VOIGT, Sebastian, TU Bergakademie Freiberg, Freiberg, Germany; BUCHWITZ, Michael, TU Bergakademie Freiberg, Freiberg, Germany; SCHNEIDER, Jörg, TU Bergakademie Freiberg, Freiberg, Germany

Some recent marine shark species show a separation of their nursery grounds from the usual distribution area of the population. Gravid females deposit their eggs in specific areas with abundant food suitable for the offspring and with low predation risk. The shark pups remain in these nursery areas after hatching until they reach a size that allows them to join the adult stock. Separation of nurseries from adult areas is also documented in Carboniferous xenacanth and hybodont sharks, which demonstrates pronounced nursery behavior since the Late Paleozoic in nonmarine environments.The co-occurrence of hybodont teeth referable to *Lonchidion* sp. and hybodont egg capsules of the form type *Palaeoxyris* in the Middle–Late Triassic (Ladinian–Carnian) lake deposits of Madygen (SW Kyrgyzstan, Central Asia) may be interpreted in terms of a reproductive strategy analogous to recent sharks. Whereas shark teeth of small size occur as probable autochthonous elements in sediments of the pelecypod-rich littoral, the *Palaeoxyris* capsules appear as allochthonous elements within massive greyish mudstones that represent prodeltaic fluvial input into the nearby lake. *Palaeoxyris* itself proves hybodont spawning, which probably occurred in the highly energetic vegetated shallow water zones along shorelines of the Madygen lake and/or discharging streams. The empty capsules then subsequently drifted and were allochthonously buried. As we find egg capsules in sediments of the Madygen lake close to where teeth of the juveniles were deposited, the Madygen freshwater environment may have formed a nursery area similar to that of recent sharks. Another similarity is the availability of hard-shelled benthos on which the young may have fed until they left the nursery. The continuous occurrence of eggs in the Madygen profile suggests a persistent use of the nursery through time. Furthermore, as indicated by the xenacanth egg capsule form type *Fayolia* in Madygen strata, a second shark species shared the Madygen area. There was probably some degree of temporal partitioning, as is seen in several recent species of the same geographic area.

Physical Drivers and Marine Tetrapod Evolution, Monday 8:45

RECONSIDERING THE EXTINCTION OF ICHTHYOSAURS

FISCHER, Valentin, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Despite their extreme adaptation to life in the open sea, ichthyosaurs were one of the first major groups of post-Triassic marine reptiles to disappear, at the end of Cenomanian, whereas plesiosaurs, mosasaurs and numerous families of marine crocodiles and sea turtles disappeared during the Cretaceous/Paleocene Extinction Event. It has been proposed that unique biological factors drove ichthyosaurs to extinction, namely a break in the food chain at the level of belemnites or a progressive ecological replacement by teleost fishes since the Middle Jurassic. However, new discoveries in France and Russia turn both these hypotheses unsatisfactory because ichthyosaur diversity remained high during the Early Cretaceous both from taxonomic and ecological points of view, with the persistence of several Late Jurassic genera into the Early Cretaceous and the colonization of various feeding guilds. The extinction of ichthyosaurs during the Cenomanian was therefore more sudden than previously described. The present study aims at replacing the extinction of ichthyosaurs within the global context of changes in marine ecosystems during the 'middle' Cretaceous. The 'middle' Cretaceous (Aptian-Turonian) is indeed punctuated by numerous and profound global climatic and oceanic changes, as well as intense underwater volcanism. These factors led to recurrent anoxic events, sometimes of worldwide extension. Interestingly, the peak of changes in the geosphere, taking place during the Cenomanian, coincides with major biological changes within the marine realm: the rise of polycotylid plesiosaurs, marine squamates, teleost fishes and chondrichtyans, the onset of the 'Chalk sea', and an extinction within marine invertebrates communities. Ichthyosaurs disappeared during this profound reorganization of the marine ecosystems. However, the precise mechanisms that lead to the sudden extinction of these successful marine reptiles cannot be understood in the current state of our knowledge given the multitude of possible causes occurring at the same time.

Technical Session IX, Tuesday 11:45

IMPACT FRACTURING OF MAMMOTH LIMB BONE DIAPHYSES (LATE PLEISTOCENE, MICHIGAN, USA)

FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; BELD, Scott, University of Michigan, Ann Arbor, MI, USA

A recently reported site near Saranac, Michigan has yielded mammoth (*Mammuthus* sp.) remains, including a variety of dental, cranial, and postcranial material. Bones occur within sediments deposited near the margin of a late Pleistocene lake basin. No date is yet available, but the context is consistent with other late Pleistocene occurrences for which age estimates range from 12,000-10,400 RYBP. In situ material is well-preserved, but much of it is extensively fractured. Most interesting are limb bone diaphysis fragments showing green-bone fracture, producing bone flakes with sharp edges. Among these fragments, a partial femoral diaphysis shows a series of three, stacked, concentric, conical fractures diagnostic of heavy percussion. Such fractures form as the energy of a blow radiates through the anisotropic, but still relatively homogeneous medium of dense cortical bone. Experiments with bone breakage have demonstrated that this pattern can be produced with a boulder wielded with sufficient force, but observation of trampled bone or bone modified by freezing or other agency of ice has shown no comparable features. Impact features such as those observed at this site are thus indicative of human association, probably related to production of sharp flakes for use as cutting implements (and other activities related to carcass processing). At the surface where a county drain intersects site stratigraphy (leading to discovery of the site) a large (ca. 7.5 kg; 22 cm major axis), bifacially flaked quartzite boulder was found. This boulder was juxtaposed with in situ bone, but its surface exposure and consequent possibility of displacement preclude describing it as in situ. It is nonetheless suggestive of human activity and is a plausible impactor that could account for bone breakage at this site. This site helps document human association with extinct fauna of the Great Lakes region, but it also replicates, and thus supports, interpretations of similar mammoth occurrences in older (pre-Clovis) loess contexts on the Great Plains, previ-

ously considered controversial principally because of their age.

Physical Drivers and Marine Tetrapod Evolution, Monday 11:30

EVOLUTION AND EXTINCTION OF RIVER DOLPHINS (CETACEA: PLATANISTOIDEA) IN CENTRAL AUSTRALIA

FITZGERALD, Erich, Museum Victoria, Melbourne, Australia

Three Recent cetacean clades include species that independently evolved obligate freshwater ecology: Platanistoidea (*Platanista*, Ganges and Indus River dolphins), Iniidae (*Inia*, Amazon River dolphin) and Lipotidae (*Lipotes*, Yangtze River dolphin). Despite molecular phylogenetics implying long histories for these odontocetes, their largely marine fossil record suggests a comparatively recent transition to freshwater. By contrast, fossil odontocetes have been collected from Late Oligocene (~24 Ma) fluvio-lacustrine deposits of the Namba Formation in northeast South Australia. Until now, these fossils have been referred to the extinct Eurhinodelphinidae, evincing early invasion of freshwater by these aberrant odontocetes. This hypothesis was tested through phylogenetic analysis, which demonstrated that the Namba dolphins are not eurhinodelphinids, but stem platanistoids, sister to Squalodelphinidae + the extant Platanistidae. This shows that Platanistoidea independently evolved freshwater forms twice in their evolutionary history: soon after their divergence from other odontocetes (~30 Ma), and later in the Neogene with the origin of *Platanista*. The Namba platanistoids inhabited a humid drainage system that was part of a larger network of river and lake basins across inland Australia: a drained area equivalent to that of the Amazon Basin. We hypothesize that platanistoid invasion of central Australian basins was facilitated by rising epicontinental seas across southeast Australia during the Late Oligocene. Despite a last appearance datum being unknown, the fate of the Namba platanistoids would have been sealed by mid-Miocene onset of aridification in central Australia. This highlights the impact of sustained continental-scale environmental shifts on the evolution of marine tetrapods that have invaded freshwater.

Technical Session V, Sunday 2:00

Z-113

FLYNN, Lawrence, Peabody Museum, Harvard University, Cambridge, MA, USA

Locality Z-113 of the Zinda Pir Dome section on the western border of the Punjab, Pakistan, provides a key small mammal fossil record relevant to the evolution of several groups of rodents. Heretofore considered early Miocene, current biochronologic understanding and available magnetostratigraphy correlate it as late Oligocene in age. The magnetostratigraphy, not fully resolved, yields two correlations: Chron C6Br, latest Oligocene, about 23.5 Ma, or C8r about 26.5 Ma. Recognizing greater age is relevant for understanding the timing of evolution and durations of ghost lineages in diverse rodents, and for constraining molecular time trees. Of principal significance in the evolution of Muroidea, the dominant group of modern Rodentia, are two distinctive genera. Z-113 records *Spanocricetodon*, which plays a pivotal role in the initial radiation of the modern cricetid-murid group. It is advanced over the array of European-Asiatic Oligocene muroids, such as *Eucricetodon*, and is the oldest record of the genus. The basal muroid clade Spalacidae is also represented at Z-113 by *Eumyarion kowalskii*. This rodent demonstrates appearance of the group by the late Oligocene, and with *Spanocricetodon* presents an earliest record for all crown muroids other than platacanthomyids. This is a new minimum paleontological age to anchor molecular trees in time. Z-113 also presents key records in ctenohystrican evolution: it is the type locality for the diatomyid *Marymus* and for the ctendodactylid *Prosayimys*. Recognizing the antiquity of the latter is important because at present, *Prosayimys* stands as outgroup to all other ctenodactylines, including several early Miocene genera. At present Z-113 demonstrates great age of key lineages that is consistent with emerging data from Anatolia to the Junggar Basin in China.

Poster Session I, (Sunday)

AMPHIBIAN DIVERSITY FROM THE EARLY OLIGOCENE BORGLOON FORMATION AT BOUTERSEM, BELGIUM

FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Richard, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The localities of Hoogbutsel and Hoeleden in the area of Tienen, known for about fifty years, have yielded the oldest Oligocene terrestrial vertebrates of Belgium. A third site was excavated in 1999 in Boutersem five kilometers away from Hoogbutsel. Six thousand kilograms of a very rich fifteen centimeters thick layer were screenwashed. The mammals of the three sites belong to the MP21 reference-level of the mammalian biochronological scale for the European Paleogene. This level directly following the "Grande Coupure" is especially interesting as the localities of this age are generally scarce in Europe. Several species have recently been described or reassessed among mammals, birds, snakes and lizards. However, amphibians are still poorly known and were only briefly mentioned in 1962. They are here described based on the new material from Boutersem and are compared with those from Hoogbutsel and Hoeleden conserved at the Royal Belgian Institute of Natural Sciences. Among the thousands of amphibian specimens, frogs are represented by vertebrae, ilia, urostyles, humeri and cranial bones attributed to new species of only two families, the Palaeobratrachidae and Pelobatidae. The presence of Discoglossidae and Bufonidae is not confirmed. Salamandrids are mainly represented by vertebrae of three species. One of these is new and presents high neural spines, ornamented dermal plates, and antero-posteriorly continuous zygapophyseal crests characteristic of the genera *Notophalmus*, *Taricha* and *Koaliella*. Such morphology has already been reported from the early Paleocene MP1-5 of Hainin and the earliest Eocene MP7 of Dormaal, both in Belgium. The two other species that can easily be distinguished by size, present a more common morphology resembling the genus *Salamandra*. Despite the numerous amphibian specimens, the anurans seem thus not very diversified. Salamandrids with dermal plates are well distributed all along the Paleogene in Europe. Today, this group of salamandrids has disappeared from Europe but is still present in North America.

Physical Drivers and Marine Tetrapod Evolution, Monday 8:00

PHYSICAL TRENDS, RHYTHMS AND ABERRATIONS IN THE WORLD OF MARINE TETRAPODS: THE CASE OF PLATANISTOID AND DELPHINOID DOLPHINS

FORDYCE, Robert Ewan, Dept of Geology, University of Otago, Dunedin, New Zealand; MARX, Felix, Dept of Geology, University of Otago, Dunedin, New Zealand; AGUIRRE-FERNÁNDEZ, Gabriel, Dept of Geology, University of Otago, Dunedin, New Zealand

Physical oceanic phenomena – "court jester" factors – are important potential drivers of evolution and extinction amongst marine tetrapods. Paleoceanographers have produced an excellent record of physical drivers independent of the marine tetrapod record. The first-order driver is plate tectonics, which generates long term trends involving change in ocean gateways, oceanic circulation, global ice volumes, longer-term eustatic sea level, continental shelf ecospace/ heterogeneity and, via continental weathering, ocean-atmosphere CO2 cycling. Second-order phenomena are the short term rhythms of orbital forcing, while aberrations are unexpected events such as the PETM. Physical phenomena are identified mainly from the proxies of physical stratigraphy, microfossil abundance/diversity, and stable isotopes. Fossils provide two sorts of temporal records that can be compared with physical oceanic factors and with molecular phylogenies: 1, taxic data, such as from the Paleobiology Database; 2, stratigraphically calibrated phylogenetic data, which provide some compensation for the general patchiness of the record. The odontocete clades Platanistoidea and Delphinoidea have fossil records that show long term, apparent mirror-image, rise and fall patterns at the family level. Platanistoidea were diverse in the Late Oligocene-Early Miocene, as represented by marine clades including Squalodontidae, Squalodelphinidae, Waipatiidae, Allodelphinidae, and stem-Platanistidae. Platanistoids declined rapidly in diversity in the later Neogene, leaving only 1-2 extant riverine species. Delphinoids, in contrast, reportedly include only Kentriodontidae in the Oligocene to about middle Miocene. The earliest members of the diverse extant clades Delphinidae and Phocoenidae are uncertainly Late Miocene; these and other delphinoids were clearly highly speciose in the Pliocene as in modern seas. Platanistoids differ from delphinoids and other odontocetes in functional complexes of the skull and forelimb, implying quite different ecologies. Physical drivers – long-term cooling and regression – therefore probably best explain the decline of the platanistoids.

Poster Session I, (Sunday)

PALEOCLIMATE, HYDROLOGY AND TAPHONOMY OF THE KAIPAROWITS FORMATION (SOUTH-CENTRAL UTAH): THE STABLE ISOTOPE PERSPECTIVE

FOREMAN, Brady, University of Wyoming, Laramie, WY, USA; ROBERTS, Eric, James Cook University, Townsville, Australia; TAPANILA, Leif, Idaho State University, Pocatello, ID, USA; RATIGAN, Deirdre , Macalester College, St. Paul, MN, USA

The Kaiparowits Formation represents a rapidly expanding and important record of Late Cretaceous terrestrial vertebrate evolution in the Western Interior. Understanding the interplay between alluvial processes and fossil preservation is important for regional correlation of faunas and reconstruction of paleoenvironments and paleoclimate. Deposition within the formation was complexly controlled by sea-level fluctuations, the initiation of Laramide tectonism, and the prevailing climate. These processes imprinted many stratigraphic patterns on the Kaiparowits, including secular shifts in paleocurrents, river planform, channel-stacking, flood-events, and modes of taphonomic preservation. For example, there is a decrease in channel-stacking and a shift to more anastomosing-like rivers within the middle part of the formation, which coincides with an increase in the number of river-hosted vertebrate sites. We obtained $\delta^{18}O$ and $\delta^{13}C$ values from unionid bivalve shells and paleosol carbonate nodules distributed throughout the ~860 m thick formation in order to constrain the forcing mechanism behind the stratigraphic patterns. River water $\delta^{18}O$ (VSMOW) estimates (~ -18‰) are indicative of high altitude runoff from existing Sevier uplifts and incipient Laramide structures. $\delta^{18}O$ estimates from soil carbonates (~ -8‰) represent low-elevation (i.e. within basin) precipitation. Pond water falls on a mixing line between these two end-members in terms of both $\delta^{18}O$ and $\delta^{13}C$. These values and patterns are consistent with an overall humid/sub-humid climate state with monsoonal precipitation patterns, and match taphonomic patterns of highly elevated bone weathering, specifically a preponderance of wet rot. This isotopic pattern does not change up-section suggesting climate was relatively invariant throughout Kaiparowits deposition, and, by extension, not a driver of channel-stacking nor the frequency of vertebrate fossil sites. We cannot explicitly separate a sea level from tectonic driver on alluvial processes. However, the lack of a brackish water signal from river-hosted mollusk shells argues against prolonged (i.e. within the life span of a unionid) marine incursions.

Romer Prize Session, Monday 8:45

ANAGENESIS AND LONG-TERM MORPHOLOGIC TRENDS IN CHASMOSAURINAE (DINOSAURIA: CERATOPSIDAE) REVEALED BY A NEW HIGH-RESOLUTION CHRONOSTRATIGRAPHIC FRAMEWORK, ONTOGENETIC ANALYSIS AND DESCRIPTION OF TWO NEW TAXA

FOWLER, Denver, Museum of the Rockies, Montana State University, Bozeman, MT, USA

A robust taxonomy is an essential foundation for all studies of paleobiology and evolution. Morphological variation forms the basis upon which fossil taxa are defined but the causes, or axes, of this variation are often overlooked. Here it is shown how ontogeny and stratigraphic position (determined using a new high-resolution chronostratigraphic framework) strongly affect interpretation of morphological evolution in chasmosaurine dinosaurs. Making use of new and previously overlooked chronostratigraphic data, southern chasmosaurines from Utah, Texas, and New Mexico, previously considered to represent late Maastrichtian (Late Cretaceous) latitudinal biogeographic variation, can now be demonstrated as lower to middle Maastrichtian morphs of a *Triceratops* clade. Critically, these older southern forms exhibit adult morphological characters (opening of parietal fenestrae, elongation of squamosals) earlier in ontogeny than seen in the late Maastrichtian end-member *Triceratops*, emphasizing ontogenetic and stratigraphic trends already recognized within this clade. The same trends can be followed further back into the Late Campanian. Two new chasmosaurine taxa from the Hunter Wash Mbr (74.56Ma–74.11Ma) of the Kirtland Fm, New Mexico, form morphological and stratigraphic intermediates between *Pentaceratops* (~74.7-75Ma; Fossil Forest Mbr, Fruitland Fm, New Mexico) and *Anchiceratops* (~72-71Ma; Units 1 & 2, Horseshoe Canyon Fm, Alberta). The new taxa exhibit gradual enclosure of the parietal embayment that characterizes *Pentaceratops*, providing support for the recently revived phylogenetic hypothesis where *Pentaceratops* and *Anchiceratops* were recovered as sister-taxa. This stepwise change of morphologic characters observed in chasmosaurine taxa that do not overlap stratigraphically is supportive of evolution by anagenesis. Within anagenetic lineages, inflection points in morphologic trends represent important shifts in selection pressures for cranial display that might be correlated to external factors. This demonstrates how high-resolution chronostratigraphic frameworks can help tease apart methodological artifacts from anagenetic change and true cladogenic speciation.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 9:15

RECONSTRUCTION OF SMALL MAMMAL DIETS DURING THE NEOGENE EXPANSION OF C_4 GRASSES IN THE GREAT PLAINS USING LA-IRMS

FOX, David, University of Minnesota, Minneapolis, MN, USA

The stable carbon isotope composition of fossil mammal teeth has provided important perspective on the Neogene history of grassland ecosystems in the Great Plains. Mammal teeth inherit the carbon isotope composition of diet, thus they record the dietary proportions of isotopically distinct C_3 (trees, shrubs, cool season grasses) and C_4 (warm season grasses, sedges) plants. Due to sample size for conventional analyses, most isotopic work on fossil mammals has focused on large-bodied mammals that integrate the isotopic signature of foraging over typically wide home ranges. Laser ablation isotope ratio mass spectrometry allows sampling of small teeth with minimal damage. I present 337 individual LA-IRMS analyses of 219 specimens representing 17 species of Lagomorpha and 76 species of Rodentia from six localities in Nebraska that range in age from 14.9 to 2.4 Ma (based on Appearance Event Ordination). Small-bodied mammals have relatively smaller home ranges and sample habitat at smaller spatial scales that can reflect habitat patchiness. At all localities, lagomorphs generally eat little or no C_4 biomass; ochotonids eat less C_4 biomass than leporids where they co-occur. Some rodent individuals eat some C_4 biomass at all localities, including minimally 8 of 21 specimens (or 3 of 9 species) at the oldest locality. Mean and median percent C_4 in rodent diets and range in dietary percent C_4 within faunas do not exhibit consistent temporal trends or abrupt changes, unlike some records from large mammals; maximum percent C_4 for rodents increases from 14.9 to 13 Ma, is roughly constant at 30-45% (depending on assumptions) until 3.6 Ma, and increases to 60-70% at 2.4 Ma. Among rodents, heteromyids and geomyids tend to eat more C_4 biomass than sciurids, where they co-occur; arvicolids, once they appear in the record, tend to eat the same as or less C_4 biomass than other rodent clades. These results are consistent with the presence of C_4 biomass in the region prior to 15 Ma, habitat patchiness for much of the Neogene, and partitioning of habitat and/or food resources between lagomorphs and rodents and among clades of rodents during expansion of C_4 grasses in the Great Plains.

Poster Session II, (Monday)

USING DIFFERENT MOLECULAR WEIGHTS OF CARBOWAX

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Polyethylene glycol (PEG), a long chain polymer known by its trade name Carbowax, is commonly used in preparation. Water-soluble, it is best used as a removable support for small and fragile fossils and as a temporary filler for molding. Long-term use is not recommended as it remains tacky and attracts dust. It can migrate into porous bone when applied as a melted liquid, causing staining. The molecular weight of Carbowax defines its consistency and melting point. Molecular weights range from PEG 200 (a clear viscous liquid at room temperature) to 20,000 (a hard opaque white solid) each having differing properties. PEG 3300 and 4600 are fairly hard, stiff and brittle. These grades offer good support and may be removed manually from a fragile fossil that can be damaged by immersion in water. Although most labs stock only one molecular weight of Carbowax (usually PEG 3300 or 4600), other grades are useful, and we can explore new ways of using this material. For example, a softer grade of Carbowax, needing less force to remove than PEG 3350 or 4600, can be applied directly to the bone and supported with a harder grade. At the Yale Peabody Museum, we have a variety of molecular weights of Carbowax, including PEG 1000, 3350, 4600, 8000, and 20,000. By combining PEG 1000 and 3350 in a 1:1 ratio, we have created soft, pliable paste for filling that eases some of the difficulties we have experienced with the removal of hard Carbowax after molding. By using these differing properties, by combining two different molecular weights, or by overheating PEG, which makes the product softer, the preparator can adapt the material to better serve needs for support or filling.

Technical Session III, Sunday 2:45

A NEW, EARLY PUERCAN (EARLIEST PALEOCENE) SPECIES OF *PURGATORIUS* (PLESIADAPIFORMES, PRIMATES) FROM SASKATCHEWAN, CANADA

FOX, Richard, University of Alberta, Edmonton, AB, Canada; SCOTT, Craig, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

The early Paleocene *Purgatorius* is the most primitive plesiadapiform primate yet discovered, mostly known from middle to late Puercan strata in Montana, deposited during the interval C29N of the geomagnetic polarity time scale. Here we describe a new species of *Purgatorius*from the Ravenscrag Formation, at the Rav W-1 horizon, Medicine Hat Brick and Tile Quarry, southwestern Saskatchewan. This horizon occurs within C29R, making this species the earliest discovered primate now known, while strengthening the evidence that plesiadapiforms, and hence primates, originated and underwent their initial diversification in North America. Most North American mammalian local faunas correlating with C29R have been assigned to the Pu1 (earliest Puercan) interval zone, but the taxonomic composition of the mammals accompanying *Purgatorius* n. sp. at Rav W-1 most resembles local faunas of Pu2 age. The occurrence at Rav W-1 of Pu2 aspect mammals within C29R agrees with similar occurrences at the Hiatt and PITA Flats localities in Montana and North Dakota, also correlated with C29R. The evidence from these three sites, all in the Williston Basin, suggests that in some areas of the Western Interior Pu2 aspect mammalian local faunas were coeval with those of latest Pu1 age, having evolved earlier than commonly assumed. A Pu1 occurrence of *Purgatorius* also strengthens the likelihood that primates originated during the Late Cretaceous.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 9:45

PALEOENVIRONMENTAL AND PALEOECOLOGICAL INTERPRETATIONS OF ISOTOPIC RECORDS DERIVED FROM EASTERN BERINGIAN CARIBOU ANTLERS

FOX-DOBBS, Kena, University of Puget Sound, Tacoma, WA, USA; THOMAS, Daniel, University of Otago, Dunedin, New Zealand; KOCH, Paul, University of California, Santa Cruz, Santa Cruz, CA, USA

We explored isotopic patterns derived from late Quaternary caribou antlers in eastern Beringia (Alaska and Yukon). Antlers are relatively abundant and generally well-preserved in the Beringian fossil record. They record paleoecological and paleoenvironmental information from the discreet time interval of antler formation, thus yielding a novel short-term window of isotopic information. We collected radiocarbon, and carbon and nitrogen stable isotope records from antler collagen, and phosphate oxygen isotope values from bioapatite. The antlers ranged in age from greater than 50,000 to 6,000 14C yrs BP, and the isotopic chronologies reflect; 1) a relatively constant diet, and 2) temporal variation related to glacial-interglacial climatic changes. We then compared these isotopic chronologies to records generated from megafauna at other high-latitude late Quaternary sites. We assessed isotopic variation within single antlers by collecting samples from antler core to rim of both modern and fossil caribou. We determined that the biological complexities of antler formation may influence isotopic interpretations; an important factor to consider in future work on fossil antlers. We also analyzed skeletal bone collagen and tooth enamel from additional dated eastern Beringian caribou and horse individuals from the same sites, and found that the antler data were comparable.

Poster Session I, (Sunday)

TROPHIC RELATIONSHIPS BETWEEN LATE PLEISTOCENE MAMMALS FROM AUCILLA RIVER, FLORIDA: EVIDENCE FROM NITROGEN AND CARBON STABLE ISOTOPES

FRANCE, Christine, Smithsonian Institution, Washington, DC, USA; KAUFMAN, Alan, University of Maryland, College Park, MD, USA

The Aucilla River site in Florida, USA (ca. 12,000 – 15,000 ^{14}C years before present) has yielded fossil specimens representing all the major groups of mammals present during the late Pleistocene in this region. A carbon and nitrogen stable isotopic study of bone collagen from this fauna provides a unique opportunity to examine the trophic relationships between the herbivores, omnivores, and carnivores, as well as the vegetation preferences of the extinct mega-herbivores and omnivores. Preliminary results include the following: 1) giant ground sloths show the highest statistical similarity to omnivores; 2) individual herbivore genera exhibit a generalized and opportunistic feeding habit with no one genus apparently dependant strictly on C4 plants and open grasslands; 3) two genera (*Castor* and *Ondatra*) exhibit isotopic values that could be indicative of specific plant choice; 4) isotopic signatures

from limited carnivore species (canids and small felids) suggest predation in forested habitats or areas dominated by C3 plants as opposed to predation on open C4 grasslands. Insofar as the dated interval at Aucilla River was one of geologically rapid climate change (including the Bölling/Allerød interstadial and Younger Dryas cooling event), the generalized feeding habits of the herbivores as well as widespread omnivory and biodiversity, suggest that this ecosystem was relatively stable and able to withstand rapid climate change at the end of the Pleistocene Epoch in North America.

Technical Session V, Sunday 2:30

UNGULATE DIETS REVEAL PATTERNS OF NORTH AMERICAN GRASSLAND EXPANSION DURING THE LATE MIOCENE

FRASER, Danielle, The University of Calgary, Calgary, AB, Canada; THEODOR, Jessica, The University of Calgary, Calgary, AB, Canada

Environmental proxies (oceanic oxygen isotopes) indicate that the late Miocene was a time of considerable climate change which favoured the expansion of C_4 plants. Studies of the carbon isotope signatures of equid tooth enamel have led to the hypothesis that there was a northward expansion of C_4 grasslands during the Hemphillian (~ 7 Ma). We tested this hypothesis by comparing the diets of late Miocene ungulates from two primary localities showing latitudinal separation (Coffee Ranch of Texas and Cambridge of Nebraska) using hypsodonty, mesowear, and microwear. We also compared the numbers of contemporaneous browsers, grazers, and mixed feeders. Comparison of the diets of the two most abundant equids from Coffee Ranch (*Dinohippus interpolatus*) and Cambridge (*Calippus* sp.) showed that the latter had a more leaf dominated diet, pointing to Cambridge as a more closed ecosystem. A speciose grazing fauna at the Coffee Ranch, comprised largely of equids, is indicative of a grass dominated ecosystem while a speciose browsing fauna at Cambridge suggest a mixed ecosystem. These findings are consistent with the previously published isotopic values which indicate more C_4 dominated equid diets in Texas. However, when our results are compared to published paleosol carbon isotopes, which show no difference in the relative C_3 and C_4 components between the localities, a different pattern emerges. Our results, which show a more tree dominated ecosystem at more northern latitudes, indicate that differences in equid enamel isotopes are a result of a behavioural lag in C_4 feeding and not of a latitudinal gradient in C_4 plant distribution. They also reveal that climate change had variable effects on ecosystems at different latitudes in terms of the relative openness of ecosystems but not in terms of plant photosynthetic type. The implications are that expansive grasslands were not formed during the late Miocene and that late Miocene ecosystems in Nebraska cannot be reconstructed as grassland savannah. The expansive grasslands and thus the gradient in C_4 and C_3 plants in the Great Plains likely formed during unrelated Plio-Pleistocene climatic events.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

UNCOVERING THE EVOLUTIONARY HISTORY OF A LINEAGE WITH NO FOSSIL RECORD: AN ODD PATTERN OF ENCEPHALIZATION IN AN ODD-NOSED MONKEY

FRAZIER, Brenda, Penn State University, University Park, PA, USA

Several million years separate the surviving members of the *Nasalis* lineage in Southeast Asia from a likely fossil ancestor, *Mesopithecus*, in Miocene Eurasia. Indirect evidence is therefore essential to illuminate the Pliocene-to-recent evolutionary history of the proboscis and simakobu monkeys (*Nasalis larvatus* and *Simias concolor*, respectively). One approach centers on other SE Asian species for which Plio-Pleistocene evidence exists (e.g., *Pongo* and *Trachypithecus*). The other focuses on the neontology of extant Asian colobines, particularly the proboscis and simakobu monkeys themselves. In this study, 3D cranial landmark data and endocranial volumes were collected from museum specimens of *Nasalis* and *Simias*. Brain and body mass data for other extant and fossil species were taken from published sources. Morphometric variables were subjected to a variety of allometric analyses. The pattern of encephalization in the *Nasalis* lineage appears to be unique among documented cases in anthropoids. The smaller-bodied simakobu is **less** encephalized relative to its larger-bodied sister the proboscis, defying allometric expectation. Compared to other fossil and extant Asian colobines, including the other odd-nosed monkeys (*Rhinopithecus* and *Pygathrix*), the simakobu's brain also appears anomalously small. Many modern mammals (e.g., kangaroos, bison, and orangutans) are known to be smaller than their Pleistocene forebears. In this context, the probable reduction in size of the simakobu since its divergence from other living species is not surprising. Although its relatively large orbits are consistent with ontogenetic scaling, its small endocranial volume rules out "simple" ontogenetic scaling as the primary mechanism of cranial size reduction. These observations demand alternative hypotheses to explain the evolutionary and developmental bases of the brain-body size relationship in this endemic primate. The continual construction and revision of such a theoretical framework enhance the explanatory power of new fossil discoveries not only in this lineage, but also in other instances where gaps in the fossil record frustrate direct investigation of extinct forms.

Poster Session II, (Monday)

CRANIOFACIAL ONTOGENY IN PACHYRHINOSAURUS LAKUSTAI: EVIDENCE FOR SEXUAL DIMORPHISM IN AN ORNITHISCHIAN DINOSAUR

FREDERICKSON, Joseph, University of Wisconsin-Milwaukee, Milwaukee, WI, USA

Pachyrhinosaurus lakustai is a ceratopsid dinosaur known from a monodominant bone bed in Alberta, Canada. These fossils were classified into three growth stages based on size as juveniles, subadults, and adults. These growth stages are problematic because they do not specify the relative maturity of the individual specimens to one another. My goal was to test the three-stage hypothesis of ontogeny through a cladistic reconstruction of the growth series. Using the primary literature, I found 67 hypothetical growth characters among 42 specimens. The data were analyzed in PAUP with all characters equally weighted. The analysis calculated 71,600 trees with the shortest length of 94 steps and a CI of 0.65. The strict consensus tree collapsed into a single polytomy, so a 50% majority rule consensus was obtained to summarize the hierarchical structure in the data. Instead of recovering three growth stages, a continuous growth series was obtained, where the most mature specimens split into two sister branches. This divergence may represent sexual dimorphism because (1) both skull types share an identical sequence of seven growth changes and (2) each adult skull type develops unique characteristics. One morph has seven defining characters: a rostral comb, a tall nasal boss, wide nasal walls, a tall vaulted parietal bar, a tall horn on the median parietal bar, a radially constricted base on the median parietal horn, and twisted caudal parietal horns (P3). The other morph has six defining characters: a long nasal boss, deep palisades on the nasal boss, middle parietal horns (P2) with a constricted base, middle parietal horns (P2) that cross the midline, a deep sulci system on the middle parietal horns (P2), and straight caudal parietal horns (P3). The two morphs reveal that many of the diagnostic traits of *P. lakustai*, such as the anteroventral twist in the lateral parietal horns and the rostral comb, are only expressed in one of the adult skull types (presumably male), but not in the other (presumably female). These results enable a hypothesis of sexually selected characters for this species.

Poster Session IV, (Wednesday)

STRATIGRAPHIC CORRELATION OF JUDITH RIVER FORMATION (CAMPANIAN, UPPER CRETACEOUS) EXPOSURES IN KENNEDY COULEE (NORTHCENTRAL MONTANA) TO THE FOREMOST FORMATION (ALBERTA): IMPLICATIONS FOR ANAGENESIS IN HADROSAURID DINOSAURS

FREEDMAN, Elizabeth, Museum of the Rockies, Montana State University, Bozeman, MT, USA; FOWLER, Denver, Museum of the Rockies, Montana State University, Bozeman, MT, USA

Kennedy Coulee (northcentral Montana, USA) exposes a highly fossiliferous section of the Judith River Formation (Fm) (middle-upper Campanian, Upper Cretaceous), and is continuous with the Foremost and Oldman Fm outcrop of Alberta. Historically, a thick coal at the base of the coulee was correlated with the Taber Coal Zone (uppermost Foremost Fm); thus, overlying sediments were considered to be mostly Oldman Fm equivalent. However, recent advancements in terrestrial sequence stratigraphic methods and their application in Alberta have prompted revision of this diagnosis, with important implications for the vertebrate fauna. The presence of thin coals throughout Kennedy Coulee suggests that the Taber Coal Zone is not restricted to the base of the section, consequently most if not the entire section may be Foremost Fm equivalent. This reassignment is independently supported by microvertebrates and trace fossils. An abundance of *Squatirhina* (Chondrichthyes) teeth in the upper portions of Kennedy Coulee suggests that the entire coulee is Foremost Fm equivalent since *Squatirhina* are previously reported from the Foremost Fm but not the Oldman Fm. Two hadrosaur sites preserving new species of *Gryposaurus* and *Brachylophosaurus* are located stratigraphically high in Kennedy Coulee, ~1-2m below a concreted channel sandstone. Presence of fossilized wood with *Teredolites* borings within the channel sand is indicative of tidal influence, and hence close proximity to the Western Interior Seaway (<50km). In which case, localities ~200km east of Kennedy Coulee, such as Malta, Montana, would have still been inundated by the Western Interior Seaway at the time of deposition of the Kennedy Coulee units. Thus, Judith River Fm outcrops of Malta, Montana, and their abundant *Brachylophosaurus canadensis*, were deposited after the regression identified at the base of the Oldman Fm, and are therefore younger than the Judith River Fm of Kennedy Coulee and its fauna. This stratigraphic reinterpretation is further supported by the more basal morphology of the new *Gryposaurus* and *Brachylophosaurus* species, consistent with their earlier occurrence within anagenetic lineages.

Technical Session XIII, Tuesday 2:15

THE EARLIEST CARNIVORANS FROM AFRICA

FRISCIA, Anthony, University of California - Los Angeles, Los Angeles, CA, USA; KYONGO, Benson, Division of Paleontology, National Museums of Kenya, Nairobi, Kenya; MACHARWAS, Matthew, Division of Paleontology, National Museums of Kenya, Nairobi, Kenya; RASMUSSEN, D. Tab, Washington University in St. Louis, St. Louis, MO, USA

Latest Oligocene deposits in the Rift Valley of northern Kenya near the village of Losodok, have yielded a number of new taxa. Most of these have been endemic African taxa such as hyraxes, proboscideans, anthropoid primates, and diamantomyid rodents. One of the few exceptions to this has been the discovery of the earliest carnivorans in Africa. The feliforms *Mioprionodon hodopeus* and *Legetetia* n. sp. represent the first mammalian migrants from Eurasia, and represent the first in a wave, including artiodactyls, perissodactyls, and large carnivorans, that will reshape African ecosystems. These earliest carnivoran taxa were small,

under 5kg, which may have been the key to their success and their pioneer status. Prior to this, Africa contained a number of creodont taxa, both pterodontines and proviverrines, but they were all relatively large. This meant the small prey, such as rodents and primates, were probably underutilized. As has been demonstrated before (e.g., in North America) creodonts in Africa were subject to an ?evolutionary ratchet? driven to large size and specialized carnivory, leaving ecological room for these new carnivoran invaders. In addition, these new taxa shed light on early small feliform taxonomy and origins, including the endemic radiation of Malagasy taxa which dates to near this time.

Technical Session II, Sunday 8:30

***KOMBUISIA* (SYNAPSIDA, DICYNODONTIA) FROM THE TRIASSIC OF ANTARCTICA, A REFUGE FROM THE TERRESTRIAL PERMIAN-TRIASSIC MASS EXTINCTION**

FRÖBISCH, Jörg, Field Museum, Chicago, IL, USA; ANGIELCZYK, Kenneth, Field Museum, Chicago, IL, USA; SIDOR, Christian, University of Washington, Seattle, WA, USA

We refer fossils from the central Transantarctic Mountains in Antarctica to *Kombuisia antarctica*, one of four Triassic dicynodont lineages known to survive the end-Permian mass extinction. The specimens show similarities in size and proportions to the South African type species *K. frerensis,* and also posses autapomorphies of *Kombuisia*, including (1) a reduced pineal foramen, (2) a narrow, fusiform preparietal bone, and (3) a bifurcation of the lateral dentary shelf to frame an oval fossa posterior to the shelf in lateral view. Phylogenetic analysis supports a sister-taxon relationship of *K. antarctica* and *K. frerensis*. Nevertheless, the Antarctic specimens are distinct from *K. frerensis* in the retention of a slit-like pineal foramen and the lack of contact of the postorbitals on the skull roof, justifying its recognition as a distinct species. The Antarctic specimens extend the geographic range of the genus from the South African Karoo Basin to a wider portion of southern Pangaea. Moreover, they extend the known stratigraphic range of *Kombuisia* from the Middle Triassic subzone B of the *Cynognathus* Assemblage Zone into rocks that are equivalent to the Lower Triassic *Lystrosaurus* Assemblage Zone, thereby significantly shortening the ghost lineage of this taxon. The composition of the lower Fremouw Formation fauna implies a trophic network structure similar to that of the ecologically anomalous *Lystrosaurus* Assemblage Zone of South Africa, indicating that this type of community structure may have been widespread in the aftermath of the extinction perhaps because of continuing environmental perturbations. However, the occurrence of *Kombuisia* and *Lystrosaurus mccaigi* in the Lower Triassic of Antarctica, and additional discordant tetrapod first and last appearances between Antarctica and fossiliferous strata elsewhere, suggest that Antarctica served as a refuge from some of the effects of the end-Permian extinction. In turn, this implies that the effects of and initial recovery from the extinction varied regionally, a pattern that fits well with new observations on later stages of the recovery from the Middle Triassic of Tanzania and Zambia.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

ADULT DORSAL VERTEBRAE OF THE TITANOSAURIAN SAUROPOD *ALAMOSAURUS SANJUANENSIS*, BIG BEND NATIONAL PARK, TEXAS

FRONIMOS, John, Texas Tech University, Lubbock, TX, USA

The titanosaurian sauropod *Alamosaurus sanjuanensis*is North America's only presently known Late Cretaceous sauropod. Despite the steady recovery of *Alamosaurus* material from sites around the southwestern United States, a significant proportion of the skeleton remains undescribed. The lack of diagnostic material such as dorsal vertebrae has hindered attempts to characterize the skeletal morphology of *Alamosaurus* and to resolve its phylogenetic position. The only dorsal vertebrae described to date come from a juvenile specimen; ontogenetic factors therefore limit their utility. A new specimen of *A. sanjuanensis* collected from latest Maastrichtian strata of Big Bend National Park in West Texas includes the first complete adult dorsal vertebrae to be described, consisting of three anterior dorsal vertebrae and one posterior dorsal vertebra. These specimens allow for the detailed characterization of anterior and posterior dorsal vertebrae in the species as well as general patterns of variation along the dorsal series. Pneumatization of the vertebrae is extensive, invading all but the most delicate laminae. "Normal" spongiosa persists only at articulation surfaces. The more complete diagnosis of *Alamosaurus* permitted by these specimens supports a phylogenetic position nearest the Brazilian titanosaurs of the Bauru Group such as *Trigonosaurus pricei* and *Uberabatitan riberoi*.

Preparators' Session, Monday 8:15

MAPPING AND RECORDING THE EXCAVATION OF A MID-CRETACEOUS CROCODILE (ARCHOSAURIA: GONIOPHOLIDAE) AT AN URBAN DIG UTILIZING A CARTESIAN MAPPING SYSTEM

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The Arlington Archosaur Site (AAS) located in Arlington, Tarrant County, TX is a productive fossil site on a private tract of property covering 1700 acres that has produced abundant remains of a variety of Cretaceous vertebrates. The vertebrate fossils represented range from dinosaurian, crocodilian, and chelonian to elasmobranch and dipnoan, with crocodilian and chelonian being most common. The site, stratigraphically located within the Mid–Cretaceous Woodbine Formation (Cenomanian; 95 Mya), represents the paleo-environment of a coastal delta plain consisting of fine grained sediments (mudstone), rich with organic material, which overlies a peat bed. During the midst of the 2009 field season, a large (~7 m) Cretaceous crocodile (Goniopholidae) was discovered and excavated from the basal peat bed in a one week period. Due to the urban location of the site, the predicted potential for bad weather, and the nature of the matrix surrounding the bone bed, an emergency excavation, now known as "Crocorama", was organized utilizing the online social networking site, Facebook. In order to facilitate the rapid removal from the field of the fossils, the site was mapped using Cartesian coordinates in a 5m x 2.5m grid system divided into 50 cm squares. Each fossil was photographed *in situ*, located and drawn in on its unique grid square prior to removal, wrapped using the soft and dry method in its own package with coordinates recorded on the package as well as on the site map content page and then stored for transport. As the site has expanded, additional grids have been developed by extending the original coordinate system. The original grid coordinates were marked with a GPS as well as the expansion grids and a digital map is being developed which will tie together the various dig locations throughout the 1700 acres. Besides allowing for the accurate recording of the fossils in the field, the Cartesian mapping system will allow for a map based storage system for the fossils once they are prepared plus it will provide valuable information to the researchers who will be expanding the research at the AAS into a variety of different areas.

Poster Session III, (Tuesday)

NEW DIDELPHIMORPH (MARSUPIALIA, MAMMALIA) AND DIMYLID (EULIPOTYPHLA, MAMMALIA) REMAINS FROM THE LATE EARLY MIOCENE OF SPAIN

FURIÓ, Marc, Institut Català de Paleontologia, Cerdanyola del Valles, Spain; RUIZ-SÁNCHEZ, Francisco, Departament de Geologia, Universitat de València, Burjassot, Spain; CRESPO-ROURES, Vicente, Departament de Geologia, Universitat de València, Burjassot, Spain; FREUDENTHAL, Matthijs, Departamento de Estratigrafía y Paleontología, Universidad de Granada, Granada, Spain; MONTOYA, Plinio, Departament de Geologia, Universitat de València, Burjassot, Spain

The Miocene sediments of the Ribesalbes-Alcora basin (Castellón, Eastern Spain) have provided a good sample of fossil remains of microvertebrates in the sections of Mas de Torner and Mas de Antolino B. The study of level 5 of the Mas de Antolino section (MAB-5) has resulted in the identification of *Democricetodon*/*Falbuschia* sp., *Megacricetodon* cf. *primitivus*, *Glirudinus* cf. *modestus*, *Microdyromys* sp., *Simplomys* cf. *julii*, Myomiminae indet., *Ligerimys ellipticus*, Sciuridae indet. and *Plesiodimylus* sp. The fossil rodent assemblage is typical of the late Early Miocene of Spain, where dormice, hamsters and squirrels were abundant. However, the discovery of *Plesiodimylus*, a dimylid insectivore, in MAB-5 is quite surprising. Hitherto, the record of this genus in Spain was limited to the late Middle Miocene and the early Late Miocene of its north-eastern region. This new occurrence in the late Early Miocene of eastern Spain is indicative of much larger stratigraphical and geographical ranges for *Plesiodimylus* than previously thought. The family Dimylidae, to which *Plesiodimylus* belongs, was characterized by some adaptations to a durophagous diet. The dimylids were probably specialized to feed on terrestrial mollusks, and consequently their distribution was restricted to environments in which gastropods were abundant.In the other sampled section, the fossil site of Mas de Torner 1 has delivered one fossil tooth of a marsupial. The only member of this group known in the Miocene of Europe is *Amphiperatherium frequens*, which has been found in some localities not younger than the mid Middle Miocene. However, in spite of its impressive Miocene continental record, the presence of remains of marsupials in Spain for this period is really sparse. Actually, similar finds had only been reported from two other localities, Buñol and Navarrete del Río, both ascribed to the Early Miocene.

Technical Session II, Sunday 10:45

NEW SPECIMENS AND PHYLOGENETIC RELATIONSHIPS OF THE SOUTH AMERICAN JURASSIC TRICONODONT *ARGENTOCONODON FARIASORUM*

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Osteological remains of Jurassic mammaliamorphs in South America are only known from the Queso Rallado locality, in central Chubut Province, Argentina. The Jurassic deposits of the basin include the Lonco Trapial and Cañadon Asfalto formations that likely span the Middle Jurassic. Three different mammaliaform groups are found in this locality: australosphenidans, an undescribed allotherian, and a triconodont. The last, *Argentoconodon fariasorum*, was originally described on the basis of an isolated upper molariform; several additional *A. fariasorum* specimens are now available, including one which preserves upper and lower jaws, as well as many postcranial elements.We reconstruct the dental formula as I?C1P3M3/i?c1p4m3. *Argentoconodon´*s dentition is very similar to that of *Volaticotherium antiquus*, likely from the Jurassic of China, and both of them resemble *Ichthyoconodon jaworowskorum* from the Cretaceous of Morocco. The anatomical similarity between *Argentoconodon* and *Volaticotherium* extends to some postcranial elements. A phylogenetic analysis including most recently described triconodonts recovers a clade formed by *Argentoconodon*, *Volaticotherium* and *Ichthyoconodon*, with a minimal mid-Jurassic age and a wide, likely Pangeic, distribution. This clade is nested within the traditional subfamily Alticonodontinae among triconodontids, supporting *Volaticotherium* as a triconodontid and not as a representative of a major new clade distantly related to other triconodonts as originally reported. Postcranial similarities between *Argentoconodon* and *Volaticotherium* suggest they may have had similar locomotory habits; thus, if *Volaticotherium* was a glider, *Argentoconodon* likely was too.

Poster Session III, (Tuesday)

APPROXIMATION OF THE DIMENSIONS OF THE MIDDLE MIOCENE IBERIAN SAVANNAS

GARCIA YELO, Blanca, Museo Nacional Ciencias Naturales - CSIC, Madrid, Spain; GOMEZ CANO, Ana Rosa, Universidad Complutense De Madrid, Madrid, Spain; SANISIDRO, Oscar, Museo Nacional Ciencias Naturales - CSIC, Madrid, Spain; DOMINGO, Laura, Universidad Complutense De Madrid, Madrid, Spain; HERNÁNDEZ FERNÁNDEZ, Manuel, Universidad Complutense De Madrid, Madrid, Spain

The aim of this research was to determine the geographical dimensions of the ecoregion associated with the terrestrial mammal fauna present in the middle Miocene (c.a. 14 ma) fossil site of Somosaguas (Madrid, Spain). Since the fauna from Somosaguas has been previously interpreted as a savanna assemblage, we studied the diversity patterns of body size structure for one modern mammalian community from each of the savanna regions of the world (except Australia). In order to avoid sampling biases carnivores were not included in this analysis and, therefore, only the body size structure of prey was studied. For this purpose, we calculated the Shannon's diversity and Pielou's evenness indices. Bothindices were also computed for the extinct fauna of Somosaguas. Four different quadratic regression models were calculated to define the relationships between diversityindices (Shannon's diversity and Pielou's evenness) and geographic characteristics (area and perimeter) of the ecoregions corresponding to the modern communities. After removing three outliers, related to substantially isolated localities in Argentina, Madagascar and India, only evenness in the prey body size structure index presented significant relationships with both the area ($r^2 = 0.935$; $p = 0.004$) and the perimeter ($r^2 = 0.945$; $p = 0.003$) for the modern localities. The application of these models to the data from the Miocene of Somosaguas allowed us to determine that the corresponding ecoregion had an area of approximately 595,660 km^2 and a perimeter of around 3,719 km. These dimensions are congruent with the size of the Iberoccitanian Region during the middle Miocene. This study opens the possibility for the development of new methodologies of paleobiogeographic inference based on the study of the ecological structure of mammal faunas.

Poster Session I, (Sunday)

BRAINCASE ANATOMY OF THE BASAL DIAPSID *YOUNGINA CAPENSIS* FROM HIGH-RESOLUTION X-RAY CT SCANNING

GARDNER, Nicholas, Marshall University, Huntington, WV, USA; HOLLIDAY, Casey, University of Missouri, Columbia, MO, USA; ZHU, Helen, Marshall University, Huntington, WV, USA; O'KEEFE, F. Robin, Marshall University, Huntington, WV, USA

Detailed descriptions of the braincase anatomy of early diapsid reptiles are rare due to the difficulty of accessing this deep portion of their often small, densely mineralized skulls. Previous descriptions of the braincase of the basal diapsid *Youngina capensis*, an important sauropsid from the Late Permian (250 Ma) of South Africa, have relied on partially preserved fossils or data that could be gathered from superficial views of the skull. We used high-resolution X-ray CT scanning (HRXCT) and Amira v. 4.0 to visualize and describe a detailed digital model of the neurocranial anatomy of *Youngina*. The braincase of *Youngina* shows many plesiomorphies compared to more derived reptiles. It is similar to those of captorhinids and *Petrolacosaurus* by the presence of a large and open fenestra ovalis. The stapes is an interesting mosaic between these primitive taxa and more derived sauropsids. It is slender and lacks a dorsal process, but still possesses a large stapedial foramen. *Youngina* shows some derived braincase characters, such as a contact between the distal paroccipital process and the quadrate, an abducens nerve which occupies a groove on the dorsum sella rather than passing through a foramen, and large basipterygoid processes. *Youngina* has a vestibulocochlear morphology similar to *Sphenodon*, which suggests similar auditory adaptations.These new data were included in a phylogenetic analysis of basal amniotes. Our analysis finds a terrestrial younginiform clade, while the aquatic tangasaurids are basal to Neodiapsida (*Youngina* plus crown diapsids). The interrelationships between non-crown neodiapsids were poorly supported and collapsed in the bootstrap analysis. Missing data are abundant in this area of the tree, suggesting that future work should focus on exploring the anatomy of other basal neodiapsids.

Poster Session I, (Sunday)

ISOTOPE PALEOECOLOGY OF THE PLEISTOCENE WASIRIYA BEDS OF RUSINGA ISLAND, KENYA

GARRETT, Nicole, Department of Anthropology, University of Minnesota, Minneapolis, MN, USA; FOX, David, Department of Geology and Geophysics, University of Minnesota, Minneapolis, MN, USA; MCNULTY, Kieran, Evolutionary Anthropology Lab, University of Minnesota, Minneapolis, MN, USA; TRYON, Christian , Department of Anthropology, New York University, New York, NY, USA; PEPPE, Daniel, Department of Geology, Baylor University, Waco, TX, USA

Africa is widely recognized as the birthplace of modern humans, but their subsequent dispersal throughout Africa and into Eurasia is not well documented in the paleontological record. Thus, the discovery of *in situ* Middle Stone Age tools associated with well-preserved fossil animal remains marks the Wasiriya Beds of Rusinga Island in Lake Victoria, western Kenya, as an important resource for understanding the interactions among early modern humans, co-occurring fauna and the environment. The Late Pleisticene Wasiriya Beds crop out discontinuously around the perimeter of Rusinga and contain several localities with artifacts and well-preserved ungulates, micromammals and gastropods. The mammalian fauna includes both extinct species and extant taxa that do not occur in the Lake Victoria region today. Hippopotamus and other taxa are consistent with the fluvial sediments in which fossils are found, suggesting locally wet conditions. Species such as oryx (*Oryx gazella*) and Grevy's zebra (*Equus grevyi*), in contrast, suggest the presence of an arid, open, grassland environment. Here we present a paleoecological analysis of stable carbon and oxygen isotopes sampled from fossil mammal teeth (n=10), pedogenic carbonates (n=13), and sedimentary organic matter (n=22) excavated from stratigraphically equivalent measured sections at the Wakondo and Nyamita localities in the Wasiriya Beds to test these alternative hypotheses of past environmental conditions in the region. Carbonate and organic matter $\delta^{13}C$ values from Wakondo demonstrate a clear stratigraphic trend of increased C_4 grass biomass through time; $\delta^{18}O$ values from this site, however, do not suggest a correlated change in moisture levels. Samples from Nyamita, on the other hand, are similar to Wakondo in their $\delta^{18}O$ values, but do not show evidence of Wakondo's increase in C_4 biomass through time. Our stable isotope results suggest that there was considerable spatial and temporal variation in climate and the abundance of grasses on small scales in the Lake Victoria region, and that long-term environmental changes played a role in shaping the biogeography of mammals in the region, potentially including humans.

Poster Session I, (Sunday)

MICROVERTEBRATE FAUNA FROM THE MAASTRICHTIAN (LATE CRETACEOUS) "SUE" QUARRY: IMPLICATIONS FOR MICROSITE ORIGINATION AND FINE-SCALED HELL CREEK FORMATION BIODIVERSITY

GATES, Terry, Field Museum, Chicago, IL, USA; MAKOVICKY, Peter, Field Museum, Chicago, IL, USA; RIEPPEL, Olivier, Field Museum, Chicago, IL, USA

The remarkably complete *Tyrannosaurus rex* fossil "Sue" FMNH PR 2081 from the Hell Creek Fm is the subject of multiple studies on the anatomy and behavior of tyrannosaurids. Although other vertebrate taxa have long been known from the site, this is the first substantive investigation documenting the microvertebrate fauna associated with Sue's remains. The microfauna to date—obtained from screenwashing over six cubic meters of sediment collected during the preparation of the skeleton—consists of several chondrichthyian fishes such as *Lonchidion*, *Myledaphus*, and a possible new species of *Chiloschyllium* (bamboo shark); osteichthyes including *Coriops*, amiids, and gar; the amphibians *Habrosaurus*, *Scapherpeton*, and two albanerpetids. Terrestrial taxa from the site include: *Chamops* and a varanid among other lizards, four theropod dinosaur tooth morphs, rare champsosaurid and crocodilian remains, the turtle *Cedrobaena*, and one multituberculate mammal. Amphibians are the most common faunal constituent, whereas gar fish remains are relatively rare, a pattern that is in stark contrast to many other Hell Creek Fm sites. The fossils are preserved in muddy sandstone interbedded with muddy siltstone layers preserving abundant leaf fossils, which provides an indication of burial time for the assemblage if the sediment alternation is seasonal. Here we propose a new method using macrovertebrate specimens as a time proxy for microvertebrate assemblages buried in the same layer by examining the taphonomic profile of the macrofossils and comparing with accepted degeneration times. The bones of FMNH PR 2081 do not show evidence of weathering, abrasion, or other physical damage associated with long exposure. Using these taphonomic features, we estimate that the microfauna obtained from this study likely accumulated in about five years or less. Increase in the precision of accumulation times is an advance from previous methods that could produce wide ranging estimates on the order of tens to hundreds of years. The narrower time span observed here may explain some of the faunal discrepancies compared to other Hell Creek microvertebrate assemblages that are more time-averaged.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 11:15

BEYOND HINGES: 3-D JOINT FUNCTION IN ERECT BIPEDS

GATESY, Stephen, Brown University, Providence, RI, USA; KAMBIC, Robert, Brown University, Providence, RI, USA; ROBERTS, Thomas, Brown University, Providence, RI, USA

The hind limbs of ground-dwelling birds bear many of the classic hallmarks of running ability: offset femoral head, elongate distal elements, reduced fibula, fused tarsals and metatarsals, digitigrade foot posture, symmetrical pes, and toe loss. Many of these skeletal features appeared earlier in dinosaur and theropod evolution. In accordance with a 2-D paradigm, hind limb motion in birds and other dinosaurs is often characterized as parasagittal, with hinge-like hip, knee, and intertarsal joints restricted to flexion/extension. Methods of skeletal motion analysis have progressed to a point where we can now ask: what is being missed when joints are not treated in 3-D during locomotion? New, high-resolution, six degree of freedom, kinematic data from biplanar x-ray analyses of guineafowl are beginning to reveal the functional complexity of so-called hinges. Our XROMM (X-ray Reconstruction of Moving Morphology) animations reveal that non-parasaggital movements (in particular, long-axis rotations) are consistent components of both steady forward locomotion and turning. Compared to joints with only one degree of freedom, articulations allowing long-axis rotation significantly increase the limb's working range. Moreover, bilateral symmetry compels the proximal joints of even the most highly adducted limbs to remain lateral to the midline rather than directly beneath the body's center of mass, thereby engendering off-axis loading. Although joint surfaces transmit compressive forces between bones, both active (muscular) and passive (ligamentous) tensile structures act in concert with articular geometry to limit mobility and coordinate joint translations/rotations. Mechanisms for generating and accommodating non-parasaggital loads are likely major influences on joint morphology and limb design, even in erect bipeds. An understanding of 3-D function within and among avian limb joints will enlighten reconstructions of locomotion in extinct theropods and the evolution of bipedalism.

Technical Session XIII, Tuesday 4:00

PHYLOGENETIC ANALYSIS OF EXTINCT AND EXTANT CINGULATA (XENARTHRA, MAMMALIA) BASED ON COMBINED CRANIAL AND POSTCRANIAL DATA

GAUDIN, Timothy, University of Tennessee at Chattanooga, Chattanooga, TN, USA; BRAMBLETT, Jeremy, University of Tennessee at Chattanooga, Chattanooga, TN, USA

Cingulates are the only armored mammals and include the extant armadillos, the most speciose group of living taxa in the order Xenarthra, as well as the extinct glyptodonts and pampatheres. The most recent comprehensive analyses of cingulate phylogeny based on morphology allow inclusion of extinct taxa from the diverse cingulate radiation, but suffer from several shortcomings, including restricted anatomical coverage and the lack of non-xenarthran outgroups. The results of these studies also differ significantly from molecular phylogenies based solely on living taxa. The goal of the present study is to reexamine cingulate relationships based on a detailed study of the entire cingulate skeleton. We examined all eight living genera of armadillos, along with five extinct armadillo genera, one glyptodont and one pampathere. A matrix of 301 discrete osteological characters and 19 taxa was constructed and analyzed using PAUP. Characters were polarized via comparison to three successive outgroups: Pilosa, represented by the three-toed sloth *Bradypus* and the anteater *Tamandua;* the hedgehog *Erinaceus;* and, the opossum *Didelphis*. A heuristic analysis with random addition sequence and 1000 repetitions resulted in two most parsimonious trees (TL = 1496, CI = 0.456, RI = 0.471). As in several recent molecular studies, three monophyletic armadillo subfamilies were recovered, the Dasypodinae, Tolypeutinae, and Euphractinae, with the latter two sharing a more recent common ancestry. Glyptodonts and pampatheres were allied as sister taxa and clustered with euphractines, and as in previous morphological studies, eutatines were polyphyletic and *Peltephilus* was the sister taxon to all other cingulates.

Poster Session II, (Monday)

THE FIRST CHARACTERS USEFUL FOR IDENTIFYING FOSSIL SCOLECOPHIDIAN VERTEBRAE TO THE FAMILY LEVEL

GELNAW, William, East Tennessee State University, Johnson city, TN, USA; MEAD, Jim, East Tennessee State University, Johnson City, TN, USA

Scolecophidian snakes are known in the fossil record beginning in the lower Eocene and have been found in North America, Europe, Africa and Australia. Only vertebral remains are known, and though identification to the subordinal level have been possible using existing character sets, more refined idenficiations have been largely based on present distributions of the families. We present 1) a review of the known fossil record of the suborder Scolecophidia (Serpentes), 2) an assessment of previously-used vertebral characters for the identification of the group, and 3) the introduction of five new characters that can be utilized to identify vertebrae to differentiate the family Typhlopidae from Leptotyphlopidae. This is the first time that diagnostic characters have been used to identify scolecophidian vertebrae at the familial level. The characters differentiate the taxa on the basis of the shape and placement of the synapophyses, shape of the cotyle, size of the zygosphene, and shape of the prezygopophysial facets. These characters have been used to identify three newly collected fossils from two caves in Western Australia. The fossils are confidently placed in the family Typhlopidae, which is consistent with what would be expected from the modern distribution of the two families.

Poster Session I, (Sunday)

NEW RECORDS OF FOSSIL TURTLES FROM GREECE

GEORGALIS, Georgios, Aristotle University, Thessaloniki, Greece; KEAR, Benjamin, Uppsala University, Uppsala, Sweden

The record of fossil turtles from Greece is sparsely documented compared to elsewhere in the European region. However, recent systematic surveys have uncovered enigmatic new finds and prompted reanalysis of existing material – including some of the largest-bodied terrestrial turtle remains yet recovered. The stratigraphically oldest specimens represent a novel genus and species of podocnemoid from the Lower Miocene (Burdigalian) Zeugostation Formation, a paralic marine (lagoonal) deposit that crops out in the Mesohellenic Basin of northwestern Macedonia. This new taxon is the first pleurodiran turtle from Greece and displays traits reminiscent of marine bothremydids – a group thought to have become extinct by the Eocene but with fragmentary remains reported from the Miocene of the Middle East (Oman) and Malta. Upper Miocene (Messinian) and Pliocene testudinid fossils are common and occur on the eastern Aegean islands of Samos and Lesbos (Vatera Formation), together with mainland Attica (Pikermi) and Macedonia (Vathylakkos Formation). The majority of specimens represent small-bodied taxa including the modern species *Testudo graeca* + *T. marginata*, and the extinct *T. marmorum* – which constitutes the oldest member of genus *Testudo* sensu stricto. Also widespread are remains attributed to the genus *Cheirogaster*, a colossal tortoise with carapace length in excess of 2 meters. Recent phylogenetic analyses suggest that the Greek *Cheirogaster* specimens represent a distinct species, *C. schafferi*, that probably dispersed into the European region from Asia or the Palearctic sometime during the Eocene.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 12:00

INCONGRUENT QUATERNARY PALEOECOLOGIC MODELS AND IMPLICATIONS FOR USING MAMMALS TO RECONSTRUCT PAST CLIMATE

GEORGE, Christian, The University of Texas at Austin, Austin, TX, USA

Quaternary mammalian paleoecology is based on the assumption that the ecology of modern mammals is directly applicable to their fossil relatives. Other authors previously recognized correlations between relative abundance of certain extant mammal clades, body mass hierarchies, and the precipitation and temperature of modern ecosystems. To test the degree to which these correlations are applicable to paleofaunas, I applied correlation-based models to reconstruct the paleoecological signal of Late Pleistocene and Holocene mammals from Hall's Cave, Kerr County, Texas. Hall's Cave has a high-resolution chronology and a diverse taxonomic assemblage, which provides a unique opportunity to evaluate a continuous record of mammals from the last glacial maximum through the modern biota. I compared cenograms to the sigmodontine diversity index, which is based on the high correlation between species richness in extant sigmodontine rodents and temperature. I also developed a model to test whether there is a correlation between other groups of extant mammals (carnivorans, lagomorphs, insectivorans, and other rodents) and modern climate. I then compared the signal of all models against independent proxy data derived from published pollen records and stable isotope analyses. I generated a Macrophysical Climate Model (MCM) of paleoclimate as a third kind of independent data. I found that the faunal paleoecologic methods had internal inconsistencies and did not yield compatible reconstructions. The paleotemperatures modeled from groups of mammals were incongruent with each other and the independent climate proxies. I generated cenograms for a series of time intervals through the sequence at Hall's Cave. The cenograms did not vary significantly from the modern fauna of Central Texas, suggesting that climate did not change from the last glacial maximum, contradicting all paleoclimate proxies. My results indicate that these techniques for reconstructing past climate yield data that are both internally inconsistent and in conflict with each other. This suggests that paleoecologic reconstructions based solely on mammals should be cautiously interpreted.

Technical Session I, Sunday 8:30

TURNING SEMICIRCULAR CANAL FUNCTION ON ITS HEAD: DINOSAUR DIVERSITY SUGGESTS A NOVEL VESTIBULAR ANALYSIS

GEORGI, Justin, Midwestern University, Glendale, AZ, USA; SIPLA, Justin, University of Iowa, Iowa City, IA, USA; FORSTER, Catherine, The George Washington University, Washington, DC, USA

Historically, investigations into the comparative function of the semicircular canals have focused on the size of the canals with respect to body mass. This is based on pioneering work wherein body mass was compared to canal size under two different assumptions: geometrical similarity (heads are proportionately the same size) and dynamic similarity (heads produce the same stress on the neck in proportion to body size). Previously, we reported a pattern of canal morphology in non-avian dinosaurs that correlated the relative height of the vertical canals with posture (bipedal versus quadrupedal). Interpretation of this correlation was difficult due to the absence of a size factor. Furthermore, in our analysis, macronarian sauropods were not categorized properly, showing morphologies similar to the sampled bipeds. Additionally, analysis of dinosaurian canal size using the prevailing method of scaling to body mass does not discriminate between the posture categories.Non-avian dinosaurs, however, exhibit a broad array of head sizes relative to body size with extremes ranging from the very large (neoceratopsians) to the very small (neosauropods). Therefore, we hypothesize that the use of body mass as a proxy for head size under either of the previously suggested assumptions does not capture an accurate correlate for semicircular canal function in dinosaurs. To test this hypothesis, we estimated head mass by scaling published body masses to ratios of head and body measurements. Regression of the canal dimensions against estimates of head mass produces complete separation of the functional groups with bipeds (less stable locomotion) showing larger canal dimensions (more sensitive canals) than quadrupeds of similar head size. The macronarian sauropods lie on the quadrupedal regression suggesting that this analysis has greater power than previous analyses to discriminate locomotion using semicircular canal morphology.We suggest that this new method of analysis has important implications for reinterpreting most of the previous work done on the connection between locomotion and semicircular canal function across vertebrates.

Evolution of the Modern African Fauna, Wednesday 8:00

NEW DATA ON THE PRIMITIVE UNGULATE (CONDYLARTH-LIKE) MAMMALS FROM THE PALEOCENE OF THE OULED ABDOUN BASIN, MOROCCO

GHEERBRANT, Emmanuel, CNRS-MNHN, UMR 7207, Paris, France; AMAGHZAZ , Mbarek, OCP, Khouribga, Morocco; BOUYA, Baadi, OCP, Khouribga, Morocco

In Africa scarce dental remains of poorly known condylarth-like mammals have been described from few Paleocene-Eocene sites in Morocco and Senegal, in contrast to their impressive Laurasian early Tertiary fossil record. The most important discoveries are genera *Abdounodus* and *Ocepeia* from Ouled Abdoun Phosphate Basin, Morocco. Since 2001, significant new material has been discovered in Sidi Chennane quarries, testifying to their early Thanetian age, ca. 60 My. *Abdounodus hamdii* is still known only by lower premolar-molar series. This is a specialized bunodont crushing form convergent with the kollpaniine hyopsodontids. A paenungulate affinity is suggested by presence of a hypolophid, postentoconulid, labial hypoconulid, crescentic trigonid crests, and cingular-like postcristid. This is

especially reminiscent of primitive hyracoids. Primitive (*e.g.*, bunodonty, paraconid, uncompressed trigonid) and specialized (P/1-2 lost, diastema) traits suggest a basal lineage lateral to crown paenungulates. Intriguing resemblances with ptolemaids are also noted, especially with Fayum *Ptolemaia lyonsi* (*e.g.*, molar pattern, P/1-2 lost, diastema). *Ocepeia daouiensis* is the best known condylarth-like mammal from Ouled Abdoun. New material includes partial skulls and lower jaws. It is distinct from *Abdounodus* in the advanced selenodonty suggesting a folivorous diet. It is also specialized in striking simiiform–like features such as a shortened rostrum (no P/1-2, weak diastema), C/1 shape, short mandibular symphysis, deep and inflated dentary. It is more primitive than paenungulates (paraconid, no hypocone, orbit distal, basicranium elongate). Despite some loxolophine resemblances, *Ocepeia* is closer to paenungulates than to Laurasian "condylarths" (*e.g.*, entolophid, dilambdodonty, jugal ventral process, wide zygoma and nasal cavity). The paenungulate features of *Ocepeia* and *Abdounodus,* and their mosaic of plesiomorphies and autapomorphies suggest an early African ungulate radiation predating that of modern Paenungulata. Their possible stem paenungulate relationship needs to be further tested with cladistic analysis.

Technical Session VI, Monday 2:15

POSTCANINE TEETH HOMOLOGIES IN MAMMALIA

GIALLOMBARDO, Andres, American Museum of Natural History, New York, NY, USA; ATOL MAMMAL MORPHOLOGY TEAM, USA

The ancestral number of postcanine teeth in Marsupialia and Placentalia is seven. While marsupials primitively have three premolars and four molars, placentals primitively have four premolars and three molars. To further complicate the comparison, some Mesozoic nonplacental eutherians have five premolars instead of four. The positional homology of marsupial and placental premolars and molars has been subject to much debate. The uncertainty about dental homologies is seldom addressed in recent phylogenetic analyses of therians, and where postcanine characters were scored, the implicit tooth homology was not sufficiently justified. Such a justification, however, is inevitable to accomplish a mammalian phylogeny as the one our team is attempting.

Here we present a hypothesis of dental homologies for postcanine teeth in mammals. We use the tallest and more trenchant premolar as a landmark for identifying tooth positions. The morphology of eutherians that have five premolars, and the sequence of tooth germ origination in ontogeny are used to deduce the order in which premolar and molar loci were lost in Theria. We also take into account that, in the two last premolar loci in Eutheria and the last premolar locus in Metatheria, the deciduous teeth are more molarized than their respective replacement teeth. Specifically, we propose that a) the primitive condition in Theria is the presence of five premolars and three molars (P1, P2, P3, P4, P5, M1, M2, and M3); b) P3 is absent in Metatheria and Placentalia; and c) the most anterior molar locus of Metatheria is homologous to the last premolar locus of eutherians; the first metatherian molar would represent the retained dP5 of generalized therians. Accordingly, the generalized postcanine dental formula would be P1, P2, P3, P4, P5, M1, M2, M3 for Eutheria; P1, P2, P4, P5, M1, M2, M3 for Placentalia; and P1, P2, P4, dP5, M1, M2, M3 for Metatheria. Lack of developmental evidence makes expansion of this nomenclature to non-therian mammals challenging; among these taxa, when replacement is not available, the more traditional criteria of tooth morphology and differential wear are employed to determine locus homology.

Poster Session IV, (Wednesday)

POPULATION STRUCTURE OF *TAPIRUS POLKENSIS* BASED ON DENTAL ERUPTION AND WEAR

GIBSON, Matthew, East Tennessee State University, Johnson City, TN, USA; WALLACE, Steven, East Tennessee State University, Johnson City, TN, USA

Individuals of *Tapirus polkensis* from the Gray Fossil Site exhibit an excellent level of preservation. Intact skulls collected from the site were arranged in a rough age class system separated into 7 categories based on the teeth present and amount of dental wear. Such an eruption series is useful for general comparisons amongst the tapirs; however the classes do not represent an age in years due to a lack of data on living tapirs. Consequently, it is possible that some age classes may contain several years of a tapirs life, or comparatively only a few months. In this study we place ages on individuals of *T. polkensis* from the Gray Fossil Site based on age data taken from The Baird's Tapir Project of Costa Rica (Baird's Tapirs, *T. bairdii*) ranging from several months to 7 years in age. Based on this comparison, eruption class 1 represents up to the first year of life, eruption classes 2 through the early part of 5 represent the following four years, and the latter part of eruption series 5 though 7 represent years 5 to over 7. Data collected from the tapirs at Gray could improve our understanding of the population found at the site. The Gray Fossil Site sample gives us insight into understanding the structure of tapir populations both past and present, potentially aiding conservation efforts of the four extant tapir species.

Romer Prize Session, Monday 9:00

TOOTH PRESSURES, NICHE OCCUPATION AND THE EVOLUTION OF THE CRANIAL ECOMORPHOLOGY OF CROCODYLIANS

GIGNAC, Paul, Florida State University, Tallahassee, FL, USA

Extant crocodylians exploit prey resources through the integrated functions of their skull, neuromuscular systems, and dentition, which allow them to traverse feeding niches during development. This integrated suite of anatomy also appears to have tracked available niche space within a narrow range of ecomorphology during their evolutionary history and has likely been the driving engine of their diversification. Under this paradigm the anatomical components of the cranial ecomorph are expected to covary as they tightly track resource use. One often overlooked aspect of this system is the functional role of the dentition, through which bite forces are administered to prey items. Tooth pressure, the maximum bite force applied over the cross-sectional area of a tooth, varies among extant taxa and correlates to dietary resources. Tooth pressures of needle-toothed, slender-snouted taxa are relatively high; those of blunt-toothed, broad-snouted forms tend to be relatively low; and the pressures of medium-snouted species are in between. Although recent research has focused heavily on rostral anatomy and performance, tooth pressures are also requisite for a comprehensive understanding of crocodylian feeding evolution. Teeth are readily available among extinct taxa for measurements of dental form necessary to quantify tooth pressure. However, bite forces are difficult to assess owing to a myriad of inaccessible anatomical variables such as muscle size, orientation, physiology, pennation, and neural control. Recent work has shown that bite forces in crocodylians can be accurately modeled using two methods: body-size scaling and jaw adductor muscle reconstruction. Tooth pressures for extinct crocodylian taxa were derived based on these methods and compared to those from all 23 living species. This study showed that by pairing rostral shape, dental form, and jaw adductor muscle function with feeding-niche occupation in extant taxa, it was possible to explicitly identify potential prey resources exploited by fossil crocodylians, categorize their feeding niches, and elucidate the evolutionary nature of phenotypic covariation in their feeding functional morphology.

Poster Session III, (Tuesday)

PLIO-PLEISTOCENE AFRICAN PAPIONIN PHYLOGENETIC HISTORY AND BIOGEOGRAPHY

GILBERT, Christopher, Yale University, New Haven, CT, USA

This study examines Plio-Pleistocene African papionin phylogenetic history and biogeography through a comprehensive cladistic analysis of craniodental morphology. In order to account for the well-documented influence of allometry on the papionin cranium, the narrow allometric coding method was applied to characters determined to be significantly affected by allometry. Resulting trees hypothesize *Parapapio*, *Pliopapio*, and *Dinopithecus* as stem African papionin taxa. Crown Plio-Pleistocene African papionin taxa include *Gorgopithecus*, *Lophocebus*, *Procercocebus*, and *Papio quadratirostris*. *Papio quadratirostris* is reconstructed here as being the sister taxon to a clade containing the extant taxa *Mandrillus* and *Cercocebus* plus the fossil taxon *Procercocebu*s. Other notable phylogenetic results suggest that *Theropithecus baringensis* is a primitive member of that genus and that *Gorgopithecus* is closely related to *Papio* and *Lophocebus*. Perhaps surprisingly, the genus *Theropithecus* is reconstructed as the most primitive crown African papionin taxon. Using these hypothesized phylogenetic trees for the Plio-Pleistocene African papionins, biogeography was subsequently examined by treating geography as an unordered cladistic character and coding biogeographic regions such as South Africa, East Africa, North Africa, Central Africa, and West Africa as character states. The biogeographic character states for each fossil and extant African papionin taxon were then mapped onto a hypothesized cladogram and dispersal events were inferred. In addition to hypothesized dispersal events between East and South Africa, African papionin monkeys appear to document a biogeographic connection between West and South Africa ~2.3 - 1.5 Ma. Future research is necessary to determine if this hypothesized faunal connection may have involved other mammalian taxa as well.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 8:30

A FUNCTIONAL INVESTIGATION INTO THE JAW JOINTS OF TWO OF THE EARLIEST STEM MAMMALS; *MORGANUCODON WATSONI* AND *KUEHNEOTHERIUM PRAECURSORIS*

GILL, Pamela, University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; ROBSON-BROWN, Kate, University of Bristol, Bristol, United Kingdom; GOSTLING, Neil, State University of New York at Oswego, Oswego, NY, USA

The evolution of the jaw joint is of pivotal importance in early mammal evolution, and here we investigate feeding-induced loads at the jaw joint in two important stem mammals. The dentary condyle is notably more developed and robust in *Morganucodon* than in *Kuehneotherium*. Previous research we conducted suggested that *Morganucodon* fed on 'hard-object' prey, whereas *Kuehneotherium* was specialized for rapid, snapping jaw closure and consuming more malleable foodstuffs, thereby indicating early ecological diversity within basal mammals. We now test the hypothesis that the dentary-squamosal jaw joint was operational and functionally important in these taxa. Mandibles were scanned using synchrotron radiation XμCT (SRXTM) or μCT to generate a 3D virtual jaw and finite element (FE) model for each taxon. For similar muscle loadings, we compared the effects on the jaw joint of chewing with the teeth in close proximity to biting with a wider gape (45 degrees). In order to generate two newtons of bite force (required to pierce beetle cuticle), *Kuehneotherium* experiences over twice as much load at the jaw joint than *Morganucodon*. However, the *Kuehneotherium* jaw gains some advantage during gaping, as *Morganucodon* experiences an increase of almost double the loading at the condyle, whereas this is less than 50% in *Kuehneotherium*. We also manipulated the ratio of muscle loadings, to simulate the increasing development of the masseter musculature in mammalian evolution. There is greater reduction of force at the condyle for *Kuehneotherium* when increasing the loading of the superficial masseter by 50%. The jaw of *Morganucodon* is stiffer, whilst *Kuehneotherium* experiences

torsion during biting. This, coupled with the poorly developed dentary condyle and relatively greater loading during biting, suggests that a surangular-squamosal contact may have been present in *Kuehneotherium*. In current phylogenetic analyses, *Kuehneotherium* is placed further up the stem than *Morganucodon* and this more plesiomorphic jaw articulation in *Kuehneotherium* illustrates the mosaic nature of early mammal evolution.

Poster Session I, (Sunday)

FOSSIL VERTEBRATES OF THE UPPER CRETACEOUS TROPIC SHALE, SOUTHERN UTAH

GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, USA; ALBRIGHT III, L. Barry, University of North Florida, Jacksonville, FL, USA; TITUS, Alan, Grand Staircase-Escalante National Monument, Kanab, UT, USA

Cenomanian-Turonian strata in the Kaiparowits Basin of southern Utah include the Dakota Sandstone, Tropic Shale, and lower portion of the Straight Cliffs Formation (Tibbet Canyon and Smoky Hollow members). This stratigraphic interval was deposited during a transgressive-regressive cycle of the Greenhorn Cyclothem in the Cretaceous Western Interior Seaway. Marine macrovertebrates collected from the fully marine Tropic Shale in the past decade in and around Grand Staircase-Escalante National Monument and Glen Canyon National Recreation Area span the Cenomanian-Turonian stage boundary, and include at least six genera of chondrichthyans (*Scapanorhynchus, Squalicorax*, *Cretoxyrhina*, Cretolamna, at least five species of *Ptychodus*, and c.f. *Ptychotrygon*), at least four genera of bony fish (*Xiphactinus*, *Gillicus*, and *Ichthyodectes* and at least one pycnodont), three taxa of turtles (*Desmatochelys*, *Naomichelys*, and one or more protostegid), and five taxa of short-neck plesiosaurs (*Brachauchenius*, *Palmulasaurus*, *Trinacromerum*, *Eopolycotylus*, and c.f. *Dolichorhynchops*). One dinosaur in the fauna, the therizinosaur *Nothronychus graffami*, is a non-marine reptile. Using detailed molluscan biostratigraphy, the Tropic Shale can be precisely correlated with deposits of similar age (Mancos Shale) in Arizona, Colorado, and Utah, and with beds on the eastern side of the seaway (Greenhorn Limestone) in Kansas and South Dakota. The fish and shark component of the Tropic fauna recovered to date resembles faunas of the same age in the Mancos Shale and the Greenhorn Limestone, but the reptilian fauna differs in the high diversity of short-neck plesiosaurs, the lack of elasmosaurs and mosasaurs, and the presence of the therizinosaur. The lack of long-neck plesiosaurs and mosasaurs may be a consequence of ecological differences. The therizinosaur occurrence is probably a case of bloat-and-float transport from land at least 100 km to the west. In contrast with the marine invertebrate fauna, the vertebrates do not appear to have suffered an extinction event at the Cenomanian-Turonian stage boundary between 94.2 and 93.5 million years ago from the globally recognized Oceanic Anoxic Event II.

Technical Session III, Sunday 3:30

SYSTEMATIC POSITION OF THE EOCENE PRIMATE *DARWINIUS MASILLAE*

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Darwinius masillae is a middle Eocene (47 Ma) adapoid primate known from a virtually-complete articulated skeleton. The skeleton came from maar lake deposits of the classic Messel locality in Germany. Fossils at Messel are found by separating laminated oil shale along bedding planes. Separation often develops preferentially through fossils, as in *D. masillae*, which is preserved on two plates, A and B. The holotype, plate A, is in the Naturhistorisk Museum at the University of Oslo in Norway. Mammalian skulls are compressed at Messel, but other bones are commonly preserved in three dimensions. Radiography and CT imaging enables reconstruction and study of bones and teeth buried within the *Darwinius* specimen.To investigate the systematic position of *Darwinius masillae*, we carried out a cladistic analysis using 30 morphological characters published by leading authorities as distinguishing primate Strepsirrhini from Haplorhini. The characters used are textbook characteristics commonly taught in courses on primate evolution, and 'total evidence' in the original aspiration of 'broadly representative and independent.' Strepsirrhini includes Lemuroidea plus Lorisoidea. Haplorhini includes Tarsioidea plus Anthropoidea (comprising Ceboidea, Cercopithecoidea, and Hominoidea). Our objective was to compare the relative merits of two hypotheses: *Darwinius* is a strepsirrhine versus *Darwinius* is a haplorhine. Addition of Tupaioidea as an outgroup, appropriate coding, and exhaustive search of all phylogenetic trees using PAUP yielded two most-parsimonious primate cladograms of 37 steps. These have a high consistency index (0.84) and high retention index (0.90), and differ only in the monophyly or paraphyly of Strepsirrhini. *Darwinius* is grouped unambiguously withwith Anthropoidea within Haplorhiniin both cladograms. The shared-derived characteristics of *Darwinius* supporting this grouping include: (1) short rostrum (with reduced premolars); (2) deep mandibular ramus; (3) partially fused symphysis; (4) spatulate incisors; (5) quadrate lower molars; (6) broad mesocuneiform; and (7) loss of grooming claws. Quadrate lower molars evolved independently in strepsirrhines. With the exception of this homoplasy, there are no derived characteristics shared with strepsirrhines. Consequently, we interpret *Darwinius masillae* as both a crown haplorhine (within the Tarsioidea-Anthropoidea crown clade) and a stem anthropoid (sharing derived characteristics with anthropoids that are not shared with tarsioids).

Poster Session I, (Sunday)

BIOSTRATIGRAPHIC CORRELATION OF A NEW TRIASSIC FOSSIL LOCALITY WITHIN THE GETTYSBURG BASIN, MARYLAND

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The Fulton fossil site lies within the Gettysburg Basin in the Newark Supergroup of Maryland. It comprises red siltstones and black shales and its location within a paleorift basin makes it an important addition to our knowledge of the Triassic history of the Atlantic Coastal Plain. Though this site has produced several vertebrate and invertebrate trace and body fossils, it has yet to be stratigraphically correlated regionally. There are two hypotheses regarding the stratigraphic position of the Fulton Site; that the site represents the New Oxford Formation (a fluvial unit), or that it belongs in the Gettysburg Formation (a lacustrine unit). Its age is also an issue. Correlation of the Fulton Site was assessed using biostratigraphic methods. The siltstones contain trace fossils (*Gwynneddichnium*) that suggest periodic flooding surfaces and mudcracks that show dessication. The shales contain several species of freshwater conchostracans (Crustacea) and fish, which are indicative of a lacustrine environment. Plant (*Pagiophyllum diffusum*) and trace fossils were dated to constrain the age of the site. The site can best be placed as between the Carnian and the Norian (Late Triassic). The lithostratigraphic boundary between the formations lies East (downsection) of the Fulton Site, placing it within the Gettysburg Formation. Having a constrained age and stratigraphic unit for this new locality will allow any future vertebrate fossil discoveries to be interpreted more accurately, giving us a better idea of the environment and fauna of the Triassic in Maryland.

Poster Session III, (Tuesday)

SAMPLING BIAS AND REDUNDANCY IN MAMMALIAN COMMUNITIES: DO THEY AFFECT TO PALAEOENVIRONMENTAL APPROACHES?

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In this work we analyzed the problems associated with the potential loss of species records in mammal palaeocommunities, that could be particularly influential on palaeoecological studies based on community structure. We determined the importance of this influence on two palaeoecological techniques that use the composition of mammalian communities to infer environmental conditions: bioclimatic analysis and cenogram structure. Theoretically, the robustness of both methodologies in palaeoenvironmental studies might be undermined by the assumed loss of recorded species in a fossil site when compared with the original palaeocommunity, due to associated and significant changes in the perceived ecological structure; this might potentially render these methods as non-functional. The analysis was carried out on both methodologies with modern mammalian communities, covering a diverse range of terrestrial biomes. In each community we did a rarefaction analysis by deleting species within random sequences. Our results indicate that it is necessary to remove a high percentage of species (always more than 50% of the species) to attain the occurrence of statistically significant differences in the studied ecological structures of the community, independent of the biome implied. These results, therefore, allow us to conclude that both bioclimatic analysis and study of cenograms are robust methodologies for the assessment of ecological structure in mammalian assemblages from fossil sites, as long as the species loss relative to the original palaeocommunity is not excessively elevated.

Poster Session I, (Sunday)

DIAGENETIC OVERVIEW ON VERTEBRATE FOSSILS FROM THE SANDY CHANNEL OF "LO HUECO" SITE (UPPER CRETACEOUS, SPAIN)

GONZÁLEZ-ACEBRÓN, Laura, Universidad Complutense de Madrid - Instituto de Geología Económica (CSIC), Madrid, Spain; BARROSO-BARCENILLA, Fernando, Universidad de Alcalá de Henares & Universidad Complutense de Madrid, Madrid, Spain; CAMBRA-MOO, Oscar, Universidad Nacional de Educación a Distancia, Madrid, Spain; CARENAS, Beatriz, Universidad de Alcalá de Henares, Madrid, Spain

The "Lo Hueco" vertebrate site was discovered in Cuenca, Spain, in a stratigraphical interval in "Garumn" facies (upper Campanian-lower Maastrichtian) formed by versicolor marly mudstones partially cut by a sandy channel structure and two sulphated intervals. It seems to correspond to a muddy coastal plain with edaphic intervals. This exceptional site has provided more than 8500 macrofossil remains, mainly from titanosaur dinosaurs, but also from fishes, amphibians, turtles, lizards, crocodiles, pterosaurs and other dinosaurs. Here, the diagenetic history of the *a priori* highest destructive deposit of "Lo Hueco" (sandy channel structure) is studied. This structure reaches up to 10 m width and 3 m height and is made up by polymictic sandy conglomerates and breccias, sandstones (sublitoarenites and subarkoses) and sandy mudstones with soft clasts and vegetal and vertebrate remains. These vertebrate remains are constituted by partly calcitized apatite, and the preservation of their internal structures ranges from well preserved (secondary osteons with birrefringence variation between their successive sheets) to totally dissolved tissues (secondary osteons replaced by non-ferroan calcite first and gypsum second). Well-preserved secondary osteons present most of the haversian channels partially covered or totally occluded by ferroan oxide cement (probably hematite). This ferroan oxide cement frequently stains the neighbouring secondary haversian tissue (including surrounding lacunae). The internal parts of haversian channels' lumen is usuallyfilled by a first precipitation of gypsum. An early fracturation process of several vertebrate remains can also be inferred, as numerous *in situ* broken remains are

postdated by ferroan oxide cement and apatite cement. Specifically, the ferroan oxide cement precipitated below and above the apatite cement in palisade (crystals of ~150 µm) and, after these two cement phases, infiltration of sand occurred, suggesting the fracturation and cementation processes are syn-sedimentary and early diagenetic. A second phase of apatite cement in the palisade has also been observed, postdating the sandy infill of the fractures.

Technical Session II, Sunday 11:45

THE PHYLOGENETIC AFFINITIES OF THE ENIGMATIC MAMMAL *DECCANOLESTES* FROM THE LATE CRETACEOUS OF INDIA AND IMPLICATIONS FOR EUTHERIAN MAMMAL EVOLUTION

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India's Cretaceous mammals have received much attention because they include the only undisputed Cretaceous eutherians, such as *Deccanolestes,* from a Gondwanan landmass and because they hail from a period when the Indian subcontinent was isolated from all other continents. *Deccanolestes* has been previously found to have Laurasian affinities, but these analyses were based on the first described, poorly preserved teeth and tarsal elements. Descriptive studies have allied *Deccanolestes* with the adapisoriculid *Afrodon*, known from the Paleocene of Africa and Europe and recently suggested to be a stem euarchontan, a stem primate, or an afrosoricid. A close relationship between *Deccanolestes* and any placental clade is of particular interest because it would represent the first pre-Tertiary fossil record of placental mammals. Extensive fieldwork in India's intertrappean beds has now recovered dozens of better preserved specimens of *Deccanolestes* and other mammals. We report the results of the first phylogenetic analysis to incorporate this new material and test the hypothesis that *Deccanolestes* is a Cretaceous placental mammal. 415 dental, cranial, and postcranial characters, coded for 83 Jurassic to Recent mammalian taxa, including 8 Cretaceous taxa from India, Paleogene euarchontans, Paleogene afrosoricids, and two species of *Afrodon*, were analyzed in TNT. The strict reduced consensus tree from 544 most parsimonious trees shows a strong affinity between *Deccanolestes* and *Afrodon*, supporting hypotheses of dispersal between India and Africa during the early Paleocene, before a subaerial connection between India and Asia existed. However, our results do not support a close affinity between either of these taxa and any crown placental clade, leaving open the sizeable gap in molecular and fossil divergence time estimates for crown placental mammals. In fact, this new data pushes the *Deccanolestes* + *Afrodon* clade into a much more basal position than earlier analyses, suggesting previously unrecognized biogeographic divisions in early eutherian evolution and strengthening reconstructions of arboreality as the ancestral condition for eutherians.

Poster Session II, (Monday)

A NEW AFRICAN RECORD FOR POLYPTERID FISHES, FROM THE LATE OLIGOCENE OF TANZANIA

GOTTFRIED, Michael, Michigan State University, East Lansing, MI, USA; OSTROWSKI, Summer, Michigan State University, East Lansing, MI, USA; ROBERTS, Eric, Southern Utah University, Cedar City, UT, USA; STEVENS, Nancy, Ohio University, Athens, OH, USA; O'CONNOR, Patrick, Ohio University, Athens, OH, USA

Polypterid fishes (Cladistia, Actinopterygii) occupy a critical phylogenetic position in many analyses as the basal-most extant actinopterygians, but the group as a whole has a rather sporadic fossil record that is restricted to Cretaceous and Cenozoic remains from South America and Africa. We report here on newly discovered polypterid material from the upper Oligocene Nsungwe Formation in southwestern Tanzania, which has also produced other fishes (teleosts and lungfish) and an increasingly diverse terrestrial vertebrate fauna. The polypterid material from the Nsungwe mainly consists of small, isolated, ganoin-covered rhombic scales, along with several dorsal pinnules, which would have supported a series of small dorsal finlets, an arrangement unique to cladistians. The scales are smooth to very lightly ornamented on their exposed surfaces. The sensory canal on lateral line scales exits posteriorly via a notch, which is hypothesized to be the primitive character state for polypterids, vs. a pore or series of pores perforating the body of the scale. The best-preserved of the dorsal finlet pinnules is slightly forked distally and symmetrical at its base, as in extant polypterids, and similar to pinnules on *Polypterus faraou*, which was recently described from the Late Miocene of Chad. The new Tanzanian material represents the oldest and southernmost East African record of polypterids. The group is better-known from younger (Mio-Pliocene) faunas further north in the East African Rift System (Kenya and Ethiopia) and from northern Africa (Chad and Libya), and is today represented by ca. 10 extant species in central and west Africa and the Nile basin.

Poster Session II, (Monday)

THE POSTCRANIAL SKELETON OF *ARCTOCYON MUMAK*, THE LARGEST ARCTOCYONID, AND ECOMORPHOLOGICAL DIVERSITY IN PROCREODI

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Procreodi is an order of Paleocene and Eocene mammals thought to lie at the base of the radiation of the paraphyletic "condylarths". Taxa within the order have been linked to the origins of other condylarth groups and of some living orders. Within the order there are specializations indicative of a range of behaviors (arboreality, grooming, digging/rooting), as well as a considerable size range including some of the largest Paleocene mammals. *Arctocyon mumak* is the largest species of the genus *Arctocyon* and the largest known Procreodi (estimated body mass from femoral diameter of 83kg). Several cranio-dental specimens from the Tiffanian of western North America are known, but only one partial skeleton (YPM-PU 18703), preserving parts of the fore- and hind limbs, pelvic and pectoral girdles and some vertebrae, with associated teeth, and other bony elements. The bones were prepared from a number of blocks and are typically fragmentary and somewhat deformed, however key features are preserved. Skeletal elements of *A. mumak* are larger than those of other *Arctocyon* species or *Anacodon*, but are otherwise similar in overall morphology. Certain features of the tarsus, such as the large plantar tubercle on the navicular and the well-developed groove below the sustentaculum tali, are shared between *A. mumak* and *Anacodon* to the exclusion of other *Artcocyon* species and are suggestive of plantigrady. A statistical analysis of seven ecomorphological ratios successfully distinguishes a taxonomically diverse group of 47 extant taxa with differing locomotor specializations. When ratios are calculated for 6 taxa within Procreodi, most values fall within the range of unspecialized terrestrial taxa. However, consistent with previous work, the smaller taxa *Chriacus* and *Thryptacodon* show arboreal features, while *A. mumak* may have been semi-fossorial or generalized terrestrial, somewhat like the modern black bear *Ursus americanus*. This analysis also suggests that certain ecomorphological measures (radial head index) are more successful when dealing with taxonomically broad samples.

Poster Session I, (Sunday)

USING TUSK MICROWEAR TO RECONSTRUCT FEEDING BEHAVIOR IN EXTINCT PROBOSCIDEANS (MAMMALIA)

GREEN, Jeremy, North Carolina Museum of Natural Sciences, Raleigh, NC, USA

Dental microwear patterns are linked with diet in living mammals and can be used as a proxy for feeding ecology in extinct taxa. Among proboscideans, microwear patterns on molars have been used to reconstruct paleodiet, yet the ecological significance of microwear on enlarged, ever-growing incisors (tusks) in proboscideans is unclear. Living elephants routinely use tusks as feeding aids (e.g., bark stripping in *Elephas*, *Loxodonta*) and a similar foraging behavior has been hypothesized for some extinct proboscideans (e.g., *Gomphotherium*). Here, I ask the question: is tusk microwear a reliable indicator of feeding behavior in fossil proboscideans? To address this question, orthodentine microwear variables were analyzed on distal wear facets of tusks in 2 living mammals [*Loxodonta* (n=5), *Odobenus* (n=6)] and 3 extinct proboscideans [*Mammut* (n=3), *Gomphotherium* (n=6), *Cuvieronius* (n=1)]. These data were used to test 2 hypotheses: 1) among living mammals, tusk microwear is significantly different between taxa that use tusks for feeding (*Loxodonta*) versus those that do not (*Odobenus*); 2) tusk microwear in extinct proboscideans is most similar to patterns in extant *Loxodonta*, supporting the use of tusks for procuring food. In support of hypothesis 1, discriminant function analysis revealed that, by having a significantly higher frequency of consistently oriented coarse and hypercoarse scratches, microwear in *Loxodonta* is significantly different from that of *Odobenus*. Among fossil taxa, microwear patterns on all *Mammut* tusks and 3 out of 6 *Gomphotherium* specimens were taphonomically altered and thus excluded. Taphonomically unaltered tusks of *Gomphotherium* and *Cuvieronius* revealed predominately fine and coarse scratches oriented in a consistent direction, supporting hypothesis 2. In addition, differences in the frequency of gouges and number of scratches between these taxa and *Loxodonta* suggest that different tusk-feeding strategies were used in extinct proboscideans. This study supports the utility of tusk microwear as a proxy for feeding behavior in the Proboscidea and broadens the range of paleoecological questions that can be addressed using dental microwear analysis.

Technical Session XV, Wednesday 9:00

COMMUNITY STRUCTURE OF THE MISSISSIPPIAN BEAR GULCH BAY FISHES

GREENFEST-ALLEN, Emily, University of Pennsylvania, Philadelphia , PA, USA; LUND, Richard, Carnegie Museum of Natural History, Mount Holly, NJ, USA; GROGAN, Eileen, Saint Joseph's University, Philadelphia, PA, USA

The paleobiogeographic context of the small, tropical marine bay preserved in the Late Mississippian Bear Gulch Limestone lens strongly resembles that of the modern African Rift Valley lake system. This diverse and highly productive ecosystem was quickly isolated by tectonic processes after formation; thus, some of its diversity likely arose from localized speciation. Analysis of Bear Gulch fish biodiversity reveals significant associations between local fish assemblages and resource exploitation, an observation on par with modern diversity studies, which highlight habitat partitioning as a major factor influencing speciation in island and rift radiations. Here we investigate the likely role this process may have played in the evolution of the Bear Gulch fish fauna by identifying ecological communities that reflect resource utilization and related factors that affect ecosystem stability. To detect communities, a correlation-network was generated from profiles of taxon abundance across the bay. Network structure was analyzed using community detection algorithms, revealing five well-supported communities. Each community is an association of chondrichthyan and osteichthyan taxa that share a unique pattern of occurrence across the bay. Some of these communities have overlapping and others opposing abundance profiles, possibly indicative of competitive control on taxon distributions. To assess potential ecological controls on these

associations, genera were coded for a set of functional characters, falling into 5 broad categories encompassing body form, fin and jaw morphology, and lifestyle. Coded genera were clustered and assigned to 14 nominal ecological guilds. The relative abundance of each guild was determined for each community. No one community was dominated by any single guild; instead each is an unique association of guilds. This likely reflects the availability of particular habitats in the bay, as not all guilds are present in all communities.

Poster Session II, (Monday)

THE OLDEST APTERODONTINAE (HYAENODONTIDAE, "CREODONTA") FROM THE MIDDLE EOCENE OF DOR EL TALHA (LIBYA)

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After the Fayum record of Egypt, the late middle Eocene Dor El Talha escarpment (Central Libya) has provided one of the richest Paleogene faunas of North Africa. Currently, six orders of placental mammals, including primates, have been found in this outcrop. Here, we present the results of the first study of hyaenodontid ("Creodonta") remains: dental and postcranial specimens discovered in 2007 and 2009 (Franco-Libyan cooperative program between University of Poitiers and University of El Fateh in Tripoli) and the historical material collected by Savage in 1965 and stored at the NHM (London). The oldest members of Apterodontinae are identified. Apterodontines were hitherto recorded in the late Eocene and Oligocene of Europe (France, Germany) and Africa (Egypt, Kenya). The best preserved Libyan material is a subcomplete mandible and maxilla with several associated postcranial elements. It is morphologically close to the late Eocene *Apterodon macrognathus*, recovered in the lower part of the Jebel Qatrani Formation (Fayum). Its teeth resemble those of the Egyptian species notably in its tubercular morphology and the bearing of a M2 metacone and a prominent parastyle of M3 on its maxilla. Postcranial elements, in particular the distal humerus, the proximal ulna and the tarsal bones indicate an ability to supinate, which excludes a cursorial locomotor type. In a first approach, the bulbous morphology of the teeth perhaps reflects an omnivorous or durophagous diet. Phylogenetic relationships of the Apterodontinae within the Hyaenodontidae have been poorly discussed. However, we note that dental features as the lack of the metaconid and the presence of a talonid on lower molars can make it close to some African and Eurasian hyainailourines.

Evolution of the Modern African Fauna, Wednesday 9:45

CENOZOIC AFRICAN BAT COMMUNITIES

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The African bat fossil record is very poor. Except for one enigmatic record from the middle Eocene of Tanzania, all pre-Miocene African bats come from North Africa and the Arabian Peninsula. All of these North Africa forms represent extinct genera except for one record of *Hipposideros* from Oman, however, some genera do represent extant families including Emballonuridae, Rhinopomatidae, Megadermatidae, Nycteridae, and Vespertilionidae. Other than isolated records from Morocco and Libya, all African Miocene bats come from East Africa and all are known from post-Aquitanian sediments (younger than 20 million years ago). All (except *Scotophilisis* from Gebel Zelten) represent modern bat families and of the 11 genera identified 73% (8) represent living forms. By the Pliocene, faunal samples begin to become available throughout Africa resulting in documentation of a wider geographic range of fossil bats. Recent study of Plio-Pleistocene large mammal biogeography indicates that North African assemblages are more similar to those of East Africa than they are to either Europe or South Africa. Initial comparison of Late Pliocene bat samples from Europe and Africa suggest that similar faunal associations do not hold for bats. Late Pliocene European and North and South African bat assemblages are all very similar being dominated by vesper bats (*Myotis* and *Miniopterus*) and *Rhinolophus*. East African Pliocene bat samples lack vesper bats and are mostly dominated by *Hipposideros* and emballonurids. However, sample sizes from East and South Africa are not especially good limiting the interpretation of these results. Additionally, all of the taxa shared in common between Europe, North Africa and South Africa are cave roosting forms and many of the fossil samples are derived from karst deposits and cave breccias. The East African taxa tend to prefer roosting in trees and hollow logs and most of the fossil material is derived from lake and over-bank floodplain deposits. The differences between East African and other African Pliocene bat samples may represent real differential distribution patterns but may also be the result of different habitat sampling as well.

Poster Session III, (Tuesday)

DIVERSITY BIASES OF THE PUBLISHED RECORD OF FOSSILS AT NINE MIOCENE MAMMALIAN FAUNAS OF NEVADA AND OREGON

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Most paleodiversity studies examine the species richness of a geographic area through time. Often this research is based only on the published literature, not accounting for additional, unpublished museum specimens. Unfortunately, publication of specimens is usually not intended to produce a record reflecting the ecological structure of the fauna. This bias is based on publishing only exceptional fossils, publication constraints, and by not reporting duplicate specimens. This reliance on published specimens introduces a potential problem because the published accounts are often more taxonomically even than the museum collections from the same area. To quantify this bias, we compared ecological parameters calculated using published and museum data from nine Miocene Great Basin mammalian faunas: the Stewart Springs fauna (early Barstovian), the Tonopah fauna (early Barstovian), the Tedford Pocket fauna (early Barstovian), the Quartz Basin fauna (late Barstovian), the Chalk Springs fauna (Clarendonian), the Fish Lake Valley fauna (middle Clarendonian), the Brady Pocket fauna (late Clarendonian), the Otis Basin fauna (late early Hemphillian), and the Little Valley fauna (early late Hemphillian). We rarified specimen data using the minimum number of individuals to compare published and museum data within these nine faunas. The museum data from eight of the nine faunas show a barely significant difference from the published data, but the Stewart Springs fauna shows a strong significance, with published data higher than museum. This anomalous result arises because of the unique publication history of the site: some of the taxa listed for the site were published without voucher specimens and none can be located today in the collections. Our results allow the construction of rules of thumb for including published data in paleodiversity studies, the first of which is that voucher specimens from the collections are necessary for substantiating the data.

Physical Drivers and Marine Tetrapod Evolution, Monday 11:15

MODERN ODONTOCETE EVOLUTION: MORPHOMETRIC DISCRIMINATION OF THE ACOUSTIC SYSTEM REVEALS ECOLOGICAL PARTITIONING BETWEEN RIVERINE AND MARINE TAXA SINCE THE MIOCENE

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The biogeography of living odontocetes is strongly shaped by divisions between marine and fluvial environments. For example, multiple odontocete lineages have independently colonized different freshwater river systems around the world, likely during episodic high eustatic sea-levels that flooded freshwater basins (e.g., Amazonia). Intriguingly, the freshwater descendents of ancestral marine odontocetes display convergent morphological specializations. Cranial modifications, especially for the auditory systems, have functional correlates with peak echolocation frequencies, ranging from high (most delphinids) to very high ('river dolphins' and phocoenids). Different acoustic properties in riverine (shallow, dark) and marine (clear) environment could plausibly drive such differences. To test this hypothesis, we developed a set of bony facial and auditory measurements from extant taxa that correlate with known overlying facial soft anatomy. We evaluated a dataset of 14 periotic and 17 skull measurements (divided by a size estimator to avoid size effect) with a taxonomic sample of extant and extinct Inioidea (specimens, n=26), Lipotoidea (n=1), Platanistoidea (n=5) and Delphinoidea (n=41). To test for environmental correlates, data were pre-classified by groups (river/marine) that showed a significantly high percentage of correct classifications for discriminant analysis (<95%) in both data sets. We also tested the classification of geological ages groupings (Miocene-Pliocene to Recent), which showed 91% correct classifications on skull and 80% on periotics. In the facial region (functionally related to sound emission), the length of insertion of the nasal plug muscle and premaxillary sacs explain the largest amount of variation in the dataset; for sound reception, the best measurements were the external length and height of the pars cochlearis, and the size of malleus fossa and aqueductus. The robust results on river versus marine classifications in fossil and extant odontocetes suggests that connection between the auditory and facial morphology can discriminate between marine or freshwater ecomorphologies, which have evolved independently in modern odontocetes.

Poster Session I, (Sunday)

10,000 MILES: MAXIMUM RANGE AND SOARING EFFICIENCY OF AZHDARCHID PTEROSAURS

HABIB, Michael, Chatham University, Pittsburgh, PA, USA

Azhdarchid pterosaurs include the largest known flying animals, with the largest species reaching a potential mass of over 250 kg. Prior work suggests that several features of azhdarchid anatomy could be associated with a soaring-dominated lifestyle, including large size, burst-flapping adapted pectoral girdle and proximal forelimb, moderate to high wing aspect ratio, and exceptional pneumaticity. However, long-range flight ability of azhdarchid pterosaurs has not been quantified in the literature. I present the results from a quantitative analysis of long-distance travel efficiency in azhdarchid pterosaurs. Power analysis indicates that the largest pterosaurs needed to reach external sources of lift, following launch, before they exhausted anaerobic muscle endurance. The efficiency of the initial climb out from launch would have impacted required proximity to lift sources. Approximately 2.5 chord lengths are usually required before a wing develops full steady state circulation (known in the literature as the "Wagner Effect"). Analysis of the tensile support in azdarchid wings suggests a potential for rapid translation and twisting of the outboard wing, which would be promoted by the T-shaped cross section of the wing phalanges. Such rapid translation can develop full circulation up to five times faster than otherwise possible and greatly reduce the flapping cycles needed to reach maximum circulation during climb out. Following climb out,

even large azhdarchids should have been capable of staying aloft by using external sources of lift. A quantitative framework already exists for estimating maximum migration range in soaring birds using thermal lift. I have extended this framework to pterosaurs by altering existing models to accommodate the membrane wings of pterosaurs and uncertainty in potential muscle physiologies. Maximum fuel capacity (stored as fat and additional muscle) was estimated by taking the difference between body masses scaled from skeletal strength (maximum) versus mass for maximum wing efficiency. This new migration model indicates that the largest azhdarchid pterosaurs had the capacity for non-stop flights exceeding 10,000 miles.

Technical Session XIII, Tuesday 3:30

PANMIXIA, PLASTICITY AND PLACE: INSIGHTS INTO PERSISTENCE OF THE NORTHERN FUR SEAL (*CALLORHINUS URSINUS*)

HADLY, Elizabeth, Stanford University, Stanford, CA, USA; PINSKY, Malin, Stanford University, Stanford, CA, USA

Why do some species go extinct and others survive? The question is surprisingly difficult to answer, in part because species' fates are decided over timescales longer than most scientific studies. Traits including body size, range size, and growth rate have been proposed as correlates of extinction risk, but we know little about the long-term processes involved.

We used serial coalescent simulations to analyze ancient and modern DNA and demonstrated that both exceptionally high migration rates and the maintenance of Arctic refugia provided resilience to the northern fur seal (*Callorhinus ursinus*). These traits allowed the species to maintain high levels of genetic diversity even through intensive harvesting by humans. Recently the species has recolonized part of its former range, despite facing threats similar to other similar marine mammals that have population genetic signatures of recent bottlenecks (e.g., the northern elephant seal). Our results also suggest that behavioral differences previously discovered in ancient populations of *C. ursinus* (longer weaning periods) result from phenotypic plasticity rather than local adaptation, providing further survival strategies for the species, and yielding insights about potentially important attributes of other threatened species.

Our evidence is derived from comparisons among 42 ancient genetic samples (100 to 2000 years before present in Alaska, Washington, Oregon, and California) and 365 modern genetic samples (representing all major eastern Pacific rookeries). The detailed paleontological record available for the northern fur seal provided a unique opportunity in facilitating an unprecedented look at genetic diversity of a species *both* within populations and between populations through time. We conclude that general species traits (panmixia, behavioral plasticity and a secure refuge) can provide long-term resilience to overexploitation, climate change, and other major stressors. This knowledge will help to predict future ecosystem changes, and helps to identify species that are most likely to benefit from management interventions such as assisted migration.

Poster Session IV, (Wednesday)

AMOUNT OF MORPHOLOGICAL VARIATION IN LIMB ELEMENTS FROM SELECT EXTANT AND EXTINCT QUADRUPEDS

HAIAR WILBORN, Brooke, Lynchburg Collge, Lynchburg, VA, USA

Reconstruction of dinosaur fossils is often based on incomplete skeletons. One assumption that goes into the reconstruction of extinct fossilized taxa is that the left and right side of an animal are identical, with the side of the fossil that has been found being reproduced as the opposite element. However, various influences in life can affect the supposed symmetry between sides, including damage due to breakage and repair, "handedness", and malformation due to disease. Some of these influences are visible to the naked eye, like malformation. However, if "handedness" or various types of disease or breakage occur, the differences between right and left may not be easily identifiable.A study of modern quadruped forearms provides a baseline for the amount of variation that can be found in a representative taxon. The modern taxon used for this study was the white-tailed deer, *Odocoileus virginianus*. The whole shape differences in an individual's ulnae and humeri were measured quantitatively and visually using Procrustes and thin plate spline analysis techniques. The individual data were then combined from all specimens to show the overall amount of shape variation that could be expected within a species.The same study was completed using the ulnae and humeri from *Stegosaurus* forearms as a comparison to the variation found in the extant group. Left and right elements were compared in individuals with complete forearms, and the shape difference documented. The complete dataset was then studied to show the amount of shape variation present within the genus. Since the forearms of the different species of *Stegosaurus* are not diagnostic, comparisons of forearm shape can be completed at the generic level.The wide range of shape variation seen within the *Stegosaurus* specimens could be due to various sources. As discussed above, situations in an animal's lifetime including disease, injury and healing, and "handedness", could cause some of the wide variation. Another source of morphological variation that is unique to fossilized animals is the deformation that can happen to a carcass in the various stages of biostratonimy and diagensis.

Poster Session I, (Sunday)

LATERAL AND TEMPORAL DISTRIBUTION OF MAMMALIAN FAUNA FROM EARLY PLEISTOCENE KOOBI FORA FORMATION, EAST TURKANA

HAKALA, Sarah, University of Georgia, Athens, GA, USA; BOBE, Rene, University of Georgia, Athens, GA, USA

The Koobi Fora Formation in East Turkana, Kenya, yields a diverse faunal record with over 90 species of larger mammals. Representing nearly 4 Myr of East African deposits, mammalian taxa from this location provide evidence for paleoenvironmental reconstructions during times when hominin species were evolving and diversifying throughout the Turkana Basin. The Upper Burgi, KBS, and Okote are members within the latter half of the Koobi Fora deposits, spanning a timeframe from 2.0 Ma to 1.39 Ma, with a total thickness of 278 m. This study provides data for the distribution of select mammalian taxa within these members. The Turkana Paleontology Database, which contains a record of over 11,000 specimens from the Koobi Fora Formation, is used to analyze temporal differences in faunal proportions as well as lateral distributions across the Ileret, Karari Ridge, and Koobi Fora Ridge subregions. Comparisons include ordinal level (Carnivora and Primates), family level (Cercopithecidae, Bovidae, Suidae, Equidae, Rhinocerotidae, Deinotheriidae, and Giraffidae), and tribal level (8 bovid tribes) analyses. Tests of significance and ordination are presented. Results show that Carnivora and Primates maintained relatively stable proportions temporally and laterally. Within the family level analysis, Bovidae remained the highest percentage throughout all 3 members and regions with Suidae having a high predominance as well. Cercopithecidae had a high percentage in the Ileret, Karari Ridge, and Upper Burgi Member and a marked increase in the Okote Member. However, Cercopithecidae also shows fluctuation with decreased percentages in the Koobi Fora Ridge and the KBS Member, although this could result from high exposure of the KBS member in the Koobi Fora Ridge subregion. Reduncini, Tragelaphini, and Alcelaphini had consistently the highest occupation of tribes across time and space. These results suggest a certain amount of stability to the environment.

Poster Session III, (Tuesday)

FORELIMB MORPHOLOGY AND LOCOMOTOR PROFILE OF *PROTOPITHECUS* AND *CAIPORA*, THE "GIANT" PLEISTOCENE NEW WORLD MONKEYS

HALENAR, Lauren, City University of New York, New York, NY, USA

The locomotor profile of the subfossil platyrrhines *Protopithecus* and *Caipora* was originally reconstructed as the type of suspensory behavior practiced by spider monkeys. It was later suggested that the two large-bodied taxa could have been the only terrestrial New World monkeys. No detailed description of the fossil morphology was used to draw this conclusion, nor does this information exist in the literature, despite the fact that these genera are represented by nearly complete skeletons. Filling this gap begins here, with a description of the forelimb. Neither of the fossils exhibits any of the classic features of terrestrial primates, such as a retroflexed medial epicondyle, a posteriorly directed olecranon process, or short straight phalanges. On the other hand, neither has a reduced thumb, an adaptation to extreme suspensory behavior, as seen in *Ateles*. There are also differences between the two fossils that suggest lumping them into a single locomotor category is an oversimplification of their positional behavior. These qualitative observations are confirmed by 3D geometric morphometric analyses of the distal humerus and proximal ulna. The fossils have an elbow morphology that is broadly similar to the extant atelines; however, there is no reason to assume that they would not have used the ground facultatively as many of their relatives do. The intermembral indices of *Protopithecus* and *Caipora* are in the range of spider monkeys, but as limb proportions are affected by body size this datum cannot be used in isolation; they are also in the range of *Pan*, a genus with a broad locomotor repertoire that goes beyond the suspensory adaptations seen in their upper body. The fossils also have relatively low brachial indices meaning their forearms are not greatly elongated as in suspensory, and terrestrial, taxa. These limb proportions, combined with robust long-bones and a baboon-like estimated body size of 20-25 kg, suggest mixed arboterrestrial substrate use, perhaps resembling a chimpanzee or gorilla. The postcranial skeleton of *Protopithecus* and *Caipora* seems to be adapted for a broader range of locomotor styles than originally assumed.

Poster Session III, (Tuesday)

TAPHONOMY OF A NEW SPECIMEN OF *TYRANNOSAURUS REX* FROM THE HELL CREEK FORMATION, MONTANA

HALL, Lee, Museum of the Rockies, Bozeman, MT, USA; KEENAN, Sarah, Louisiana State University, Baton Rouge, LA, USA

Despite the description of nearly 50 specimens of *Tyrannosaurus rex* since its discovery in 1902, stratigraphic and taphonomic information for this taxon remains sparse. Here we report a taphonomic study related to the excavation of a partial (~10% complete) *T. rex* skeleton (MOR 2925) from the Late Cretaceous (Maastrichtian) Hell Creek Formation, Garfield County, Montana. MOR 2925 represents a middle Hell Creek site, approximately ~50 m below the contact with the Fort Union Formation, and consists of disarticulated postcranial elements (n=29) from a single individual. The bone-bearing layer occurred at the base of a ~2 m dark purple organic-rich mudstone that graded into an overlying light grey to green mudstone. Underlying and grading into the bone-layer was a dark grey, blocky mudstone. Isolated fine-grained sandstone lenses (14 cm thick), well-developed rhyzoliths, and plant fragments up to 10 cm in length within the bone-bearing unit indicated a pedogenically modified floodplain environment. Elements were distributed within a single horizon

that extended ~15 m laterally from the quarry. Vertebrae (n=8), including an atlas, and ribs (n=7) dominated the assemblage. Pubis and rib fragments (n=7) were aligned parallel to their dispersal direction, which trended approximately east to southeast. Weathering and abrasion were minimal, and scavenging was not evident, which suggests limited subaerial exposure or fluvial transport following deposition. Associated microfossils include a single shed theropod tooth, fig seeds, and unidentifiable plant fragments. Description of bone modification, associated micro- or macrofossils, lithology, and stratigraphic position of isolated sites places them into a broader paleoenvironmental setting, which aids in paleobiological interpretations. Without these observations, fossils lack a significant amount of their scientific value, and scientists lose the opportunity to test important evolutionary and ecological hypotheses.

Poster Session I, (Sunday)

A NEW GENUS OF PTYCHODONTID SHARK FROM THE ALBIAN OF TEXAS AND ITS PHYLOGENETIC PLACEMENT WITHIN PTYCHDONTIDAE

HAMM, Shawn, none, Forney, TX, USA

The Ptychodontidae (Cretaceous) is proposed to consist of four genera, *Hylaeobatis problematica* from the Barremian of Europe, *Heteroptychodus steinmanni* from the Aptian to Middle Albian in southeastern Asia, a new genus and species from from the Middle Albian of Texas, and *Ptychodus,* a taxon having nearly worldwide distribution from the Cenomanian through Early Campanian. *Hylaeobatis*, *Heteroptychodus,* and the new genus are considered to be successive basal sister taxa to *Ptychodus* as they possess characters intermediate between the hybodont family Lonchidiidae and *Ptychodus*. Each genus is widely separated geographically and stratigraphically, endemic in distribution, and independently derived a durophagus dentition in the marine realm. Based on stratigraphic occurrence, morphological trends within the Ptychodontidae show continuous specialization in tooth crown morphology. Phylogenetic analysis of the dental characteristics of each member of the family indicates that the new genus is the most recent ancestor of *Ptychodus*.

Poster Session III, (Tuesday)

3D ANALYSIS OF PRIMATE HINDLIMB JOINTS: RECONSTRUCTING POSITIONAL ABILITIES IN EXTINCT PRIMATES

HAMMOND, Ashley, Pathology and Anatomical Sciences, University of Missouri Medical School, Columbia, MO, USA; KOSCIELNIAK, Nikolas, Pathology and Anatomical Sciences, University of Missouri Medical School, Columbia, MO, USA; PLAVCAN, J. Michael, Department of Anthropology, University of Arkansas, Fayetteville, AR, USA; WARD, Carol, Pathology and Anatomical Sciences, University of Missouri Medical School, Columbia, MO, USA

Positional behaviors vary considerably in extant catarrhine primates. Being able to accurately reconstruct locomotor adaptations in extinct taxa is key for interpreting the evolution of this diversity. An important component of locomotor behavior is hip abduction potential, as this affects mobility in arboreal environments. It remains unclear, however, how femoral and acetabular form interact to contribute to the position of the knee in 3D space. Features of the acetabulum, such as depth and acetabular fossa size, have been suggested to limit femoral head mobility but have not been fully assessed. This study uses surface-based 3D methods to quantify femoral and acetabular dimensions, as well as congruence between the joint surfaces. We sample continuous laser scan data from extant species with distinct locomotor specializations, using 3D angular, linear, and surface area measures generated using PolyWorks and Rapidform software. We use these data to test hypotheses about hip mobility and positional behavior in extant taxa, and to reconstruct hip joint function in a series of fossil cercopithecids and hominoids. An expansive acetabular fossa should allow more positions of the femoral head within the acetabulum but our data show that the acetabular fossa is not differentially greater in suspensory species than more terrestrial ones. Larger species appear to trade off certain mobility-enhancing features of the hip in lieu of articular loading surface. When compared to other suspensory apes and monkeys, African apes in particular have small acetabular fossae and deep acetabulae, and a high degree of congruence between hip joint articular surfaces. Acetabular form appears to have less of an influence on hip mobility than femoral dimensions. Instead, the range of possible knee postures during locomotion appears to be more strongly influenced by femoral neck and shaft lengths, neck-shaft and bicondylar angles, greater trochanter dimensions, position of ligamentum teres insertion on the femoral head, and acetabular orientation. The fossils examined display unique combinations of morphologies that suggest variation in locomotor behaviors and abilities.

Poster Session IV, (Wednesday)

NEOGENE SUIDAE OF THAILAND AND THEIR BIOSTRATIGRAPHY

HANTA, Rattanaphorn, Northeastern Research Institute of Petrified Wood and Mineral Resources, Nakhon Ratchasima, Thailand; KUNIMATSU, Yutaka, Primate Research Institute, Aichi, Japan; JINTASAKUL, Pratueng, Research Institute of Petrified Wood and Mineral Resources, Nakhon Ratchasima, Thailand

Suid fossils have been reported from Neogene basins, Ban San Klang (BSK) in Pong basin, Had Pu Dai (HPD) near Kho Kha, Na Sai basin, and Chiang Muan basin. At BSK, a partial mandible with P^4-M^3 of a tetracodontine was described astheholotype of *Conohyus thailandicus*. At HPD, a suid was originally described as *Hyotherium*, but later changed to *C. thailandicus*. It suggests the areas are Middle Miocene in age, not late Early Miocene. The suid discovered from Na Sai basin is *C. thailandicus*, suggestinga similar ageto BSK. In Chiang Muan, there are *C. sindiensis* and *Parachleuastochoerus sinensis* from the lower coal seam, and *Hippopotamodon* cf. *hyotherioides* from the upper coal seam. However, no additional specimen of *Conohyus* was found, except a single third lower molar which issimilar in size and morphology to *P. sinensis*. Therefore, the presence of *Conohyus sindiensis* is in doubt. A hyotheriine was first recognized in the area and is the first knownfrom SE Asia. Based on a magnetostratigraphic study, Chiang Muan ranges between 13 to 9.8 Ma. Thus, the lower coal seam is Middle Miocene and the upper coal seamis early Late Miocene. Two more localities, Wang Nua and Soem Ngam yielded suid fossils. In Wang Nua, the teeth of *Conohyus* were found and suggest uppermost Middle Miocene to basal Late Miocene. In Soem Ngam, a slightly larger *H.* cf. *hyotherioides* than that of Chiang Muan was discovered suggesting it is approximately thesame ageas Chiang Muan. The occurrence of Thai suids suggests two periods of interchange. The presence of *Conohyus* indicates an interchange with those in Myanmar and possibly extended to Indo-Pakistan region during middle Miocene. Later, in the late Miocene it seemingly colonized southern China with the presence of *P. sinensis* and *H.* cf. *hyotherioides*. Moreover, in NE Thailand, at least three taxa of suid were found in Nakhon Ratchasima. Thereis one tetraconodontine, *Tetraconodon*, one suine, *Hippopotamodon*, and indeterminate species. It is the first *Tetraconodon* known in Thailand, seemingly closely related to the Myanmar species. Unfortunately, the fossils from Tha Chang are from an unknown stratigraphic horizon, therefore, making correlationwith other areas difficult.

Poster Session I, (Sunday)

NEW SPECIMEN OF THE TERRESTRIAL REPTILE *MACROCNEMUS* FROM THE LATEST LADINIAN XINGYI-FUYUAN MARINE REPTILE LEVEL, SOUTHWESTERN CHINA

HAO, Wei-cheng, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-yong, Department of Geology and Geological Museum, Peking University, Beijing, China; RIEPPEL, Olivier, Department of Geology, The Field Museum, Chicago, IL, USA; MOTANI, Ryosuke, Department of Geology, University of California, Davis, CA, USA; TINTORI, Andrea, Dipartimento di Scienze della Terra, Università degli Studi di Milano, Milano, Italy

The strange European terrestrial prolacertid reptile *Macrocnemus bassanii* is known from the Besano Formation (Grenzbitumenzone, Anisian-Ladinian boundary, Middle Triassic) of Monte San Giorgio of Switzerland and Italy. *Macrocnemus fuyuanensis,* which is about 7 million years younger than the European taxon, was described from the latest Ladinian Xingyi-Fuyuan *Keichousaurus* Fauna in southwestern China, where abundant marine reptile fossils have been found in four layers in a 15 km wide region.

A new well preserved specimen of *Macrocnemus* was collected from the lowest fossil-bearing layer of a 40 cm thick grayish-black, platy marly limestone with abundant *Keichousaurus* specimens. It is from the same locality as *M. fuyuanensis* and almost of the same body size. The skull is complete with a large orbit and narrow postorbital region: the external naris is narrow and long. Its lower jaw is 90 mm long with a narrow mandibular fossa of 16 mm length. There are eight cervical vertebrae: the first two are much shorter, with lengths of 9 mm and 12 mm respectively, while the fourth and fifth are the longest, with lengths of 28 mm. The dorsal vertebral count is 17 and there are two sacrals. These measurements almost match those of *M. fuyuanensis* and *M. bassanii.* The exception is that its tibia is 85 mm long but the femur 83 mm, differing from the original description of M. fuyuanensis whose diagnostic character is a relatively shorter tibia. At this point, the new specimen is closer to *M. bassanii.* The only difference observed currently in the postcranial skeleton is the number of dorsal vertebrae, with the new specimen and *M. fuyuanensis* possessing 17, but *M. bassanii* with only 16. Other possible differences include the longer anterior extension of the scapula of the new specimen, and possibly nine cervical vertebrae. A closer study of this new specimen will test if Macrocnemus fuyuanensis can be distinguished from *M. bassanii.*

The presence of Macrocnemus together with Tanystropheus and several genera of small fishes in the latest Ladinian Xingyi-Fuyuan Fauna further strengthen its migration-evolution from Monte San Giorgio of the Western Tethys.

Poster Session I, (Sunday)

POSTCRANIAL ANATOMY OF *OPHIACODON NAVAJOVICUS* (EUPELYCOSAURIA: OPHIACODONTIDAE), FROM THE UPPER PENNSYLVANIAN OF CANYON DEL COBRE, NEW MEXICO

HARRIS, Susan, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; SPIELMANN, Justin, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

The most complete postcranial skeleton known of the Late Pennsylvanian pelycosaurian-grade synapsid *Ophiacodon navajovicus* is from the Upper Pennsylvanian interval of the El Cobre Canyon Formation (Cutler Group) at Cañon del Cobre, Rio Arriba County, New Mexico. The skeleton was preserved in brownish-red mudstone with blue concretions located approximately 80 m below the contact of the El Cobre Canyon Formation and the overlying Arroyo del Agua Formation. Cranial elements are represented by fragments of the right maxilla and dentary. The postcranial elements include vertebrae representative of all regions of the vertebral column, a nearly complete pelvis, a complete right femur and portions of other limb bones, as well as bones of the right pes. The completeness of the skeleton contrasts with most other collections of *O. navajovicus*, which consist of isolated elements. *Ophiacodon navajovicus* differs from all other known species of *Ophiacodon* in the retention

of the following primitive characters: ventral ridge of the postaxial presacral centra are flat with well-defined longitudinal borders, adductor ridge of the femur is weakly developed and positioned mid-ventrally along the shaft, and the neck of the astragalus is almost half of the proximodistal height of the element. The unique morphology of the ventral surface of the centrum in *O. navajovicus* is potentially advantageous in the identification of isolated postaxialcervical and dorsalcentra when present in combination with the typical ophiacodontid wing-shaped transverse process, in which a web of bone extends from the diapophyses to the parapophysis and the centrum has a wedge-shaped cross-sectional outline. Therefore, *O. navajovicus* can be considered of potential use in Late Pennsylvanian tetrapod biostratigraphy. As currently understood, the stratigraphic distribution of *O. navajovicus* in New Mexico, Utah and Colorado indicate that *O. navajovicus* characterizes the Cobrean land-vertebrate faunachron (lvf).

Evolution of the Modern African Fauna, Wednesday 12:00

NEW ESTIMATES OF HOMINOID TAXONOMIC DIVERSITY IN AFRICA DURING THE NEOGENE AND ITS IMPLICATIONS FOR UNDERSTANDING CATARRHINE COMMUNITY STRUCTURE

HARRISON, Terry, New York University, New York, NY, USA

Extant non-human hominoids from Africa are restricted to a few specialized and relictual species (two species of *Pan* and one species of *Gorilla*), which represent the terminal taxa of a much more diverse community of apes that lived in Africa during the Miocene. It has been suggested that the marked decline in the taxonomic diversity of hominoids and ape-like stem catarrhines occurred as a direct consequence of increased competition from cercopithecoids, which first appear during the early Miocene. However, this perceived relationship appears to be based on inadequate sampling of the fossil record, especially from the later part of the Miocene. The diversity of fossil catarrhine species through time is directly correlated with the number of fossil localities being sampled, so it is possible to infer that the hominoid diversity during the poorly sampled later Miocene is likely to be an underestimation. Nevertheless, the greatly improved fossil record from Africa in recent years confirms that the reduced diversity of hominoids during the later Miocene was not as dramatic as previously reported, and that the decline was not tied to an increase in cercopithecoid diversity. Hominoid and stem catarrhine diversity remained relatively high throughout most of the Miocene, and this continued into the Pliocene with the diversification of the early hominins. Cercopithecoids, by contrast, maintained a low taxonomic diversity throughout much of the Miocene, but the number of species began to increase during the late Miocene, and they reached their greatest diversity during the Plio-Pleistocene. Changes in relative diversity of catarrhines during the Miocene are unlikely to be explained as a consequence of direct competition between cercopithecoids and hominoids. Rather, it appears that several major climatic and ecological changes during the Neogene led to important restructuring (both taxonomically and adaptively) of the catarrhine communities, and that these environmental factors impacted differentially on cercopithecoid and hominoid diversity.

Poster Session II, (Monday)

BENEFITS, CHALLENGES AND SOLUTIONS OF COLLECTIONS AT SMALL PROGRAMS AND INSTITUTIONS USING EXPERIENCE FROM THE UNIVERSITY OF NORTH DAKOTA

HARTMAN, Joseph, University of North Dakota, Grand Forks, ND, USA; WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA; SCHUMAKER, Karew, University of North Dakota, Grand Forks, ND, USA

Universities and institutions of smaller size face unique fossil collection management challenges due to their size. Despite scale issues, such facilities maintain significant regional collections of value to scientific research that may go overlooked. The collection facilities at the University of North Dakota (UND) are an example. UND has a relatively small paleontology program with strong regional collections. Similar to other small programs with a common interest in paleontology and related public education, UND has received little state support. UND collections have a limited computerized specimen and locality database. Even though the program at UND is small, there are a number of benefits that result from this. These benefits include an emphasis on regional fossils, with many population size samples, numerous collections for small-scale undergraduate research projects, fossils that serve as a local attraction for school groups, and ease of access for visiting scientists. The challenges related to the small size are primarily related to monetary support. A full time curator/collections manager position is not possible, so the responsibility falls upon the paleontology professor. UND has dealt with this challenge by involving students in the conservation and curation process which not only helps to maintain the collections, but provides students with collection management experience. Designated space for collections may also be limited in small programs. UND has taken advantage of available space although it is spread out through various classrooms, store rooms, and laboratories. Small programs may also have limited access to analytical equipment. Such needs have facilitated numerous collaborations within and outside of UND. Work solutions can be created for almost any challenge associated with a small collection, but the overall benefits of having regional collections outweigh challenges as they stimulate scientific inquiry for professionals, students, and the public. Increased awareness and access of regional collections would show officials at state and local levels that continued support is vital for education and scientific progress.

Poster Session II, (Monday)

A REEVALUATION OF THE FOSSIL JACKALS OF THE STERKFONTEIN VALLEY, SOUTH AFRICA

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Though jackal fossils are found throughout the hominin bearing sites in the United Nations "Cradle of Human Kind" World Heritage Site (Sterkfontein Valley, Gauteng, South Africa), little attention has been paid to their systematic attribution. Several names (e.g., *Canis antiquus* and *C. brevirostris*) have been erected to account for some of the morphological variation exhibited within the sample, but the vast majority of the fossils from the sites are attributed to *C. cf. mesomelas*. In this study, we qualitatively and quantitatively compare all of the jackal-sized canid fossils that are represented by craniodental remains to a large sample of modern canids including 121 modern jackals from all three species (*C. adustus*, *C. aureus* and *C. mesomelas*) and all of their available subspecies as well as 91 specimens of six other modern canid species. In many linear and shape measures, as well as principal components analyses including 1) upper carnassial measurements, 2) lower carnassial measurements and 3) combined lower carnassial and lower premolar measurements, the fossil jackal variability exceeds that found in each of the modern species. Not only do we find that *C. antiquus* is a valid taxon (with mesodistally short lower premolars and carnassials, and small canines and incisors as well as a shallow mandible), and *C. brevirostris* may also be distinct (with a short premolar-molar row and small premolars), some of the other fossil jackals from other localities may also be worthy of reclassification; Namely, the specimens from Swartkrans Member 3 and some of the Sterkfontein specimens which have distinctively large lower carnassials (though curiously, the Swartkrans specimens have upper carnassial measurements that are similar to those of modern *C. mesomelas* while those of these Sterkfontein have upper and lower carnassials that are correspondingly large) and some of the specimens from Swartkrans Member 5 which have statistically small upper carnassials. The specimen from Minnaars does not stand out in any of these measures. Our analyses also have implications for the taxonomy of the modern jackals, particularly that of *C. aureus* which may be worthy of splitting.

Technical Session XII, Tuesday 2:45

NEW LARGE BLUNT-SNOUTED DYROSAURID (MESOEUCROCODYLIA) FROM THE PALEOCENE OF COLOMBIA

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Dyrosaurids are typically known as longirostrine, marine crocodyliforms best known from the Paleocene and Eocene of western Africa. Dyrosaurid fossils are exceptionally rare within South America, with only three taxa diagnosed. Recently described fossils of a new dyrosaurid (*Cerrejonisuchus improcerus*), podecnemidid turtle (*Cerrejonemys wayuunaiki*), and giant boine snake (*Titanoboa cerrejonensis*) from the Cerrejón coal mine in northeastern Colombia represent the first glimpse of tropical South American middle–late Paleocene (58–60 mya) terrestrial ecosystems. The deposits likely represent ancient estuarine to riverine environments. Here we describe a new large-bodied dyrosaurid (3–5 meters in total body length) that was recovered from the same deposits, and that represents a distinctly new and very different morphology for Dyrosauridae. The new dyrosaurid is known from four nearly complete skulls, preserving the snout, orbital region, skull table, parts of the braincase, and several teeth. The skull has expanded and elongate supratemporal fenestrae that are longer than they are wide, a diagnostic character of Dyrosauridae. The snout is notably short (39–50% of total skull length) as compared to the previously reported small-bodied dyrosaurid, *Cerrejonisuchus improcerus* (55–59%). The teeth are round and blunt which, in combination with a short snout, was likely an adaptation for durophagy. The orbits are laterally placed, as seen in Paleogene sebecid crocodyliforms that are likely to have been mostly terrestrial. Postcrania include several vertebrae, ribs, thick osteoderms, distal ischia, and a partial fibula. Thick osteoderms are likely also an adaptation for a more terrestrial habit, as in marine crocodyliforms, including other known dyrosaurids, that instead possess reduced or absent osteoderms. The distal ischia are thin and spatulate, reflecting a reduction of the ischiocaudalis muscle utilized in pitch control within the water, also consistent with a more terrestrial or freshwater habit. The large size, blunt-snout, and more terrestrial habit of the new dyrosaurid represents a completely new ecomorphotype for the family Dyrosauridae.

Poster Session III, (Tuesday)

FIRST OCCURRENCE OF THE MARINE CROCODYLIFORM *TERMINONARIS* FROM THE UPPER CRETACEOUS (TURONIAN) OF MANITOBA

HATCHER, Joseph, Canadian Fossil Discovery Centre, Morden, MB, Canada; JANZIC, Anita-Maria, Canadian Fossil Discovery Centre, Morden, MB, Canada

The recent discovery and collection of the large marine crocodile *Terminonaris* from Manitoba marks the first reported occurrence of this rare taxon within the province. During the Turonian, marine deposits from the Western Interior Seaway of North America preserved the disarticulated skeleton west of the town of Dauphin, Manitoba along the eastern bank of the Wilson River. The deposits are composed of calcareous shales from the Keld Member of the Favel Formation. Fort Dauphin Museum (FDM) specimen MD-1055-1 consists of elements from the appendicular skeleton including the incomplete right illium, right proximal

humerus, incomplete left hind limb (femur, tibia, incomplete fibula) and incomplete left pes (astragalus, calcaneum, tarsals 3 and 4, incomplete metatarsals and incomplete phalanges) along with three dorsal vertebrae, three large caudal vertebrae, many ribs and osteoderms. In comparison to Royal Saskatchewan Museum specimen P2411.1 of *Terminonaris robusta* from Carrot River, Saskatchewan, the femur of MD-1055-1 is 38 mm shorter in length but exhibits a longer centrum in the largest caudal vertebra by 21 mm. These measurements as well as similar size related features of the axial skeleton are consistent with the genus. FDM specimen MD-1055-1 is hereby referred to as *Terminonaris* sp.; only the seventh documented occurrence of the genus in North America and the first documented occurrence of the taxon in Manitoba.

Poster Session IV, (Wednesday)

A NEW ASSESSMENT OF THE ENIGMATIC MANDIBLE OF THE LIVING FOSSIL LAONASTES AENIGMAMUS (RODENTIA, MAMMALIA)

HAUTIER, Lionel, Museum of Zoology, Cambridge, United Kingdom; SAKSIRI, Soonchan, Department of Biology, Faculty of Science, Mahasarakham University, Mahasarakham, Thailand

Rodents are considered to be one of the great success stories of mammal evolutionary history. While exceptional for an intense diversification of lineages, the evolutionary history of the order Rodentia comprises only a small number of morphological morphotypes for the mandible that could partly explain the intense debates about the taxonomic position of the latest described member of this clade, the Laotian rock rat *Laonastes aenigmamus* (Diatomyidae). This discovery has relaunched the debate on the definition of the Hystricognathi suborder identified using the angle of the jaw relative to the plane of the incisors. Our study aims to end this ambiguity. For clarity, it became necessary to revisit the entire morphological diversity of the mandible of extant and extinct rodents. However, current and past rodent diversity brings out the limitations of the qualitative descriptive approach and highlights the need for a quantitative approach. Here, we present the first descriptive comparison of the masticatory apparatus of *L. aenigmamus* combining classic comparative anatomy with morphometrical methods. First, we quantified the shape of skulls and mandibles of rodents using 3D landmarks. Then, the analysis of osteological features was completed by a detailed description of muscular insertions examined by standard dissections. We showed that the difficulties in classifying *L. aenigmamus* stem from the fact that it presents a mixture of sciurognathous and hystricognathous characters (i.e., the two rodent suborders). The contribution from the fossil record was decisive in exploring the morphological variation. Most of the information available from the fossil material pertains to its morphology and the means to quantify morphological characters have become of great importance. This study illustrates how an holistic approach allows an objective study of the morphological variation while excluding any typological approach that implied a quasi-invariable distinction of different morphotypes. These results also bring new insights into the evolution of hystricognathy and have profound implications for the interpretation of the fossil record of early hystricognath rodents.

Poster Session IV, (Wednesday)

SIMPLE FEMORAL INDICATORS OF LOCOMOTION DERIVED FROM ANATOMICAL STUDIES

HAWKINS, Patrick, East Tennessee State University, Johnson City , TN, USA; WALLACE, Steven, East Tennessee State University, Johnson City , TN, USA

Soft tissue anatomy can be ecologically or phylogenetically informative and is very useful as a supplement to skeletal data. Dissections can provide such anatomical details, but are not always informative for paleontologists. Using recently published muscle maps, our own dissection, and comparisons with close relatives, we investigated the femoral anatomy of *Pristinailurus bristoli*, a lesser panda from the Mio-Pliocene Gray Fossil Site in East Tennessee. Proximally, the presence of the gluteofemoralis in *Ailurus fulgens* allies them with arboreal procyonids, but the attachment site is direct and obscured by other posterior thigh muscles, making this character useless for the fossil. Fortunately, some visible osteological features on fossils can confirm the identity of a muscle, as well as its importance and action. For example, the relatively tall greater trochanter on *P. bristoli* indicates that it was more terrestrial than *A. fulgens*. The quadratus femoris, an extensor, is obvious in both species, although larger and more distal in *P. bristoli*. Distally, sesamoid articulations show where a muscle tendon changes direction before attaching to a long bone such as those embedded in the gastrocnemius. Although modern pandas have these sesamoids, their diminutive facets on the posterior femur suggest that the muscles are not as powerful. Also emphasizing the importance of limb flexion is the large lateral process for the attachment of the superficial digital flexor, which aids the gastrocnemius. These distal features are similar to those of the more terrestrial *Procyon lotor*, which were readily available for comparative dissection. As *A. fulgens* is more specialized for tree climbing than *P. lotor*, the fossil taxon is suggested to be intermediate, with clear adaptations for both activities based on simple osteological features. These features are identifiable only because of modern anatomical studies that outline their function and location. Regardless of the difficulty in finding direct attachments within generalized groups of muscles, future anatomical research emphasizing osteological features is highly recommended.

Poster Session I, (Sunday)

CRANIAL ANATOMY OF *OPHIACODON UNIFORMIS*: NEW INSIGHTS FROM AN EXCEPTIONALLY PRESERVED SPECIMEN USING COMPUTED TOMOGRAPHY

HAWTHORN, Jessica, University of Toronto, Toronto, ON, Canada; SCOTT, Diane, University of Toronto at Mississauga, Mississauga, ON, Canada; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada

Representatives of the family Ophiacodontidae (Synapsida, Eupelycosauria) comprise the earliest record of synapsid diversification, and as such are critical to understanding the initial stages of synapsid evolution. Exquisite, new three-dimensionally preserved cranial material of *Ophiacodon uniformis* (USNM PAL 487098) from the Lower Permian (Leonardian) Petrolia Formation of Baylor County, Texas, is studied for the first time. This specimen, the best-preserved and most complete known skull of *Ophiacodon*, was fully prepared, illustrated, and scanned using x-ray computed tomography (CT) to allow for an improved, detailed description of its cranial morphology. USNM PAL 487098 exhibits the light construction of the skull with thin-walled bone typical of ophiacodontids. Like other derived ophiacodontids, it possesses a prominent supraporbital shelf composed of lateral expansions of the pre- and postfrontals, which are separated by a narrow incision forming the supraporbital notch. The frontals, though expanded at the level of the notch, do not contribute to the margin of the supraorbital shelf. This differs from the conditions observed in the independently evolved supraorbital shelves of derived members of Sphenacodontidae and Edaphosauridae, where the frontal contributes to the shelf margin. The postorbital and jugal are mediolaterally expanded where they form the postorbital bar, further reinforcing and protecting the orbital region. The distinctive supracanine buttress is clearly visualized on the medial surface of the maxilla through CT imaging. The vomer is tall, as is the anterior process of the pterygoid, separating the snout internally into distinct halves anterior to the cultriform process of the parasphenoid. The sphenethmoid is preserved in the orbit, as expected, but a possible ethmoid ossification is also identified, previously unknown in early synapsids. The dramatically improved understanding of ophiacodontid skeletal anatomy will form the basis of a thorough reevaluation of the evolutionary history of this early clade of synapsids.

Technical Session VII, Monday 3:00

CLIMATIC REGULATION OF MAXIMUM BODY SIZE IN POIKILOTHERMIC VERTEBRATES: AN EMPIRICAL TEST USING THE CRETACEOUS AND PALEOGENE RECORD OF NORTH AMERICAN TRIONYCHID TURTLES

HEAD, Jason, University of Toronto, Mississauga, ON, Canada

Body size of fossil reptiles is a potentially powerful thermometric proxy because a critical minimum ambient temperature limits maximum body size for a specific mass-specific metabolic rate in poikilothermic vertebrates. As a result, Mean Annual Temperature (MAT) is the ultimate regulator of size for a given physiology and ecology. Multiple proximate factors can constrain body size, however, including habitat availability and food resources, and paleoclimatic reconstructions based on poikilothermic body size must account for other size-regulating mechanisms or risk underestimating temperature. To test whether body size is maximized for MAT in extinct poikilotherms over long time scales, size changes measured as carapace length in the fossil records of trionychine and plastomenine trionychid turtles from the Late Cretaceous through Paleogene in Western North America were compared with paleotemperature estimates from coeval floral and isotopic data. Body size change generally corresponds with temperature in both clades: sizes increase from the Cretaceous to the Paleogene, with maxima occurring during the Paleocene and Early Eocene followed by subsequent decreases during the late Eocene. Absolute paleotemperature estimates for the largest fossil taxon *Axestemys*, derived from the relationship between size, metabolism, and minimum MAT for habitats in extant trionychids, approximates paleofloral estimates during the Bridgerian NALMA; however, temperature values derived from the majority of the turtle record substantially underestimate temperature relative to other proxy data. Additionally, size increases within the earliest Paleogene do not correspond to known temperature changes, but instead track the transition from fluvial to lacustrine depositional systems. These results indicate that although proportional changes in body size suggest a climatic signal, absolute size is not maximized relative to MAT for the examined samples, and that additional factors, especially changes in depositional environment, had a controlling influence on body size in fossil trionychids.

Poster Session I, (Sunday)

BIOSTRATIGRAPHIC SIGNIFICANCE AND REDESCRIPTION OF THE ENIGMATIC VERTEBRATE *COLOGNATHUS OBSCURUS* FROM THE UPPER TRIASSIC CHINLE GROUP, SOUTHWESTERN U.S.A.

HECKERT, Andrew, Dept. Geology, Appalachian State University, Boone, NC, USA

There are approximately 27 specimens of the bizarre Upper Triassic vertebrate *Colognathus obscurus,* known from Texas, New Mexico, and Arizona, reposited in museums across North America. The holotype was recovered from the same jacket as the holotype skull of the phytosaur *Leptosuchus crosbiensis* in Crosby County, Texas, and 23 of the other specimens have reasonable provenance data. The vast majority of *Colognathus* occurrences are from exposures of the Upper Triassic Tecovas Formation in Crosby County, Texas, including the type locality, the “upper” and “lower” Kalgary microvertebrate sites, Walker’s Tank and vicinity, Brunson Ranch, Sand Creek, Davidson Creek, and the Blanco River. There are two other Texas specimens from exposures of equivalent strata in Palo Duro Canyon in Randall Coun-

ty, Texas. Isolated occurrences of shed(?) teeth are known from a microvertebrate locality near Lamy in the Los Esteros Member of the Santa Rosa Formation in central New Mexico and Crocodile Hill in Petrified Forest National Park, in the uppermost Blue Mesa Member of the Petrified Forest Formation in east-central Arizona. All occur with one or more Adamanian (Late Triassic—Carnian-Norian?) index taxa (*"Leptosuchus," Stagonolepis, Tecovasuchus, or Crosbysaurus*) A specimen putatively from the stratigraphically lower, Otis Chalk, Texas region is of questionable provenance. Almost all occurrences are singleton fragments of teeth or tooth-bearing (dentigerous) elements. None preserve definitive evidence of skeletal fenestrae or sutures with other elements. The best *Colognathus dentigerous* fragments include a single, conical/pyramidal to recurved, anterior tooth and an elongate, molariform posterior tooth; less complete specimens consist of only one of these teeth. The posterior, molariform tooth is readily recognizable as a shed crown. Initially *Colognathus* was considered an osteichthyan, but was later generally considered to be an aberrant procolophonian. A sectioned jaw reveals that tooth implantation resembles that of pleurodonty overridden by acrodonty, which instead hints at a lepidosaurian affiliation for *Colognathus*.

Technical Session X, Tuesday 9:45

FROM BABY BIRDS TO FEATHERED DINOSAURS: INCIPIENT WINGS AND THE EVOLUTION OF FLIGHT

HEERS, Ashley, University of Montana, Missoula, MT, USA; DIAL, Kenneth, University of Montana, Missoula, MT, USA

The function of proto-wings in theropod dinosaurs during the evolution of avian flight has long intrigued the scientific community. Recent studies demonstrate that immature ground birds with extremely underdeveloped and rudimentary wings are capable of generating useful aerodynamic forces during wing-assisted incline running and controlled flapping descent. Feather development in these birds resembles feather evolution in theropod dinosaurs, and reveals a predictable relationship between wing morphology and aerodynamic performance. This empirical, ontogenetic relationship can be used to infer aerodynamic performance of theropod proto-wings. Following the methods of Usherwood and Ellington, aerodynamic forces generated by dried wings of chukar partridges (*Alectoris chukar*) were measured as the wings were spun like a propeller at a range of Reynolds numbers, to mimic different-sized theropod proto-wings swinging at biologically relevant angular velocities. At slow angular velocities, wings produced aerodynamic forces similar in magnitude to those produced by immature chukars during wing-assisted incline running. At fast angular velocities, wings produced forces sufficient to support body weight. These findings suggest that proto-wings described by the fossil record may have provided useful aerodynamic function early in the history of theropods, with improvements in aerodynamic performance occurring as enhanced pectoral musculatures afforded higher wing beat frequencies.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

SEXUAL DIMORPHISM IN CRANIAL SHAPE OF THE SPOTTED HYENA (*CROCUTA CROCUTA*)

HENSLEY-MARSCHAND, Blaire, Indiana University, Bloomington, IN, USA

The spotted hyena (*Crocuta crocuta*) is of interest to both paleontologists and archaeologists alike. Occurring now only in Sub-Saharan Africa, this species was widespread throughout Africa, and Eurasia during the Pleistocene. Specimens of this denning animal can be found in high densities in bone caves throughout this area. The biogeography of this species is complex, suggesting separate north- and south-African Pleistocene refugia and a genetic affinity with the cave hyena (*Crocuta spelea*).Most of the literature concerning sexual dimorphism in this species involves discussion of the unique genitals of the females of this species, but this soft tissue identifier is not commonly available for archaeological or paleontological specimens. The females of this species are, on average, larger than the males, and it was previously unknown whether this size difference translated to a shape difference in the skeletal remains of this species. Spotted hyena crania from the Field Museum of Natural History (Chicago, IL) and the William R Adams Zooarchaeology Laboratory (Indiana University, Bloomington, IN) were included in this study. Of the eighteen specimens, five were labeled as female, eight as male, and five were of unknown sex. A total of thirty-two 3-D landmarks were plotted for each specimen encompassing shape variation in maxillary tooth distribution and cranial length, width, and height. A multivariate analysis of variance between females and males finds a significant difference between the sexes. Additionally, specimens of unknown sex can be identified to sex based on discriminant function classification of skull shape variables.Archaeological and paleontological communities can use these techniques to add to the data available for site analysis. New, previously unavailable determinations of sex can be used to support or oppose hypotheses regarding the agent of accumulation for sites in which spotted hyena remains are present. An abundance of female specimens will support a den-type origin while a paucity of females will oppose such a theory.

Poster Session IV, (Wednesday)

MORPHOLOGICAL VARIATION IN THE HADROSAUR DINOSAUR *GRYPOSAURUS* FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH

HERRERO, Lucia, The Webb Schools, Claremont, CA, USA; FARKE, Andrew, Raymond M. Alf Museum of Paleontology, Claremont, CA, USA

Recent fieldwork in the Upper Cretaceous (Campanian) Kaiparowits Formation of southern Utah has yielded a number of new dinosaur specimens, with hadrosaurids particularly abundant. Known taxa include *Parasaurolophus* sp., *Gryposaurus notabilis*, and *Gryposaurus monumentensis* (unique to the formation). In 2007, a field crew from the Raymond M. Alf Museum of Paleontology (RAM) discovered a partial hadrosaur skull (RAM 12065) in a channel sandstone within the upper part of the middle unit of the Kaiparowits Formation. The skull includes the frontals, postorbitals, parietals, and squamosals, as well as a partial braincase. It can be definitively assigned to the genus *Gryposaurus*, based on the frontal's contribution to the orbital rim and the nasal-invasive nasofrontal contact. Despite this, the skull differs in several key details from other *Gryposaurus* specimens found in the Kaiparowits Formation, including the shape of the supratemporal fossa and the the morphology of the postorbital. In all known specimens of *G. monumentensis* and *G. notabilis*, the caudal portion of the postorbital is sharply angled dorsally, providing a kinked profile to the skull roof in lateral view. In RAM 12065, the skull roof is planar. *Gryposaurus incurvimanus* shows intraspecific variability in this trait, suggesting that similar variation is possible for the other species but has not been recognized yet. Because the nasal arch, an important feature for differentiating *Gryposaurus* species, is missing, RAM 12065 cannot be diagnosed to the species level. Two possibilities exist: 1) the specimen belongs to *G. monumentensis* or *G. notabilis*, or 2) the specimen represents a previously unknown species. If RAM 12065 belongs to *G. monumentensis* or *G. notabilis*, then the diagnosis of those species should be revised in order to include the variations found in RAM 12065, most importantly the "unkinked" postorbital.

Technical Session XVI, Wednesday 3:15

INFERRING DIET FROM MORPHOLOGY IN EARLY WHALES: MORPHOMETRIC ANALYSIS OF FEEDING STRATEGY IN *REMINGTONOCETUS*

HIERONYMUS, Tobin, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; COOPER, Lisa, University of Illinois Urbana-Champaign, Urbana, IL, USA; VINYARD, Chris, Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA; THEWISSEN, J.G.M., Northeastern Ohio Universities College of Medicine, Rootstown, OH, USA

Cetacean ancestors include artiodactyls (even-toed ungulates) that show a mosaic of morphologies associated with both terrestrial and aquatic habits. Morphology of the feeding apparatus in archaeocetes, such as *Remingtonocetus*, is distinct from that seen in closely related terrestrial artiodactyls, but also distinct from that seen in extant odontocetes, providing an ambiguous picture of the feeding strategies that accompanied the initial cetacean invasion of marine habitats. To assess possible feeding strategies, we measured a suite of morphological variables related to the feeding apparatus in *Remingtonocetus* as well as a selection of extant odontocetes, terrestrial artiodactyls, and terrestrial and aquatic carnivorans. Mammalian aquatic predation strategies fall into two general groups: snap feeding, in which the animal pushes its mouth through the water to engulf prey; and suction feeding, in which the water around the prey is forcibly drawn into the mouth. We thus coded feeding strategies in extant taxa as snap, suction, or terrestrial. We applied phylogenetic principal components analysis (PPCA) to the morphometric data, clustered the taxa using the resulting PPC scores, and compared feeding strategy among well-supported clusters. Extant snap-feeding odontocetes separate from all other taxa, with PPC scores related to an elongate, narrow bony rostrum and a dorsoventrally shortened mandible. Extant suction feeding odontocetes fall out with the remaining taxa on the first axis, but show separation on the second axis, with PPC scores related to a broad, elongate basicranium and a narrow, short mandible. *Remingtonocetus* clusters within snap-feeding odontocetes, suggesting a similar feeding strategy. Pinnipeds do not show consistent differences from terrestrial carnivorans, suggesting a separate solution to aquatic feeding that is not adequately characterized by the measurements taken in this study. These results suggest that while the inferred modes of locomotion and prey detection for archaeocetes were markedly different from those of extant odontocetes, snap-feeding is likely to be the primitive feeding mode for early marine cetaceans.

Poster Session III, (Tuesday)

MODELING COMPLEX PAST ENVIRONMENTS WITH BULK ISOTOPIC DATA

HIGGINS, Pennilyn, University of Rochester, Rochester, NY, USA; MACFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL, USA; BERSHAW, John, University of Rochester, Rochester, NY, USA; GARZIONE, Carmala, University of Rochester, Rochester, NY, USA

Isotopic data from the tooth enamel of fossil mammals have emerged as an excellent source of information toward understanding ancient climates. As isotopic methods have improved, smaller sample size requirements have allowed for serial sampling from a single tooth, making explorations of intra-annual climate patterns possible. However, for smaller teeth, such annual-scale studies generally are not possible.

We present a simple method for extracting annual-scale patterns of climate using bulk isotopic data from large water-dependent mammals. This model (the Carbon versus Oxygen or 'CvO' model) was built using isotopic data from mammals for which annual temperature, precipitation amount, and the timing of precipitation are known (extant mammals) or can be estimated using the Macrophysical Climate Model (fossils less than 40 ka). Despite the potential for oversimplification, the CvO model presents an opportunity to interpret ancient intra-annual climate patterns at localities where only bulk isotopic data are available from fossils. The CvO model is most useful when making comparisons between widely separated fossil localities or between fossils of differing ages from localities in close proximity.

Technical Session VII, Monday 3:15

FOSSIL CROCODYLIFORMS AND TURTLES FROM THE EARLY CRETACEOUS OF NORTHEASTERN MALI

HILL, Robert, New York College of Osteopathic Medicine, Old Westbury, NY, USA; SERTICH, Joseph, Stony Brook University, Stony Brook, NY, USA; ROBERTS, Eric, James Cook University, Townsville, Australia; O'LEARY, Maureen, Stony Brook University, Stony Brook, NY, USA

Recent fieldwork in Cretaceous strata of northwestern Africa has significantly expanded the known diversity of non-avian sauropsid taxa, particularly crocodyliforms. Here, we describe new vertebrate fossils from the Early Cretaceous (possibly older) fluvial conglomerates in the Tilemsi Valley of northeastern Mali. These rocks previously yielded remains of titanosaurian dinosaurs and were briefly reported to contain crocodyliforms and turtles. The most complete fossils belong to a brevirostrine crocodyliformand include the symphyseal portion of a right dentary with five alveoli; a partial basioccipital, otoccipital, and parabasisphenoid; a partial right quadrate, quadratojugal, and posterior jugal; and a partial left nasal and prefrontal. Size and preservation suggest that these elements may represent a single individual. Also preserved, but likely not associated, are a partial lower jaw preserving portions of both dentaries and splenials, a partial left maxilla, and a complete metatarsal. A separate longirostrine taxon is represented by a partial right maxilla with nine alveoli. Among the non-crocodyliform material also recovered is a partial scapula and shell fragments from a possible pleurodire turtle. The new brevirostrine crocodyliform specimens compare closely with the Gondwanan peirosaurids. For example, the quadratojugal contributes approximately 20% of the mandibular condyle. The lateral margin of the dentary is concave for the reception of a large maxillary tooth as in *Miadanasuchus* and *Trematochampsa.* Coincident with this concavity are two sets of alveolar couplets similar to those in *Itasuchus*. Although the specimens are fragmentary, this combination of characters strongly suggests that they represent a member of Peirosauridae. Unusual or autapomorphic features of these specimens include the presence of confluent alveoli and a lower jaw whose lateral margin is concave opposite the rostral-most extent of the splenial symphysis. Inclusion of the new specimens as a composite OTU in a phylogenetic analysis shows that it groups with other African peirosaurids including *Trematochampsa*, *Hamadasuchus*, and *Stolokrosuchus*.

Physical Drivers and Marine Tetrapod Evolution, Monday 9:45

SKELETAL SPECIALIZATIONS FOR LOCOMOTION IN AQUATIC BIRDS: PHYLOGENETIC AND PHYSICAL ASPECTS

HINIC-FRLOG, Sanja, Carleton University, Ottawa, ON, Canada; ROWE, Geoff, Statistics Canada, Ottawa, ON, Canada; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada

Many bird lineages have evolved to become successful in aquatic environments. In order to infer how the physical aquatic environment has shaped osteological specializations within these groups we use a novel quantitative comparative approach to estimate the degree to which morphology and phylogeny can predict swimming behavior in extant birds. Furthermore, we identify skeletal traits specific to each locomotor behavioral group which contribute most to predicting that behavior. The data set comprises 145 bird genera and 32 skeletal characters, including lengths and widths of major appendicular, shoulder girdle and pelvic girdle elements. The relationships between avian genera were estimated based on published molecular phylogenies. A penalized-likelihood multinomial regression equation, which included coefficients for osteological traits and phylogeny was established for each of six behavioral groups. The phylogeny was represented by a Hierarchical Design Matrix (HDM), analogous to a nested Analysis of Variance. The regression equations were cross-validated to predict each behavioural category. An analysis without the HDM coefficients was used to investigate the predictive power of osteological coefficients in the absence of phylogeny. The results show that phylogeny is a powerful predictor of swimming behavior. Osteology alone is also very powerful in such prediction, although to a lesser degree, suggesting that osteology is generally highly conserved within bird groups. Comparison of the standardized estimated coefficients for the osteological traits in the osteology-only analysis with those of the phylogeny-plus-osteology analysis revealed important differences. For example, in the osteology analysis, ulnar length and hip width contribute the most to the prediction of plunging behavior (i.e. diving to water surface from the air). However, when both osteology and phylogeny are considered only ulnar length was highly predictive. Thus, in plungers, which have evolved at least twice among extant birds, lengthening of the ulna is a derived specialization associated with the aquatic environment that should be further investigated.

Poster Session II, (Monday)

REVISION OF THE EOCENE AMBER LACERTID *SUCCINILACERTA SUCCINEA* (SQUAMATA) BASED ON 3-DIMENSIONAL X-RAY COMPUTED TOMOGRAPHY

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Computed tomography (CT) is a powerful tool in paleontology for visualizing minute details and internal morphologies of fossils. Despite the obvious suitability of CT for studying fossil inclusions in amber, this approach has only been applied to a few cases. Here we use High-Resolution X-Ray CT to revise the morphological description of the famous "Königsberg" amber lizard *Succinilacerta succinea*. This type specimen from the Baltic Eocene is the oldest known lizard in amber and a member of the Old World family of wall lizards, the Lacertidae. Although the specimen is nearly complete, a milky layer obscuring most of its body has prevented proper comparison with other amber lacertids and phylogenetic placement. Using a three-dimensional CT approach, we were able to digitally remove this layer to reveal the body of *S. succinea* in extremely fine detail. Although the specimen appears to be completely hollow, the high resolution of scalation and external morphology permits revision of previous descriptions. For example, the ventral side of the throat and belly are revealed for the first time, showing scalation features such as the lack of a 'collar', which is an important character distinguishing modern Palearctic lacertids from the African radiation. In a phylogenetic analysis of Lacertidae, *S. succinea* also clusters with the African taxa, confirming recent molecular clock-based hypotheses that the African lineage may have split from the Palearctic clade in the Eocene of Europe before migrating southward. If this is the case, *S. succinea* and other Paleogene amber lacertids should no longer be dismissed as "stem" taxa in studies of the crown clade. Our results emphasize the importance of soft tissue characters in systematics, and indicate the need for extensive taxonomic and morphological revisions regarding amber lacertids. We also illustrate the value of CT in bridging paleontological and neontological studies, by providing new morphological characters that can be used to place fossil taxa within modern phylogenies.

Romer Prize Session, Monday 9:15

THE EVOLUTION OF RIBCAGE ANATOMY AND BREATHING FUNCTION IN THE MESOZOIC THEROPODS

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Ribcage anatomy of theropods is an essential key to rationalize the evolution of a unique breathing mechanism seen in extant birds. In extant birds, ribcage movement contributes to generating gas flow, and the inspired air first flows into the caudal airsac system. In this study, I investigated comparative anatomy of ribcages in theropods, with an emphasis on the fossil record. Firstly, I collected data on the ribcage anatomy of 111 theropod species from the Mesozoic, through direct observations on museum specimens (37 species) as well as from the literature (74 species). On the basis of these data, character evolution was traced on a compiled phylogenetic framework based on recent published analyses. The results demonstrated that mechanical refinements of the ribcage were accumulated in a stepwise pattern in the following sequence. Initially, the ossification of sternum occurred. Then, the ossification of sternal rib occurred in the Middle/Late Jurassic. Subsequently, ossified uncinates were polyphyletically acquired during the Neocomian. These findings suggest gradual changes of costal aspiration mode in theropods. Secondly, I developed a model for representing the ribcage kinematics in three-dimentional coordinate space, on the basis of direct measurements on the fossil specimens. In this model, I used the orientations of the rotational axis for the rib and the rib curvatures of the theropods without the ossified sternal ribs. This model allows for a quantitative test of the mode of ventilation, whereas the previous studies discussed only the morphology of the costovertebral articulations. As a result, models of ribcage movements in *Tyrannosaurus* (Tyrannosauroidea), *Allosaurus* (Allosauroidea), and *Majungasaurus* (Ceratosauria) suggested greater volumetric changes in the anterior or mid-thoracic regions than in the posterior thoracic regions. Consequently, without other accessory components (e.g., abdominal muscles), these theropods were not suited for the mode of ventilation seen in the extant birds, where the inspired air flows into the posterior region. These lines of evidence lead to the interpretation that the highly specialized respiratory system seen in extant birds were not completed at the time of acquirement of the airsacs by some theropods, but after the acquirement of the movable joint between the vertebral and sternal rib in the Late Jurassic.

Poster Session I, (Sunday)

OLIGOCENE *MALAYEMYS* AND MIOCENE *GEOEMYDA* (GEEMYDIDAE; TESTUDINES) FROM JAPAN

HIRAYAMA, Ren, Waseda University, Shinjuku-ku, Tokyo, Japan; SHIKANO, Kanji, Gifu Shoutoku Gakuen University, Minokamo, Japan; SONODA, Teppei, Ibaraki University, Mito, Japan

Geoemydids (Geoemydidae; Testudines) are the most diverse living chelonian family. Nonetheless, its fossil record is rather poor before the Pleistocene. Recent discoveries of turtle remains from both Paleogene and Neogene deposits of the Japanese Islands should throw new light on the calibration of geoemydid diversification.

One is a partial skeleton, including dentary, fragmentary shell, and left pubis, from the Late Oligocene Fukui Formation (25.7 mya based on FTD) of the Sasebo Group at Fukushima Island, Matsuura City, Nagasaki Prefecture, northern Kyushu. This was collected by Mr Y. Fudoji in 1994. Carapace is estimated as about 16 cm long. Dentary has a flat and broad triturating surface as in few living geoemydids such as *Malayemys*. It is large in proportion, suggesting this individual had a huge head, of which length was almost one third of the carapace length as in living *Malayemys*. Relatively large nuchal has narrow first vertebral scute, and the humero-pectoral sulcus is excluded from the entoplastron, as in *Malayemys*. Costal has no dorsal ridge unlike living species. Its plastron has the thickness almost twice the living genus. Thus, this Japanese specimen might represent a new taxon of *Malayemys*.

Another specimen is a nearly complete shell from the Early Miocene Nakamura Formation (19 mya based on FTD) of the Mizunami Group of Minokamo City, Gifu Prefecture, central Honshu. This was collected by Shikano in 1989. Carapace is only 10 cm long, although its ossification suggests this was mature. Musk duct foramina are preserved in peripherals. Carapace has three dorsal keels. Median keel has flat surface as in living *Geoemyda* species.

Posterior peripherals have serrated margin at the scute border. These characters suggests its affinities with living *Geoemyda*. Its extremely small size is shared by *G. spengleri*. Its much wider vertebrals and radiated pattern of longitudinal sculptures on carapace seem unique features of this taxon.

Recent molecular research suggests both *Malayemys* and *Geoemyda* should be rather isolated from other geoemydids. These Japanese materials support the hypothesis that their origin should be traced back as early as the Paleogene.

Poster Session II, (Monday)

MIRACINONYX TRUMANI (CARNIVORA: FELIDAE) FROM THE RANCHOLABREAN OF GRAND CANYON, ARIZONA AND ITS IMPLICATIONS FOR THE ECOLOGY OF THE "AMERICAN CHEETAH"

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A new and surprising record of *Miracinonyx trumani* has been recognized from the Grand Canyon of northern Arizona. Three sites along the length of the canyon contain fossils of *M. trumani*: Rampart Cave, Next Door Cave, and Stanton's Cave. Rampart Cave contains partial skeletons of a juvenile and a sub-adult cat. Cranial materials from Rampart Cave are distinct from *Puma* in the presence of a heavy dentition, a reduced protocone of the P4, short robust canine, and a reduced diastima between the c1 and p3. Next Door Cave has a single record of an adult calcaneum of *M. trumani* that is morphologically distinct from *Puma* in its large size and the presence of a well-developed navicular facet. Stanton's Cave contains phalanges that are similar to *Puma* but are proportionately gracile in comparison with modern *Puma*.The presence of *Miracinonyx* within the Grand Canyon raises questions about the ecology of this large cat. Previously, *Miracinonyx* was proposed as a cheetah (*Acinonyx jubatus*) ancestor, or convergently cheetah-like felid that hunted prey in open savanna-like habitats. The rarity of ungulates adapted to a savanna-like habitat during the Rancholabrean within the Grand Canyon and the occurrence of the fossils of *Miracinonyx* within the canyon suggest that *Miracinonyx* was not confined to the cheetah-like model. The extinct mountain goat *Oreamos harringtoni* was the most common ungulate within the Rancholabrean of the Grand Canyon and occurs at Rampart Cave and Stanton's Cave and was perhaps the preferred prey for the *Miracinonyx* population at the Grand Canyon. We propose that the Grand Canyon *Miracinonyx* may have had a feeding ecology similar to that of the modern snow leopard (*Uncia uncia*), a large felid adapted for swift pursuit of mountain and canyon ungulates over nearly vertical rocky terrain.

Poster Session III, (Tuesday)

UNDERSTANDING GRASSLAND EXPANSION, CLIMATIC FACTORS AND HYPSODONTY EVOLUTION THROUGHOUT THE MIOCENE IN THE JOHN DAY BASIN, OREGON

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Fossil mammals from the John Day Basin of central Oregon (l. Eocene to l. Miocene) document the ubiquitous grazing adaptations that independently evolved in many North American mammalian lineages at the beginning of the Barstovian Land Mammal Age (~15.8 Ma). However, paleosols indicate that these adaptations were preceded by bunch and sod grasslands present in central Oregon by the Arikareean (~30 Ma) and Hemingfordian (~19 Ma), respectively. It is assumed that these were C_3 grasses and that C_4 grasses were never abundant in the John Day Basin due to the high latitude of the region and the prevalence of winter precipitation. These grasslands were established before the onset of the middle Miocene Climatic Optimum (MCO), a period of increased global temperatures from approximately 17 to 14 Ma. The Miocene units of the John Day Basin (Haystack Valley Member of the John Day Formation, Mascall and Rattlesnake Formations) encompass the MCO and therefore provide an opportunity to assess the effects of climate change on grasslands and the response of grassland mammals. These effects are investigated by combining stable isotope and tooth wear analyses. Stable carbon isotopes from mammalian tooth enamel reflect diet as well as environmental information such as habitat openness and aridity. Stable oxygen isotopes offer additional information about factors affecting the isotopic composition of meteoric and plant water: temperature, elevation, precipitation, and seasonality. Microwear analysis is used to determine dietary abrasiveness. Modern grazers exhibit increased abrasion caused by either biogenic silica or grit from arid environments. These analyses have been conducted on 50 teeth of Miocene ungulates from the John Day Basin, including equids, rhinocerotids, camelids, merycoidodontids, and antilocaprids. Combined, these methods are used here to track ungulate diets throughout the Miocene of the John Day Basin, track changes in seasonality and aridity, and ultimately test the hypothesis that North American C_3 grasses were expansive during a period of climatic change.

Poster Session II, (Monday)

TOOTH PUNCTURE MARKS ON A SKULL OF _DINICTIS_ (NIMRAVIDAE) FROM THE OLIGOCENE BRULE FORMATION OF NORTH DAKOTA ATTRIBUTED TO PREDATION BY _HYAENODON_ (HYAENODONTIDAE)

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A complete skull of *Dinictis felina* (Mammalia: Carnivora: Nimravidae) (NDGS 59) was recovered from a clayey siltstone in the lower part of the Oligocene Brule Formation, from a North Dakota registered natural area in Stark County. The right P2-M1 and left M1 are present, all other teeth are broken or have been sheared off at the bone line, and the right zygomatic arch was broken and distorted. The mandible was not recovered. This fossil occurred 5.55 meters above the contact with the South Heart Member of the Chadron Formation, and 3.15 meters below the Antelope Creek tuff of the Brule Formation. Associated vertebrate fossils including *Mesohippus bairdii* and *Palaeolagus burkei* indicate a latest Orellan (Or4) interval zone (32.5-32.0 Ma). Other associated vertebrates include *Stylemys* sp., ?*Subhyracodon* sp., *Ischyromys* sp., *Hesperocyon gregarius*, *Eumys elegans*, *Leptictis dakotensis*, *Leptomeryx evansi*, and a small eomyid (possibly *Paradjidaumo*). Also associated were the gastropod *Skinnerelix leidyi,* the trace fossil *Pallichus* sp., and seeds from *Celtis* sp. During preparation of the *Dinictis* skull, distinct and well defined tooth puncture marks were noted on the right temporal and parietal bones, with another possible bite mark present on the left parietal, although this latter mark is less distinct because of missing and fractured bone. Two possible gnaw marks are present on the left maxilla, near the orbit and suture with the frontal. No evidence of healing was observed around the puncture marks. Comparisons with other puncture marked specimens are made. Measurements of the geometry of the punctures, spacing between the punctures, and comparison to skulls and dentaries of potential predators indicate that *Hyaenodon* (Mammalia: Creodonta: Hyaenodontidae) was the likely attacker of this *Dinictis*. Although not recovered from this locality *Hyaenodon* is known from the Brule Formation and has been recovered from Stark County.

Poster Session IV, (Wednesday)

CRANIAL AND POSTCRANIAL ANATOMY OF _OROHIPPUS_ (MAMMALIA, PERISSODACTYLA)

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Studies in the eighties and nineties cast doubt on the monophyly of *Hyracotherium* and thus created uncertainty as to whether species previously assigned to *Hyracotherium* represented basal equids. As a result, later equids, such as *Orohippus* from the Bridgerian of North America, have been included in phylogenetic analyses of basal perissodactyls in order to provide unequivocal representatives of the Equidae. Although dentitions of *Orohippus* are fairly well known, little has been described or analyzed of its cranial and postcranial osteology. This study describes cranial and postcranial material of specimens of *Orohippus* held in the U.S. National Museum of Natural History, with the intent to uncover and score phylogenetically useful characters. Skulls of *Orohippus* exhibit posteriorly broad nasals with a transverse suture with the frontal, a character that is likely a perissodactyl synapomorphy. *Orohippus* also exhibits a confluence of the foramen ovale and the medial lacerate foramen, which is characteristic of equids, palaeotheriids, and *Lambdotherium*, among Eocene perissodactyls. *Orohippus* also exhibits other ancestral features for perissodactyls, such as contact between the premaxilla and nasal, presence of a postglenoid foramen, a prominent coracoid process of the scapula, a high greater trochanter of the femur, and a marginal fovea of the femoral head. Combining these osteological characters with dental characters in a phylogenetic analysis of basal perissodactyls provides support for recognizing certain species previously assigned to *Hyracotherium* as basal equids.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 8:00

STRUCTURE AND FUNCTION OF THE REPTILIAN MANDIBULAR SYMPHYSIS: INSIGHTS FROM SQUAMATES

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The mandibular symphysis links the two mandibular rami and offers numerous insights into the evolutionary biology of the head and feeding apparatus. The joint is diverse among saurian reptiles, including clades that interdigitate the joint (crocodyliforms), cap it with a novel element (ornithischian dinosaurs) or completely fuse it (birds). However, lepidosaurs, non-avian saurischian dinosaurs, and numerous other fossil taxa rely primarily on soft tissues to link the otherwise bony elements. This presents a challenge to testing functional and phylogenetic hypotheses because these soft tissues are not well-documented in most extant taxa nor are they preserved in the fossil record. Using microCT, serial histology, and microscopy, we investigated the morphology of the mandibular symphysis in a variety of squamate taxa including iguanians, geckos, scincomorphs, lacertoids, and anguimorphs, in order to identify structurally and functionally informative characters in these trophically diverse species. The symphyses of all squamate taxa investigated exhibit dorsal and ventral fibrous portions of the joints that possess an array of parallel and woven collagen fibers, as well as anchoring Sharpey's fibers. The middle and ventral portions of the joints are complemented by contributions of Meckel's cartilage. Kinetic taxa have relatively loosely-built symphyses, with large domains of parallel-oriented fibers, whereas hard biting and akinetic taxa have symphyses primarily composed of dense, woven fibers. Whereas most taxa maintain unfused Meckel's cartilages, iguanians and geckos independently evolved fused Meckel's cartilages. However the morphology of the

cartilages suggests a role for different developmental mechanisms. Given the small absolute sizes of these joints, osteological correlates of soft tissues are poorly defined without microscopic approaches; however correlates in larger taxa are recognizable. These data shed light not only on squamate evolutionary morphology, which itself is complicated and important, but also form an anatomical basis to analyze symphyseal morphology and function in many non-avian dinosaurs, pseudosuchians, and other fossil taxa.

Poster Session III, (Tuesday)

AN ANALYSIS OF THE *MEGALONYX JEFFERSONII* MATERIAL FROM ACB-3 CAVE, COLBERT COUNTY, ALABAMA AND AN EXAMINATION OF MEASURING TECHNIQUES FOR GROUND SLOTHS

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Excavations by the Red Mountain Museum personnel of Birmingham, Alabama from 1984 to 1987 revealed the remains of multiple *Megalonyx jeffersonii* (Jefferson's ground sloth) specimens from ACb-3 Cave, Colbert County, Alabama. The excavation team suggested as many as sixteen *M. jeffersonii* were recovered from the cave deposits, but a subsequent reported MNI (minimum number of individuals) suggests fewer sloths. The recovered sloths (currently residing at the McWane Center in Birmingham) range in individual age from fetal to adult and provide the best known evidence of denning, and possible maternity use of caves, by ground sloths. In addition, size variation is apparent and may indicate the presence of both genders in the cave. Most of the specimens have been prepared and are the focus of the research project outlined here. This research addresses the following questions: 1) what is the MNI of the sloth sample, 2) is the reported geological age of the site an accurate representation of all the sloth individuals, 3) are there two sizes of adults, reflecting sexual dimorphism, and 4) how do the sizes of these sloths compare geographically and temporally to *M. jeffersonii* from other localities? The MNI was determined based on total number of non-replicating elements (such as the femur), stratigraphic placement (short term or long term deposition), and taphonomic scenario. Sloth remains were measured to determine if there is a gradation in adult sizes or if there is a punctuation of two size groups suggesting sexual dimorphism. Measurements of sloths from ACb-3 Cave were compared to data from other known sloth localities to test existing hypotheses concerning sloth evolution and biogeography. Traditional published measurement techniques on ground sloth remains have lacked detailed descriptions and illustrations, therefore an additional component of this project is an illustrated guide for standard ground sloth measurements.

Poster Session IV, (Wednesday)

DENTAL MICROWEAR ANALYSIS OF EOCENE BRONTOTHERIOIDEA AND IMPLICATIONS FOR PALEODIETARY INTERPRETATIONS OF LONG EXTINCT SPECIES

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The dental microwear of ten North American brontotherioid taxa (*Lambdotherium, Eotitanops, Palaeosyops, Telmatherium, Mesatirhinus, Metarhinus, Dolichorhinus, Diplacodon, Duchesneodus, Megacerops*) was analyzed to examine paleodietary change from early to late Eocene time. Using digital photomicrographs taken at 100x, pits and scratches were traced and partitioned into discrete size categories based on widths and diameters, and counted in a 1.6×10^5 μm^2 area. All brontotheres have relatively high average frequencies of narrow scratches (<5 µm width) and small pits (5-20 µm diameter) with low frequencies of larger microwear features. This wear pattern is unusual in comparison to extant large-bodied browsers and grazers which have higher frequencies of scratches >5 µm wide. It is presently difficult to interpret brontothere paleodiets, but the data suggest folivory with very few coarse-grained abrasives in comparison to the modern large mammals examined thus far, suggesting a feeding ecology that is not observed in recent times. Possibilities are that brontotheres were highly selective feeders or that their food was virtually free of extrinsic grit. Statistically significant differences between brontotheres were found, most strongly among narrow scratches and small pits, suggesting subtle ecological differences. An earlier microwear analysis using lower magnification (35x) was unable to detect these differences. Notably, late Eocene brontotheres show significant increases in scratches >5 µm wide, indicating shifts in feeding behavior or habitats. While most of the samples are time-averaged, *Metarhinus* and *Duchesneodus* microwear data are derived from mass-death assemblages (MDAs) where numerous individuals were buried simultaneously. The variance in the microwear data from time-averaged samples was generally much higher than the MDAs. This suggests that diets fluctuated somewhat through time, and that average microwear values are time-averaged representations of diet. Strong bimodality in the frequency of microwear features in the Uintan taxon, *Dolichorhinus*, suggests fluctuation between two steady states, possibly suggesting seasonal dietary shifts.

Technical Session XVII, Wednesday 3:00

ELONGATION AND REDUCTION OF THE ARM IN THEROPOD DINOSAURS

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Numerous hypotheses have been suggested for the function of the arms in various theropod clades, including prey capture, clasping during mating, scratch digging, wing assisted incline running, and even gliding and flight. Bipedality in theropods may have allowed the forelimb to evolve free from the constraints imposed by terrestrial locomotion, and it has been suggested that this freedom allowed a wider range of forelimb morphologies to emerge. While derived maniraptorans clearly had longer arms than their predecessors, and clades like tyrannosaurids and parvicursorines had reduced forelimbs, the distribution and evolution of various changes in forelimb length among theropods have not yet been documented in detail. In particular, ancestral states for relative forelimb length, as well as for segmental patterns within the forelimb, have not been reconstructed in a phylogenetic context. To investigate this, we collected data on the lengths of the bones of the forelimb in 125 theropod taxa. These measurements were scaled against the length and circumference of the femur, which were used as proxies for overall body size. The relative lengths of the forelimb bones, and of the forelimb as a whole, were mapped as continuous characters onto a broadly-sampled theropod phylogeny. Reconstruction of ancestral states was carried out using both linear and squared change parsimony to examine hypotheses of clade-specific forelimb length change. This analysis showed that forelimb elongation does not characterize all maniraptorans, and instead occurs only within Paraves. Elongation also takes place independently in ornithomimosaurs. Shortening of the forelimb occurs independently in ceratosaurs, carcharodontosaurs, tyrannosaurs and alvarezsaurs. The relative lengths of the constituent bones of the forelimb often change in different ways in different clades.

Technical Session III, Sunday 1:45

EUROPEAN EARLY PALEOGENE LOUISININES: HIGH DIVERSITY AND ENIGMATIC RELATIONSHIPS

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The European early Paleogene has yielded a relatively high diversity of louisinine apheliscids (22 species), peaking in the Paris Basin latest Paleocene with 13 species (10 new) in six genera (two new). The case has already been made on dental and postcranial evidence that louisinines together with North American apheliscids belong to the order Macroscelidea (elephant-shrews) and not hyopsodontid condylarths (ungulates), where they had formerly been placed. Alternative earlier views on the relationships of some apheliscids have included the "insectivoran" family Adapisoricidae. Indeed the louisinine *Paschatherium dolloi* was originally placed in *Adapisorex*. To tackle this issue, cladistic analysis has been undertaken of European louisinines, the better represented of North American apheliscids, African macroscelidean *Chambius* and some early "insectivorans" including adapisoricids. Probably because tarsals, key to apheliscid affinities, are known for only a few taxa, the "insectivorans" *Adapisorex*, *Litocherus* and *Macrocranion* sit nested within Apheliscidae. Excluding tarsal characters from the analysis has the effect of excluding the "insectivorans" from the Apheliscidae, but also of splitting the latter into two independent clades, consisting of *Paschatherium* and the rest. Excluding also the North American apheliscids from the analysis produces a Louisininae plus *Chambius* that is monophyletic. Support for homogeneity of the Apheliscidae thus currently appears weak, despite the tarsal evidence. A potential primitive louisinine from the late Paleocene of Walbeck, Germany, formerly referred to *Adunator*, shows cheek teeth with sharp cusps and relatively strong cresting. It blurs some of the distinctions between the typical piercing, slicing "insectivoran" dentition and the crushing bunodont type of derived apheliscids. The implication is that many of the bunodont trends seen in apheliscids occurred convergently, complicating the unravelling of their dental history. Better resolution of relationships is likely to depend upon the description of more cranial and postcranial remains of Paleocene mammals and the discovery of earlier Paleocene louisinines in Europe.

Poster Session III, (Tuesday)

RECONSTRUCTING HABITAT DIVERSITY FROM FAUNAS OF THE MIDDLE AND LATE MIOCENE OF EASTERN OREGON

HOPKINS, Samantha, University of Oregon, Eugene, OR, USA; CALEDE, Jonathan, University of Oregon, Eugene, OR, USA; GUSEY, Aili, University of Oregon, Eugene, OR, USA

The Miocene mammalian faunas of eastern Oregon were the subject of classic studies in paleoecology more than fifty years ago. The pioneering work of Shotwell rested on collections from classic Middle and Late Miocene sites in the McKay Reservoir and Owyhee areas. In this early work, Shotwell hypothesized the existence of substantial microhabitat variation in both areas, and suggested that the classic story of the spread of grasslands in these areas was a result not of the introduction of an entirely novel habitat type, but rather an increase in the dominance of a habitat that was present even in the Middle Miocene. This perspective has found support in subsequent studies of grass phytoliths and of stable isotopes in soil carbonates. These studies have rarely focused on the record of Oregon, however, which has been less studied for these questions because of the absence of open habitat C4 grasses.

Shotwell's work has come under fire for problems with statistical artifacts in his methods of analysis; however, his fossil collections are ideal for paleoecological studies, having been made with rigorous attention to avoiding collecting bias. A comprehensive analysis of Shotwell's collections as well as specimens curated or collected subsequently enables a test of these ideas about changing habitats in Oregon through the Miocene. We apply some more robust statistical methods to analyzing habitat representation in the fossil record of eastern Oregon, using collection records to describe relative abundances and community composition. Cluster analysis, principal components analysis, and other multivariate methods were used to distill the general trend in faunal composition and establish the habitat affinities of the faunas at individual sites. We find that there are significant differences in the communities represented by different localities collected by Shotwell, and that those differences often correspond reasonably well with Shotwell's reconstructed habitats. Ongoing field work in this area focused on nonfaunal proxies for habitat type, such as paleopedology and geochemistry, is expected to vindicate Shotwell's fifty-year-old paleoecological conclusions.

Technical Session IV, Sunday 2:15

ON BECOMING AQUATIC: THE CASE OF THE MARINE IGUANA (*AMBLYRHYNCHUS CRISTATUS*) AND THE PACHYPLEUROSAURS FROM THE TRIASSIC OF MONTE SAN GIORGIO, SWITZERLAND

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Positive imbalance between bone resorption and accretion leading to an increase in bone compactness is mainly observed in secondary aquatic reptiles living near-shore and feeding on plants or immobile prey. Bones increased in compactness are more likely to reveal the entire life histories based on histological and skeletochronological data. We studied thin sections of long bones of extinct (Pachypleurosauridae: *Serpianosaurus mirigiolensis*, *Neusticosaurus* spp. from Monte San Giorgio, Switzerland) and extant marine reptiles, hypothesized to be ecologically similar, and of closely related terrestrial taxa (Iguanidae) to gain insight into their life histories. We show that bone compactness changes distinctly from terrestrial to secondary aquatic extant iguanids and the extinct pachypleurosaurs by continuous deposition of periosteal and endosteal bone and by no or only minor resorption.

Long bones of the marine iguanas (*Amblyrhynchus cristatus*) exhibit dense, nearly avascular pachyostotic bones surrounding a medullary cavity. Their innermost periosteal layers (up to two) show fast growing bone tissue (woven-fibered bone grading into parallel-fibered bone) followed by the accretion of lamellar-zonal bone. The pachypleurosaurs from Monte San Giorgio show the same bone tissue types as the marine iguanas. However, their bone compactness additionally increases by retaining a calcified cartilaginous core in the endosteal region. Results also revealed that the *N.* spp. show less compact bones compared to their stratigraphically older relatives. The former exhibit higher vascularization in the periosteum and lower vascularization in the endosteal region where the calcified cartilage is often entirely replaced by trabeculae.

The marine iguana and the *N.* spp. show similar histological and skeletochronological patterns in their long bones, regarding for example the cortical growth and the age of reaching sexual maturity. The stratigraphically older *S. mirigiolensis* shows similarities with completely terrestrial iguanas.

This study focuses on two related reptilian lineages demonstrating striking similarities in the evolution of the life history in secondary aquatic members.

Poster Session III, (Tuesday)

SPATIAL-TEMPORAL LIMITATIONS OF AGE DETERMINATION USING RARE EARTH ELEMENTS WITH NEOGENE FAUNAS FROM FLORIDA

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Rare earth elements (REEs) are exchanged for Ca in bioapatite crystals during fossilization in proportion to those of surrounding pore waters. Analysis of relative concentrations of REEs can date fossils of unknown age from temporally mixed sites. We expand beyond this approach to test the suitability of REE dating in geographically small regions (ca. 500 km^2) with many fossils sites of differing ages. The two areas analyzed were western Alachua Co., Florida (ca. 29.7° N, 82.6° W) with six represented ages (early Miocene–latest Pleistocene), and Bone Valley, Florida (ca. 27.7° N, 81.9° W) with four represented ages (middle Miocene–early Pleistocene). As expected, greater lithologic and taphonomic heterogeneity leads to more variation in REE concentrations in each known-age regional sample of fossils than in specimens from a single locality. But a regional signal preserved in the REE concentrations allows between 75 and 98% of specimens from these two areas to be assigned the correct age using discriminant analysis. Assignment error rates inversely correlate with difference in age between samples. Using the discriminant functions based on fossils of known age, we attempted to date problematic specimens from these two regions. For example, the Haile 1E site, previously undated, is late Blancan. Bone Valley specimens of the large canid *Epicyon haydeni* were previously assigned a latest Hemphillian age, although they lacked stratigraphic provenance, making them the youngest known members of this genus and species. REE analysis dates the majority of these *E. haydeni* fossils to either the Clarendonian or early Hemphillian, the same chronologic range the species has in Nebraska, and calls into question the hypothesis that the species persisted longer in Florida than in the rest of North America. REE analysis was not always successful; e.g., it could not conclusively age a bone of the rhino *Aphelops* from the Bone Valley. REE analysis can do more than date fossils from a single locality with two possible ages. A regional approach will work, at least in some cases, provided the sites within the region share similar depositional and taphonomic histories.

Poster Session II, (Monday)

GEOGRAPHIC VARIATION IN THE JAWS OF HOLOCENE *SPHENODON* (LEPIDOSAURIA: RHYNCHOCEPHALIA) DEMONSTRATED BY LANDMARK ANALYSIS

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The tuatara, *Sphenodon*, is an extant terrestrial reptile mainly restricted to islands off the coast of New Zealand. As the only extant rhynchocephalian it has played an important role in understanding the phylogenetic context of its fossil relatives (such as *Diphydontosaurus*) that were successful and globally distributed during the Mesozoic. However, the extensive Holocene fossil record of *Sphenodon* has been largely overlooked. This record shows that the genus was previously distributed across both the North and South Islands and provides a valuable resource for examining variation related to size and geographic location. Almost 150 Holocene *Sphenodon* dentaries from seven different localities (North Island: 3, South Island: 4) were landmarked and after Procrustes superimposition were subjected to geometric morphometric analysis. Results show that variation in shape includes differences in the dorsoventral height of the element, relative length of the tooth row and posterior process, and shape of the ventral margin and coronoid process. The main ontogenetic changes involve an increase in jaw depth and reduction in relative tooth row length. Multivariate analysis of variance and sum of squares comparisons demonstrates that there are significant shape differences between adult jaws from localities on the same island as well as those from locations separated by the Cook Strait about 450,000 years ago. The amount of shape variation that can be accounted for by location is twice that of latitude and ten times that of longitude. The apparent geographic morphotypes do not necessarily represent different species but they do demonstrate relatively recent geographic variation in *Sphenodon*.A comparison of the Holocene sample to a number of Mesozoic Rhynchocephalia (e.g., *Clevosaurus*, *Cynosphenodon*, *Gephyrosaurus*, and *Priosphenodon*) showed that shape variation was substantially greater between the Mesozoic taxa and no Mesozoic taxon was found to possess a dentary of equivalent shape to that of *Sphenodon*. This contradicts the still widely held notion that *Sphenodon* is no different from its fossil relatives and 'unchanged for over 150 million years'.

Poster Session III, (Tuesday)

ESTIMATION OF CROCODILIAN BODY FORM FROM SNOUT-VENT LENGTH AND TAIL GIRTH

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We present a multiple regression equation which estimates body mass (MBd) from Snout vent length and maximum tail girth (TG) data in 38 American alligators (*Alligator mississippiensis),* ranging in MBd from 5 to 280 kg. The equation has wide applicability because many fossil vertebrates had crocodile-shaped body forms. Dissection of alligators shows that the vent is approximated by the posterior limit of the ischium, providing a landmark for measuring SVL (snout vent length) in fossil vertebrates. Alligator tail girth is approximated by an ellipse whose two axes are respectively the maximum transverse between tips of transverse processes, and the dorsal ventral distance between the ventral chevron and the dorsal spinous process of the vertebrae, a method applicable to fossil vertebrates. This equation has two advantages over equations using Total Length (TL). Firstly, tail length varies more than snout-vent length (SVL) among species, and secondly, it is more likely to find fossil specimens with complete trunks and skulls than specimens which are complete from snout tip to tail tip.

The equation is Log MBd (g) = -4.7346 + (1.8421 x log SVL(mm)) + (1.3774 x logTG).

with r = 0.9913. Logs are log10. Interaction between SVL and TG was not significant (Pr > F =0.0672).

Alligator body masses were normally distributed.

Technical Session II, Sunday 9:30

BONE HISTOLOGY AND GROWTH IN THE PERMO-TRIASSIC THEROCEPHALIAN *MOSCHORHINUS KITCHINGI* (SYNAPSIDA: THERAPSIDA) FROM THE KAROO BASIN OF SOUTH AFRICA

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Therocephalians were an ecologically diverse and speciose clade of non-mammalian therapsids whose fossil record spans the Middle Permian through Middle Triassic. Their remains

are common in nonmarine Permo-Triassic rocks of Africa, exceeded only by those of dicynodonts in abundance, and are well represented by both cranial and postcranial material. Their excellent fossil record and survivorship of the end-Permian extinction make them an ideal group for studying life history evolution during large-scale ecological perturbations. Here, we offer a preliminary report of the long bone histology of the Permo-Triassic akidnognathid therocephalian *Moschorhinus kitchingi* and investigate its life history tactics in the context of the end-Permian extinction. Serial sectioning of 16 elements from nine individuals spanning the Permo-Triassic boundary facilitates a comparison of histomorphologic traits across a broad temporal interval. In general, early subadult *Moschorhinus* display humeral and femoral cortices with extensive woven- and parallel-fibered bone (PFB) with dense, radial and reticular vascularization and a moderately thickened bone wall with annuli and lines of arrested growth (LAGs). Late subadults display a humerus with an increasingly thickened bone wall and a medullary region that is nearly completely occluded by coarse trabeculae. The femoral cortex and outermost cortex of the humerus show more PFB and longitudinally oriented canals at this stage (~70-80% largest size). Most elements display at least one annulus. Beyond these general observations, variation in the degree of cortical vascularity and number of preserved LAGs and annuli cannot be attributed to body size alone, and may, thus, reflect differences in growth strategies adopted in Permian and Triassic environments. These preliminary observations merit further investigation into predicted changes in growth tactics within individual genera and species during the Permo-Triassic transition. Future research phases will investigate the histology of other therocephalians with the goal of understanding large-scale patterns of life history evolution in Permian and Triassic eutheriodonts.

Poster Session III, (Tuesday)

SPECIES AND GENUS-LEVEL VARIATION IN THE TOOTH ENAMEL MICROSTRUCTURE OF TYRANNOSAURID DINOSAURS

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To date, the vast majority of studies on dinosaur enamel microstructure have been concerned with broad evolutionary patterns among Dinosauria and have mostly ignored finer-scale differences among species or genera of the same clade. Preliminary work was undertaken within Dromaeosauridae to verify if diagnostic enamel characters are present at the generic level. Despite the simplicity of their enamel, there were distinctive combinations of characters, or schmelzmusters, found for each study taxon. To further explore the utility of enamel microstructure in differentiating dinosaur genera and species, the enamel of eleven tyrannosaurid specimens was examined. Five specimens were from known species or genera, while the rest were indeterminate. The enamel microstructure of tyrannosaurids is relatively complex, as it is composed of up to four enamel types organized around a dense network of tubules. The enamel of most theropods, in contrast, contains only one simple enamel type. Predictably, diagnostic schmelzmusters were found for each known tyrannosaurid taxon. Discrete diagnostic features include the presence or absence of a well-defined basal unit layer and/or incremental lines; cross-sectional diameter and shape of columnar units; and density and location of enamel tubules. More subjective diagnostic characters involve the general appearance of the columnar enamel that makes up the bulk of tyrannosaurid schmelzmusters. For instance, some columns were linear and uniform while others were wavy and variable. Also, some columns were discernable up to the outer enamel surface (OES), while others lost definition towards the OES and formed an amorphous layer of parallel crystallites. Where the latter was observed, the percentage of total enamel thickness the amorphous layer comprised was noted. Data from the known taxa were used to narrow the identities of the indeterminate specimens. For example, UCMP 150589 was tentatively identified as *Daspletosaurus*, as they shared the absence of a BUL, a jagged column appearance, a less pronounced column narrowing, rectangular column cross sections, and similar proportions of the amorphous layer to total enamel thickness.

Poster Session III, (Tuesday)

A UNIQUE ANCIENT ECOSYSTEM: THE THEROPOD DOMINATED LATE CRETACEOUS KEM KEM DINOSAUR ASSEMBLAGE OF SOUTH EAST MOROCCO

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Despite uniformitarian arguments to the contrary, as knowledge of the deep past has grown it has become increasingly clear that some ancient vertebrate ecosystems have no modern analogues. Possible examples, such as the fossil assemblage from the Late Cretaceous Kem Kem beds of Morocco, present two challenges: (1) to demonstrate that such candidate ecosystems are truly unique and are not taphonomic artefacts; (2) to identify principal components (e.g. trophic structure) of such ecosystems. Although articulated skeletons are rarely found in the Kem Kem sequence, large numbers of isolated finds from several localities permit a detailed assessment of taxonomic diversity, as well as the temporal and geographical distribution of taxa. Fossils of fish, amphibians, turtles, crocodyliforms, pterosaurs and dinosaurs, reveal a diverse ecosystem with several highly unusual features. Arguably the most striking of these is that theropod remains, representing *Carcharodontosaurus*, *Deltadromeus*, *Spinosaurus*, a '*Rugops* –like' abelisaur and several undescribed taxa, completely dominate the dinosaur macrofossil and ichno-assemblages. Significantly, at least three genera reached or surpassed the size of *T. rex*. By contrast, ornithopod fossils are extremely rare and sauropods, while taxonomically more diverse (*Rebbachisaurus* and possibly two other unnamed, large forms), are also only represented by sparse records. The co-occurrence of principal taxa in multiple localities and horizons in the sequence, an absence of obvious taphonomic biases affecting vertebrate remains, present in some other predator dominated assemblages, and a repetition of this unique taxonomic profile in geographically remote, but essentially contemporaneous units such as the Bahariya Formation in Egypt, suggest that the taxonomic composition of the Kem Kem cannot be explained away as a purely taphonomic artefact. The ecology of the Kem Kem vertebrate biota is uncertain, but profound differences in the jaw morphology and postcranial anatomy of the large theropods suggest a number of feeding specialisations (macrophagy, piscivory and possibly omnivory) that go some way toward explaining this unusual assemblage.

Poster Session IV, (Wednesday)

A NEW ORNITHOPOD (DINOSAURIA: ORNITHISCHIA) SPECIMEN FROM THE UPPER CRETACEOUS BAJO BARREAL FORMATION OF PATAGONIA, ARGENTINA

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We describe an associated partial postcranial skeleton as the third definitive ornithopod dinosaur record from the Upper Cretaceous Bajo Barreal Formation of central Patagonia, Argentina. Specifically, the specimen was recovered from the uppermost Cretaceous (Campanian-?Maastrichtian) Upper Member of the Bajo Barreal Formation as exposed on an ephemeral island in the southeastern portion of Lago Colhué Huapi in southern Chubut Province. Identifiable skeletal elements include four partial dorsal vertebrae, three incomplete proximal caudal vertebrae, a middle caudal neural arch, a partial distal caudal vertebra, a dorsal rib fragment, the right calcaneum, and portions of the left metatarsal III and right metatarsal IV. Comparisons with corresponding elements of other ornithischians indicate that the material pertains to a medium-sized, non-hadrosaurid ornithopod. In particular, the morphology of the calcaneum is characteristic of these dinosaurian herbivores. The new discovery enhances our understanding of the latest Cretaceous continental vertebrate assemblages of central Patagonia and adds to the generally meager record of Late Cretaceous ornithischians from the Southern Hemisphere. Furthermore, it is important in constituting a representative of Ornithischia from the same general geographic region, and probably an equivalent stratigraphic unit, as two problematic members of this clade: the supposed ceratopsian *Notoceratops* and the fragmentary hadrosaurid *Secernosaurus*. The taxon represented by the new specimen may therefore have relevance for resolving the controversies surrounding the stratigraphic provenance of both of these Patagonian ornithischians and the systematic position of *Notoceratops*.

Poster Session I, (Sunday)

A FOSSIL ANURAN FROM THE LOWER CRETACEOUS SASAYAMA GROUP OF HYOGO PREFECTURE, SW JAPAN

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The Lower Cretaceous formation of the Sasayama Group is distributed in the eastern part of Hyogo Prefecture, Southeast Japan. The formation is composed mainly of conglomerate, sandstone and mudstone intercalating several tuff beds which yield zircon FT ages of ca 120 Ma to 140 Ma. In 2006, a new terrestrial vertebrate fossil assemblage was found from the red mudstone of the formation on the bank of the Sasayama River in Tanba City. During four seasons of excavations from 2007-2010, more than 10,000 fossil specimens such as partial skeleton of an individual sauropod, shed teeth of theropods and ornithopods, and microvertebrates, were collected from the formation. The microvertebrate assemblage consists of mainly fragmental elements of anurans such as tibiofibula and humerus, and of some disarticulated specimens of lizards. In addition to these fragmental specimens, a few articulated skeletons of anuran were also discovered. One of these specimens, which is nearly complete but compressed skeleton, shows some ancestral characters of anurans such as free ribs of presacral vertebrae, and an ilium having a plain shaft with cylindrical cross section. A preliminary phylogenetic analysis of the specimen was conducted on the basis of previous published taxon-character data. The analysis found six most parsimonious trees, and all of these trees indicate that the fossil anuran is a basal member of the Archaeobatrachia. Preparation of the specimen and other articulated fossil frogs is still in progress. Further investigations of these specimens will help to clarify the taxonomic diversity of fossil anurans from the Early Cretaceous which are relatively rare compared with these of the Late Cretaceous.

Poster Session I, (Sunday)

TAPHONOMY AND SEDIMENTOLOGY OF A BONEBED FROM THE UPPER CRETACEOUS MIFUNE GROUP IN KYUSHU, JAPAN

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The "Upper" Formation of the Mifune Group (Coniacian - Santonian) is the most productive sediment for terrestrial vertebrate fossils in the Upper Cretaceous of Japan. Two bonebeds, 1004-A and 1004-B, assigned to the middle part of the non-marine "Upper" Formation,

cropped out at the same quarry in Mifune Town. To evaluate the taxonomic reconstruction of the vertebrates from the Mifune Group, I present here the taphonomic and sedimentological data of the bonebed in the Mifune Group. The facies of bonebed 1004-A is a greenish gray siltstone alternated with thin fine sandstone beds representing reverse grading, and siltstone that contains large amounts of plant fragments. Therefore this facies is interpreted as a levee and flood plain deposit. Although the collected specimen is still insufficient, taxonomic composition of bonebed 1004-A might be monodominant. The material consists of isolated theropod, a few crocodyliforms, and turtle elements. The facies of bonebed 1004-B, lying under 1004-A, is a pebbly sandstone accompanied by rip-up mud clasts. The sandstone units show fining-upward, are cross-stratified, and have an erosional basal contact. This facies may suggest channel-fill fluvial deposits. About 1100 specimens indicate that this bonebed has multidominant and high diversity taxa; the taxonomic composition consists of at least 3 lineages of theropods, hadrosauroid, ankylosaurid, crocodyliforms, 6 genera of turtles, actinopterygians, and eutherian mammals. Because there are several degrees of abrasion stages and breakage classes, it suggests variable accumulation processes on each of the bones. It is considered that the remains in bonebed 1004-A were preserved in the overbank deposit without reworking, while reworking and concentration of fossils from the previous sediments formed bonebed 1004-B in the meandering river system. Although both marine and paralic depositional settings are abundant in the Upper Cretaceous of Japan, these results indicate the terrestrial and freshwater vertebrate paleocommunity was also diverse in the Late Cretaceous of the active margin of East Asia.

Technical Session XIV, Wednesday 9:30

ANATOMY OF THE BASAL THEROPOD *TAWA HALLAE* AND ITS IMPLICATIONS FOR EARLY DINOSAUR PHYLOGENY

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Much of our understanding of early theropod dinosaur evolution relies on the Late Triassic taxa *Herrerasaurus* from South America and *Coelophysis bauri* from western North America, two disparate body plans that share few derived character-states. *Tawa hallae*, a basal theropod from the Petrified Forest Member of the Chinle Formation in northern New Mexico (Ghost Ranch), fills this morphological gap. Known from multiple well-preserved and nearly complete skeletons, *Tawa* provides new osteological data for understanding basal theropod evolution and early dinosaur relationships. *Tawa hallae* shares several characters with neotheropods, such as a subnarial gap between the premaxilla and maxilla, pneumatic openings in the cervical vertebrae, and a symmetrical, blade-like fourth trochanter on the femur, whereas it also retains some plesiomorphic features that are widespread among basal dinosaurs, including a restricted antorbital fossa on the maxilla, a short pre-acetabular process of the ilium, and an elongated metatarsal I. To test the phylogenetic relationships of *Tawa* and basal dinosaurs, we performed a parsimony analysis on a comprehensive dataset consisting of 41 taxa and 315 characters. *Tawa* is recovered as the sister-taxon to Neotheropoda with strong character support values. The transitional mosaic of character-states present in *Tawa* strengthens the placement of herrerasaurids, *Chindesaurus*, and *Eoraptor* as basal theropods rather than basal saurischians. Crucially, *Tawa* helps polarize character-states within Neotheropoda, demonstrating that many features previously thought to be coelophysoid synapomorphies may actually represent neotheropod plesiomorphies. This further splits the traditional Coelophysoidea into a paraphyletic grade of basal neotheropods, which reduces several Late Triassic and Early Jurassic theropod ghost lineages. These data suggest that *Tawa* is vital to understanding character evolution and phylogenetic diversification among early dinosaurs and neotheropods alike.

Technical Session XIV, Wednesday 12:00

UNCOVERING THEROPOD EGGS: WATER VAPOR CONDUCTANCE AND NESTING STRATEGY OF *TROODON*

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The water vapor conductance rate (G_{H2O}) calculated for a fossil egg provides important information on nesting environment when compared to eggs of modern reptiles and birds. Most avian eggs are exposed to the atmosphere during incubation, and the eggs exhibit low porosity and gas conductance that aid in water conservation, while permitting adequate oxygen and carbon dioxide exchange. In contrast, reptiles typically incubate their eggs underground or in vegetation mounds characterized by high humidity and low oxygen conditions. Accordingly, their eggs are far more porous and typically have G_{H20} values four to eight times greater than those of birds. *Troodon* egg clutches consist of tightly packed, elongate eggs standing near vertical within the substrate. A lithologic change occurs at roughly two-thirds of the egg length. Potential incubation modes hypothesized for troodontid eggs include complete burial within a substrate or partial burial with the upper portion covered by a vegetation mound or by an attending adult. To test these hypotheses, we analyzed eggshell thin sections from five locations on the asymmetrical *Troodon* egg. The pore density in the upper half of the egg is 2x greater than in the lower portion. This variation in porosity suggests the presence of distinct incubation media for the lower and upper portions of the egg. The mean G_{H2O} of 46 mg water per day Torr calculated for the entire egg is comparable to the 45 mg of water per day Torr of an avian egg of comparable mass. This low water vapor conductance supports previous interpretations that the eggs were partially buried and incubated by an adult.

Physical Drivers and Marine Tetrapod Evolution, Monday 9:15

PHYSICAL DRIVERS OF EVOLUTION AND THE HISTORY OF THE MARINE TETRAPOD FAUNA OF ANGOLA

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Modern marine species populations are often evaluated in terms of bottom-up, resource limited structure, or top-down, predator controlled structure. In a larger timeframe, investigation of physical drivers in marine tetrapod evolution relies on the recognition of patterns and the correlation in timing of physical events with biotic change. However, it has been demonstrated through the study of fossil cetaceans that a broader deep-time perspective within a top-down or bottom-up framework is informative. Here we examine the fossil record of Cretaceous marine tetrapods in Angola to discern patterns that may reflect physical drivers of evolution, and that are also relevant to population structure. In modern marine ecosystems, distribution patterns reflecting primary productivity are indicative of bottom-up control. In the fossil record, productivity-controlled distribution patterns can also be perceived. Physical parameters resulting in environmental stability, sea-level change, oceanic anoxic events, paleoclimate, and paleogeography are examined in comparison with taxonomic diversity and life history patterns. Mosasaurs originated during a time of high global temperatures and shallow temperature gradients. As upper-trophic-level species of modest size and plesiopedal limb structure (capable of terrestrial locomotion), early mosasaurs were subject to both top-down and bottom up pressures. The attainment of larger size coupled with emigration and biogeographic distribution in areas of high primary productivity, and niche differentiation shown by $\delta^{13}C$ values, indicate bottom-up pressures. Productivity along the African coast since the formation of the Atlantic Ocean facilitated the co-occurrence of diverse marine tetrapods through time, and has culminated today in the Benguela large marine ecosystem. Just as the current Benguela ecosystem has tetrapod species populations dominated by both bottom-up (cetaceans) and top-down strategies (sea birds and pinnipeds), so too did the Cretaceous community, with mosasaurs and plesiosaurs having predominantly bottom-up population structure, while sea turtles and pterosaurs were more subject to top-down pressures.

Poster Session IV, (Wednesday)

ON THEIR KNEES: DISTAL FEMUR ASYMMETRY IN UNGULATES AND ITS RELATIONSHIP TO BODY SIZE AND LOCOMOTION

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Distal femur asymmetry (where the medial trochanteric ridge is larger than the lateral one) has been observed in horses, where associated with a stay apparatus, and bovids, where associated with open habitat preference. We measured femora of 63 species of ungulates (including 21 extinct species, plus 3 proboscideans, and 3 carnivorans) and plotted the degree of asymmetry against a body size estimate (average femur cross-sectional diameter). Carnivores, camelids, and proboscideans show little asymmetry. Within other ungulates there is a clear correlation between the degree of asymmetry and body size. Within ruminant artiodactyls asymmetry also correlates with habitat: open habitat species have more asymmetric femora than closed habitat ones, a pattern also seen among rhinos and tapirs. Among equids, extinct brachydont species (assumed to be closed habitat) have a lesser degree of asymmetry than hypsodont ones (open habitat). Both the lack of asymmetry in camelids and proboscideans, and the greater degree of asymmetry among open habitat forms, imply a correlation with locomotor behavior. Most ungulates use the gallop gait at high speeds, during which they land on a single hind limb from a period of suspension. Neither camelids (habitual pacers), nor proboscideans (whose fast gait is an amble), would be likely to experience this type of hind limb stress. (Interestingly, the included chalicothere and brontothere show little asymmetry, indicating an elephant-like, versus rhino-like, gait.) Additionally, open habitat ungulates would be more likely to habitually gallop than closed habitat ones. We propose that distal femur asymmetry in ungulates is related to supporting the body mass, including a large gut mass, during the gallop. (The issue of gut mass may explain why large cursorial carnivores do not exhibit femoral asymmetry.) By analogy with humans, where a larger lateral trochanter resists lateral dislocation of the patella, the larger medial trochanter in ungulates may resist medial patella dislocation. Scaling factors (e.g., gut mass versus muscle cross-sectional area) would make this issue more acute in larger galloping ungulates, hence their greater degree of femoral asymmetry.

Poster Session II, (Monday)

A NEW SMALL PACHYCEPHALOSAURID FROM THE SAN JUAN BASIN, NEW MEXICO AND A RE-EVALUATION OF PACHYCEPHALOSAURIDS FROM THE KIRTLANDIAN LVA (LATE CAMPANIAN)

JASINSKI, Steven, State Museum of Pennsylvania, Harrisburg, PA, USA; SULLIVAN, Robert, State Museum of Pennsylvania, Harrisburg, PA, USA

Two partial pachycephalosaurid skulls, from the upper Fruitland and lower Kirtland formations (Upper Cretaceous), are recognized as belonging to a new species of *Stegoceras*. This new pachycephalosaurid differs from the only other recognized species of *Stegoceras* (sensu stricto) in possessing: a reduced and sub-rectangular posteromedial extension of the parietal; parallel squamosal sutural surface contacts of the posteromedial extension of the parietal; enlarged and medially positioned supratemporal fenestrae; and a small (adult) size. Fusion of the frontal and parietal in one specimen, coupled with a smooth dorsal surface of the frontoparietal dome, is consistent with an adult ontogenetic stage. Gross histology reveals four histomorphs, the fourth (outer-most layer) indicates arrested growth, further attesting to its mature state. The new pachycephalosaurid is known from, and restricted to, the upper Fruitland Formation (Fossil Forest Member) and lower Kirtland Formation (Hunter Wash Member); the collective vertebrates from these contiguous strata make up the Hunter Wash local fauna. Contrary to previous reports, the *Prenocephale* (=*Sphaerotholus*)-like pachycephalosaurids are not known from the early Kirtlandian, but are restricted to the Willow Wash local fauna of the upper Kirtland Formation (De-na-zin Member). This new pachycephalosaurid is temporally younger (Kirtlandian) than the well-known *Stegoceras validum* from the Judithian of Alberta, Canada.

Poster Session I, (Sunday)

RELATIVE ABUNDANCE OF LATE PLEISTOCENE MEGAFAUNA IN CENTRAL ALBERTA, CANADA

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The late Pleistocene history of Alberta includes a record of the ultimate ecosystem disturbance (i.e., a total loss of plant and animal life) caused by the coalescence of glacial ice across much of the province. Subsequent glacial retreat allowed for the return of plants and animals to Alberta. Therefore, Alberta's Quaternary faunal record has the potential for providing perspective on how mammals respond as ecologically disturbed regions become available for re-colonization. Significant work has gone into describing the Ice Age fauna from Alberta, but as of yet, relatively little work has been dedicated to understanding the actual structure of Quaternary faunal assemblages in the province. Development of such a dataset will be necessary to fully understand the composition of pre- and post-glacial faunas in the province, and may eventually provide an important historical perspective for modern conservation questions.

Pleistocene fossils collected from gravel deposits near Edmonton were used to examine patterns of relative abundance of megafauna from both pre- and post-glacial time periods. Relative abundance for genera of Pleistocene megafauna was calculated using the number of individual specimens (NISP) from twelve individual localities (i.e., gravel pits) comprising two regional data sets. Pre-glacial localities with reasonable numbers of radiocarbon ages (n > 5) are dominated by horse (*Equus*). Mammoths (*Mammuthus*) and bison (*Bison*) are common, but other megafauna (e.g., Jefferson's ground sloth [*Megalonyx*], Yesterday's camel [*Camelops*]) are comparatively rare. There is some indication that post-glacial faunas are dominated by *Bison* rather than *Equus*, but further radiocarbon age data are needed to verify this.

Poster Session III, (Tuesday)

PREDATION ON EARLY MIOCENE PRIMATES, *PROCONSUL*, *DENDROPITHECUS* AND *LIMNOPITHECUS* FROM RUSINGA ISLAND

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Early Miocene deposits from Rusinga and Mfangano Islands, Kenya, have yielded one of the largest collections of primate fossils in the world. In addition to these rich primate assemblages, more than 50,000 mammal, reptile, bird, invertebrate, and macrobotanical fossils are known, presenting a unique opportunity to study the ecology and faunal communities in which these early primates lived. Here, I present the first formal taphonomic analysis of the primate assemblage in order to identify the accumulating agents of these Miocene catarrhines. Preliminary reports of damage and skeletal part frequencies of *Proconsul* fossils suggested that some individuals were accumulated as prey by medium-sized creodonts. I further tested this hypothesis by comparing surface modifications and skeletal part frequencies to actualistic studies of modern carnivore assemblages as well as modern raptor assemblages. Data on the location, frequency, and size of tooth pits, gnawing, probable raptor damage and insect modification, and where possible, breakage patterns were collected on specimens of *Proconsul*, *Dendropithecus,* and *Limnopithecus.* I accounted for post-depostional deletion of skeletal parts by examining weathering stages and fragmentation. Multiple tooth pits on fossil long bone shafts and gnawing on the epiphyseal ends of fossil long bones are consistent with damage produced by modern carnivores. I also found irregular punctures marks on fossils consistent with damage left by modern raptors when de-fleshing carcasses. These results confirm that creodonts were responsible for accumulating a portion of the primate assemblage on Rusinga Island, but suggest that raptors also preyed upon the smaller species of *Proconsul*, *P. heseloni*. These results represent the first evidence of raptor predation on fossil primates from Rusinga, and further inform our understanding of the selection pressures faced by our earliest hominoid ancestors.

Technical Session VIII, Monday 3:00

MODES OF GNATHOSTOME FIN SPINE DEVELOPMENT INFERRED FROM THREE-DIMENSIONAL HISTOLOGY

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Dermal spines are found on some extant shark and bony fish groups, but in the past they had a much wider taxonomic distribution across early stem- and crown-group gnathostomes. When spines are associated with median and/or paired fins they are referred to as fin spines. Fin spines usually only appear in crown gnathostomes but morphologically similar spiny structures have been identified on stem gnathostomes. There is a large degree of morphological diversity in spines which has rendered them useful taxonomic tools, but questions about their growth and evolution remain unanswered. Here, I present a comparative analysis of spine vascularization using detailed three-dimensional reconstructions of placoderm (*Romundina*) and acanthodian spines as well as a putative osteichthyan spine base from the Devonian of Scotland. The specimens were scanned at the European Synchrotron Radiation Facility (ESRF) in Grenoble and permit virtual three-dimensional reconstruction of vascular architecture of the spines. These reconstructions of the material show that the spines from the placoderm and acanthodian each have their own unique vascularization, indicating different growth modes. The vascular architecture of the acanthodian spine is organized into three layers of bifurcating longitudinal canals, implying that the oldest part of the spine is the tip. In contrast, the oldest part of the *Romundina* spine appears to be the middle part of the anterior edge, and growth continued in all directions from that point to create the overall shape of the spine. Dentine elements (the outer mantle of the acanthodian spine, a superficial layer of tubercles in the *Romundina* spine) were also added and organized in fundamentally different ways. The putative osteichthyan spine base contains endochondral bone, a tissue unknown in acanthodians and placoderms.The evidence shows that morphologically similar spines in early vertebrates grew quite differently despite their overall external similarities and creates a potentially rich source of phylogenetic characters.

Technical Session IV, Sunday 2:00

PHYLOGENETIC ANALYSIS OF SHASTASAURIDAE ILLUMINATED BY *GUIZHOUICHTHYOSAURUS* FROM CHINA INDICATES A POSSIBLE PATHWAY OF THE MIGRATION OF THIS FAMILY

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Shastasauridae has been widely reported from the Middle Triassic of Italy and the Late Triassic of North America. During the last decade, a large number of *Guizhouichthyosaurus* (Shastasauridae) were found from South China, filling the paleogeographic gap. The stratigraphic sequence of this family is, from older to younger: *Besanosaurus* (Anisian-Ladinian boundary), *Guizhouichthyosaurus* (Late Ladinian and Early Carnian), *Shastasaurus* and *Shonisaurus* (Late Carnian and Norian).

The phylogeny of Shastasauridae was analyzed based on a published data matrix by adding *Guizhouichthyosaurus*. The matrix contained 105 characters and 34 species. A maximum parsimony analysis resulted in 12 most parsimonious trees with CI=0.5940, RI=0.8372, TL=234. The tree topology suggests that Shastasauridae is monophyletic: (*Besanosaurus*, (*Guizhouichthyosaurus*, (*Shastasaurus*, *Shonisaurus*))), with ten characters supporting the basal node: long parietal supratemporal process, squamosal not participation in UTF, humerus squarish, radius contiguous shaft notched, upper and lower dental groove absent, pubis obturator foramen mostly in but open on one side, more than 60 vertebrae centra and tibia wider than long, etc. *Guizhouichthyosaurus* is the sister group of *(Shastasaurus*, *Shonisaurus*), supported by maxilla dorsal lamina, scapula axis and glenoid facet orientations at about 60 degrees, radius more than 1.5 size of ulna. The phylogenetic sequence is in accordance with the stratigraphy and paleogeographic distribution of the family, indicating that Shastasauridae possibly migrated to South China from Western Tethys during the Middle Triassic and then spread to Eastern Pacific during the Late Triassic. They later had multidirectional migration pathways as there are *Himalayasaurus* specimens found in the Norian of Tibet (Western China).

Guizhouichthyosaurus shared some characters with *Besanosaur*us and some other characters with *Shastasaurus*. Some characters suggest progressive changes from *Besanosaurus to Shastasaurus* through *Guizhouichthyosaurus.* For example, the radius/ulna length ratio is 1.2 in *Besanosaurus*, 1.5 in *Guizhouichthyosaurus* and 2.0 in *Shastasaurus*.

Poster Session II, (Monday)

COMPARISON BETWEEN THE CHINESE MIDDLE TRIASSIC MARINE REPTILE FAUNAS AT THE EAST END AND THE MONTE SAN GIORGIO FAUNA AT THE WEST END OF TETHYS

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Three Middle Triassic marine reptile faunas are known from the Tethys: the middle Anisian Panxian-Luoping *Mixosaurus panxianensis* Fauna (about 240 mya) in the eastern part; the Anisian/Ladinian boundary Monte San Giorgio *Mixosaurus cornalianus* Fauna (about 237 mya) in the western part; and the latest Ladinian Xingyi-Fuyuan *Keichousaurus hui* Fauna (about 230–228 mya) in the East.

The Panxian-Luoping Fauna shows a strong similarity to the younger Monte San Giorgio Fauna by the co-occurrence of several genera of marine reptiles and fishes, e.g. *Mixosaurus*, *Placodus*, *Nothosaurus*,*and Lariosaurus*, occurring in the course of global sea level rises on the stage-scale and the period-scale. They represent a rapid biotic radiation and the quick westward establishment of a new vertebrate ecosystem with concurrent marine paleoenvironmental stabilization along the northern coastline of the Paleotethys. Recent collection of new phreatoicidean isopod fossils,similar to Australian fresh water *Protamphisopus wianamattensis*, also reveals a potential southward (Australian) invertebrate paleogeographic affinity.

The Xingyi-Fuyuan Fauna, comparing to the older Monte San Giorgio Fauna, has no confirmed record of *Mixosaurus*, but still yields *Nothosaurus*, *Lariosaurus*, as well as the pachypleurosaur sauropterygian *Keichousaurus*, the askeptosaurid thalattosaur *Anshunsaurus*, and the shastasaurid ichthyosaur and cyamodontoid placodonts. More interesting is that the strange *Tanystropheus* and the terrestrial *Macrocnemus* appear in both faunas, even though the Monte San Giorgio Fauna is about 7 million years older. The level of Xingyi-Fuyuan Fauna corresponds to the last stage of the Middle Triassic biotic radiation in a stable marine paleoenvironment, and in the stage-scale regressive course, but on the period-scale in the process of the global regression. It might be a result of eastward migration from the western Tethys.

Poster Session III, (Tuesday)

CROCODYLIFORMS FROM THE EARLY MIOCENE DOMO DE ZAZA LOCALITY OF CUBA

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The Domo de Zaza locality is an Early Miocene deposit located in the province of Sancti Spiritus (south-central Cuba). Terrestrial, lagoonal, and marine environments are represented, and at least two enigmatic crocodyliforms can be identified. One is currently only known from distinctly compressed serrated teeth closely resembling those of *Sebecus* and related forms from the Cenozoic of South America. The other is known from fragmentary cranial and mandibular material and is more difficult to assess. The dentary symphysis is short and the lateral squamosal groove does not flare anteriorly, arguing against tomistomine or gavialoid affinity. It has a dorsoventrally expanded medial quadrate hemicondyle resembling that of crocodyloids (though not with the same degree of expansion), but the lateral Eustachian foramina open dorsolateral to the median foramen, which argues against a close relationship with *Crocodylus*. The quadrate foramen aereum is not dorsolaterally shifted on the quadrate ramus, as it would be in an alligatoroid, but the squamosal-quadrate suture intersects the posteroventral corner of the external otic aperture, a feature unique to alligatoroids. The supratemporal fenestrae are unconstricted and the descending lamina of the exoccipital does not extend to the basioccipital tubera, arguing against a relationship with caimans. A sebecid in the Miocene of Cuba would be consistent with evidence from other vertebrates suggesting extensive dispersal between the Greater Antilles and South America during the Neogene, and it would be the first Neogene record of the group outside South America. The other crocodyliform may indicate the presence of an endemic West Indian lineage not closely related to any living group during the Neogene.

Poster Session IV, (Wednesday)

***BISON ANTIQUUS* FROM NORTHWESTERN OAXACA, SOUTHERN MEXICO**

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Newly discovered specimens of a skull with horn cores, horn core fragment and several isolated molars were collected from Late Pleistocene floodplain and lateral bar fluvial deposits that crop out in the Mixteca region of northwestern Oaxaca, between 17º 35'-17º 55' Lat N and 97º 20'-97º 40' Long W. The associated fauna collected from the same strata include lizards, glyptodonts, rodents, two llama species, deer, two equid species, two proboscidean species, as well as nine taxa of terrestrial and freshwater mollusks.The bovid specimens have the diagnostic cranial features of *Bison antiquus*, which include medium-sized horn cores (38 cm burr to tip), which are downwardly arched and ventral to the frontals; horn core growth straight; horn core tip cordiform that lies well anterior to the occipital plane; horn core posterior margin straight; frontals slightly domed, occipitals nearly flat. The teeth are hypsodont with prominent ribs and styles/stylids and with dimensions within the reported range for the species.*Bison antiquus* had a wide geographic distribution in North America during the Rancholabrean, from Alaska, south-central Canada, western, central and southeastern USA and central Mexico. Also, in Central America there are two records, one from El Salvador and other from Nicaragua. The record of *B. antiquus* in southern Mexico links its former records, which are separated each other more than 1,200 km and further confirms this wide geographic distribution.Recent mesowear analysis showed that signals of Pleistocene *Bison* samples from USA are more typical of not extreme grazers or mixed-feeding ungulates. The *Bison antiquus* from northwestern Oaxaca has a mesowear univariate score of 1.44, which is in the lower extreme of grazers (plain *Bison* is on upper extreme, score 2.73) and the upper end of mixed-feeders; a sample of this species from New Mexico has a score of 1.31. This indicates that the Mexican specimens had a less abrasive diet than modern plain *Bison* and that they probably incorporated some browse in their diet or ate different types of grasses compared with the Recent *Bison*.

Poster Session II, (Monday)

FIRST EVIDENCE OF A TYLOSAURINE MOSASAUR FROM CHILE

JIMÉNEZ-HUIDOBRO, Paulina, Universidad de Chile, Santiago, Chile; OTERO, Rodrigo, Consejo de Monumentos Nacionales, Santiago, Chile; RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago, Chile

We report here a left ischium of a large tylosaurine mosasaurid (SGO.PV.6650, National Museum of Natural History of Santiago, Chile) from the late Campanian beds (based on fossil invertebrates with good chronostratigraphic value) of the Chanco Formation (Region del Maule, Central Chile). The bone displays a sigmoidal shape preserving its acetabular portion, without well-differentiated facets. The external surface is convex and smooth, while the internal surface is flat and wrinkled. The transverse section is elliptical and the distal and medial margins show a reduction of the bone thickness, suggesting the presence of a blade-like portion that is not preserved. The sigmoidal shape differs from the straight ischium seen in *Mosasaurus* and *Platecarpus*, while in *Clidastes*, this bone has a reduced acetabular portion and broader general shape. SGO.PV.6650 most closely corresponds to the ischium of the genus *Tylosaurus*. The most compressed portions of SGO.PV.6650 match the gracile processes of the ventral portion of the ischium of *Tylosaurus*. Since SGO.PV.6650 does not preserve the anterior or ventral processes, it is not possible to establish an accurate generic identification; nevertheless its morphologic affinities allow us to refer it to the subfamily Tylosaurinae. This is the first occurrence a Tylosaurinae in Chile and southern portion of South America. A comparison between the Chilean tylosaurine and *Lakumasaurus antarcticus* from northeast Antarctic Peninsula will help to understand the biogeography of tylosaurines (in particular the Weddellian Biogeographic Province), in the southern hemisphere while highlighting the fossiliferous potential of this region.

Technical Session VIII, Monday 2:00

FUNCTIONAL MORPHOLOGY OF THE EARLIEST VERTEBRATE FEEDING STRUCTURES

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Teeth constitute the majority of the vertebrate fossil record and are typically the first site of direct interaction between an animal and its food; this makes them obvious targets for the application of engineering approaches to understanding their functional morphology. Such work is well advanced for mammals, together with many reptile and fish groups. However the potential of such methods for elucidating conodont functional morphology remains unexplored, despite conodonts representing a major portion of Paleozoic and early Mesozoic marine vertebrate diversity and possessing an excellent fossil record, which preserves a variety of tooth forms rivalling or surpassing that of other vertebrate groups. To address this shortcoming, we have conducted the first rigorous analysis of conodont tooth function based upon engineering principles. Following a similar methodology to that previously applied to mammals, our approach treats conodont teeth as tools. We have concentrated on the food processing (P_1) teeth and focussed initially on those with a flattened, blade-like morphology. We have tested the current hypothesis of P_1 tooth function through analysis of the geometry of function – relating to the most efficient shape for food fracture – in a range of taxa. This has revealed that the diversity of conodont tooth morphology in fact reflects a diversity of function and occlusal mechanics. We demonstrate how changes in size and shape of the functional components (e.g. cusps and denticles) influence functional mode (cutting versus puncturing). For the first time, this has established constraints on the properties of the food types consumed by conodonts (e.g. viscoelastic versus brittle). This work will ultimately help place evolutionary changes in conodont tooth morphology within a functional and ecological context and allow investigation of the extent to which functional mechanics of blades can be generalised, thereby permitting an assessment of functional convergence in feeding structures in other vertebrates.

Technical Session XIII, Tuesday 3:45

DISCORDANT CRANIAL MORPHOLOGICAL DISPARITY AND TAXONOMIC DIVERSITY IN PINNIPED VERSUS FISSIPED CARNIVORANS

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Species number is a common measure of a clade's diversity, but taxonomic diversity and morphological disparity are not always concordant. Here we demonstrate the discordance of taxonomic and morphological diversity in the order Carnivora. In evolutionary studies, Carnivora is often treated as two groups: monophyletic aquatic pinnipeds (e.g., seals) and paraphyletic fissipeds, which include terrestrial, arboreal, fossorial, and semi-aquatic species. Fissipeds date from the early Paleocene and are more taxonomically diverse (129 extant and over 300 extinct genera), while pinnipeds date from the late Oligocene and are less diverse (21 extant and 48 extinct genera). To test if this taxonomic diversity also translates to morphological disparity, we collected 3D landmark coordinate data (k=23) from the crania of 37 extant and extinct fissiped species (n=64), encompassing all extant families and the full breadth of ecological diversity, and 28 extant species of pinnipeds (n=67). After Procrustes superimposition and Principal Components Analysis, morphological disparity of the two groups was measured in three ways: A) mean pairwise Procrustes distance; B) mean Procrustes distance from the group centroid; and C) convex hull volume. Results for all three disparity measures show that pinniped cranial disparity is significantly greater than that of all fissiped carnivorans (Disparity B, p=0.02) and that of their sister clade, Musteloidea (B, p=0.01). Analyses of cranial regions further show that pinniped facial disparity is significantly larger than that of fissipeds. Pinniped disparity is greater in the zygomatic/orbital region, while fissiped disparity is greater in the palatal region. Rostral disparity is equal in Disparity A and B, but much greater in pinnipeds in Disparity C, which measures morphospace occupation, indicating that there are a few species with very unusual rostral morphology. The specialization of the postcranium during the terrestrial-marine transition, and the related shift of prey capture and mating display functions to the cranium, have likely driven the remarkable cranial disparity in pinnipeds, despite their low taxonomic diversity.

Technical Session IV, Sunday 3:00

CRANIAL JOINTS IN *SPHENODON* (RHYNCHOCEPHALIA) AND ITS FOSSIL RELATIVES WITH IMPLICATIONS FOR LEPIDOSAUR SKULL MECHANICS

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The tuatara, *Sphenodon*, is the sole survivor of the Rhynchocephalia, a diapsid group that was widespread during the Mesozoic. Increasing evidence shows that rhynchocephalians were anatomically diverse with respect to feeding apparatus and skull shape. Moreover, there is an apparent evolutionary trend towards increased bite force as indicated by shorter outlevers, stouter teeth, and larger adductor chambers in derived taxa. One aspect of skull anatomy that remains largely overlooked in most vertebrate clades is variation in the structure of cranial joints. In life these are held together by soft tissues that allow small movements that may reduce peak stresses in surrounding bone.A detailed survey of the cranial joints in several rhynchocephalians and stem lepidosaurs was conducted using large samples of disarticulated skull bones. Results show that by comparison to basal taxa (e.g., *Sophineta*, *Gephyrosaurus*) derived taxa (e.g. *Clevosaurus, Sphenodon*) possess more complicated cranial joints, often involving extensive overlaps. Derived taxa thus have an increased surface area for soft tissue attachment and probably a greater capacity to deal with stress sustained during feeding. Differences in the location of the most complex joints in derived taxa may relate to alternative modes of shearing employed (a precise orthal scissor-like cut in *Clevosaurus* and a prooral rip in *Sphenodon*), each of which required a specific muscle arrangement.

To further examine the role of cranial joints during feeding we constructed a computer based finite element model of a *Sphenodon* skull. This was loaded according to a sophisticated representation of muscle mechanics that closely matches that observed in the living animal. Models with and without cranial joints behave in a similar fashion but in the former deformation is focused at the joints. Critically, the deformation is greater at some joints than others, and is related to both joint morphology and location. This suggests that differences between the cranial joints of fossil taxa reflect differences in how their skulls accommodate stress.

Technical Session XI, Tuesday 2:45

A NEW METHOD FOR THE QUANTITATIVE ANALYSIS OF MORPHOLOGICAL VARIATION IN VERTEBRATE PALEONTOLOGY

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We introduce Elastic Geodesic Analysis (EGA), a novel approach for morphometric analysis of anatomical structures. The boundaries of the objects of interest are represented by either closed or open continuous curves. These are parameterized by a square-root velocity function that maps each point on the curve to a vector in R^n. Shapes of curves are invariant to rigid rotations, translations, scaling, as well as reparameterizations. Shapes are represented as elements of an infinite-dimensional, nonlinear manifold equipped with a well-defined Riemannian metric. Shape differences are quantified by computing geodesics (shortest paths) on the shape space, which is an infinite-dimensional sphere where geodesics can be analytically specified. The main advantages of our approach are: i) representation of a multi-dimensional curve by a single function, ii) L2 Riemannian metric that enables elastic warping of shapes, iii) efficient method of computing geodesics using path-straightening flows, and iv) intrinsic statistical analysis on the tangent space using the differential geometry of the shape space.

Using hadrosauroid facial elements, we show the efficiency of EGA as an exploratory tool for finding patterns of shape variation, and identification and quantification of evolutionary trends of morphological change. For example, EGA on a sample of 50 jugals allowed discrimination of these bones according to clades like brachylophosaurs, saurolophs, or lambeosaurines. Within group variation was greater among brachylophosaurs than in other clades. Local shape T-tests showed that jugal variation between hadrosauroid clades is localized in particular spots of the ventral and posterior margins, whereas changes in jugal shape between basal hadrosauroids and Hadrosauridae, and between basal (e.g., *Aralosaurus*) and derived lambeosaurines (e.g., *Parasaurolophus*) lied on the rostral process. This supports the important role in the restructuring of the anterodorsal region of the maxilla and nearby areas of the face during hadrosaurid and lambeosaurine early evolution. This study demonstrates the potential of EGA for approaching morphology-based questions in evolutionary biology.

Poster Session III, (Tuesday)

GIANTS AND THEIR LITTLE SECRETS: TOOTH MICROSTRUCTURES IN MYLODONTID SLOTHS (MAMMALIA, FOLIVORA)

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Giant ground sloths are among the few mammals whose teeth lack the hard, protective outer enamel layer. Like other toothed xenarthrans, they have developed continuously growing teeth with a composition of different dentine types and of cementum. Sloths actively chew their food and therefore need tooth relief. Resistant rims are generally formed by orthodentine. A broad scanning electron microscopic study of microstructures in xenarthran teeth showed that species of *Scelidotherium*, *Lestodon*, *Glossotherium*, *Paramylodon*, and *Mylodon* have an unusual, washboard-like structure in the outer portion of the orthodentine. Raised parts are radially orientated and perpendicular to the outer margin of the tooth. Microstructurally, the washboard-like structure consist of bundles of several, individual dentinal tubules (ca. 5-15 per bundle). This is remarkable because dentinal tubules usually are subparallel to each other. In scelidotherine and mylodontine sloths instead, tubules form bundles which converge towards the tooth´s centre and which are between 300 to 700 µm in length. The bundles therefore look like ice-cream cones and are somewhat offset against each other. This structure was found in specimens which are late Pliocene and younger in age. It is an interesting fact that *Octodontotherium* as well as *Nematherium* as basal mylodontids lack the washboard-like structure which is considered to be a derived character. This leads to the hypothesis that this structure has been developed independently in scelidotherine sloth and in mylodontine sloths. The washboard-like structure most probably serves as a grinding reinforcement to enhance food processing in the oral cavity. Remarkable is that the washboard-like structure occurs both in wide- and narrow-muzzled ground sloths which are thought to have had different feeding behaviours. The structure can be compared to functionally similar structures known from rhinocerotid enamel, which are there caused by vertically oriented Hunter-Schreger bands.

Technical Session II, Sunday 8:45

A COMPREHENSIVE REVISION OF THE DICYNODONT 'WASTEBASKET GENUS' *DICYNODON* (THERAPSIDA: ANOMODONTIA)

KAMMERER, Christian, American Museum of Natural History, New York, NY, USA; ANGIELCZYK, Kenneth, Field Museum, Chicago, IL, USA; FRÖBISCH, Jörg, Field Museum, Chicago, IL, USA

The herbivorous dicynodonts were the most abundant and speciose terrestrial vertebrates of the Late Permian. Although the alpha taxonomy and phylogeny of Permian dicynodonts have recently become increasingly well-resolved, one major obstacle remains: the genus *Dicynodon*. The first dicynodont to be described, *Dicynodon* contains 149 nominal species, most of them represented by a single specimen from the Karoo Basin of South Africa. This plethora of poorly-characterized species has seriously hindered accurate estimation of species diversity in the terminal Permian and vertebrate extinction severity across the Permo-Triassic boundary. Here we present a comprehensive revision of the species of *Dicynodon* and interpret these results in a phylogenetic, stratigraphic, and biogeographic framework. The majority of nominal species of *Dicynodon* can be recognized as synonyms of other Permian dicynodont taxa (predominantly *Diictodon*, *Oudenodon*, and *Tropidostoma*). We recognize only 12 valid species worldwide that can be assigned to "*Dicynodon*" *sensu lato* (i.e., dicynodontoids similar to the type species *Dicynodon lacerticeps*). Phylogenetic analysis of Permo-Triassic dicynodonts indicates that "*Dicynodon*" is paraphyletic with respect to both Lystrosauridae and Kannemeyeriiformes. We recognize four valid species of South African "*Dicynodon*": *Dicynodon lacerticeps*, *Daptocephalus leoniceps*, *Dinanomodon rubidgei*, and *Sintocephalus alticeps*. A second species of *Dicynodon sensu stricto*, *D. huenei*, is present in the Usili Formation of Tanzania, but other nominal species of *Dicynodon* from Europe, Asia, and the Americas are not referable to this genus and should not be used for biostratigraphic correlations with the African species. *Dicynodon lacerticeps* and *Dinanomodon rubidgei* are found in both the *Cistecephalus* and *Dicynodon* Assemblage Zones of South Africa, whereas *Daptocephalus leoniceps* is restricted to the *Dicynodon* Assemblage Zone.

Poster Session I, (Sunday)

MULTISPECTRAL IMAGING AND ANALYSIS OF A LIAONING "MYSTERY SPECIMEN"

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A small 20 mm unidentifiable, vertebrate specimen was found in the process of preparing away the matrix from a *Microraptor* slab. The nature of the specimen was unclear and it was subjected to micro-analytical testing. The specimen consisted of a few nearly complete bones and fragments, surrounded by a brown halo in both the slab and counterslab. There were also numerous small-shelled invertebrates scattered throughout the matrix. A suite of spectroscopic and imaging techniques was employed across the photonic spectrum ranging from x-rays to infrared. The use of a microscope equipped with laser fluorescence, that actually penetrated into the matrix, revealed bones, teeth and skull elements completely unseen at the surface. This immediately identified the specimen as a hatchling fish demonstrating the technique's ability to reveal unknown data buried in the matrix. X-ray spectroscopy indicated that the brown halo was composed of calcium phosphate and was likely a residue from degraded bone, but this feature only exists on the plane of fracture. The invertebrate shells were surprisingly calcium phosphate, making them a possible analog for bone preservation. Infrared spectroscopy revealed authigenic changes in the quartz matrix only in the areas of the halo and shells. UV imaging also revealed chemical similarity between the halo and micro-halos around the phosphatic shells reinforcing the idea that similar preservational mechanisms were at work. The combination of these techniques demonstrates conclusively that we can examine specimens in three dimensions across different spectral regimes revealing previously unseen information. This type of analysis has the potential of directly resolving a number of the ongoing arguments over the interpretation of structures associated with the famous Liaoning specimens.

Preparators' Session, Monday 10:45

RANGE OF MOVEMENT IN A NOASAURID FORELIMB: *IN SITU* DATA AND JOINT RECONSTRUCTION

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Discovery of a diminutive forelimb on an articulated skeleton of a noasaurid theropod presented an opportunity to study its range of motion. In situ orientation and joint spacing was preserved by preparing a one-piece silicone mold that incorporated a portion of the adjacent shoulder girdle and ribcage. The forelimb was removed from the skeleton for further preparation, and the glenoid and sternal plates were fully exposed. The humerus, radius, ulna, carpus, and manus were then more fully prepared. A second round of molds and casts were made from the prepared limb elements. After study of opposing joint surfaces, joint spacing and movement were restored by embedding mechanical joints composed of 3-4mm stainless steel ball studs into sockets. The finished jointed and poseable forelimb model enhances visualization of the relation between joint surfaces and exploration of range of motion and the positioning of the strongly-clawed manus. Forelimb manipulation of live crocodilians and dissections of chicken and alligator shoulder and elbow joints provided comparative data on range of motion, joint spacing, and articular cartilage.

Physical Drivers and Marine Tetrapod Evolution, Monday 8:15

GLOBAL GEOCHEMICAL CONTEXT OF EARLY MESOZOIC MARINE REPTILE EVOLUTION

KELLEY, Neil, University of California Davis, Davis, CA, USA; MOTANI, Ryosuke, University of California Davis, Davis, CA, USA; JIANG, Da-yong, Peking University, Beijing, China; RIEPPEL, Olivier, The Field Museum , Chicago, IL, USA

Early Mesozoic geochemical records display trends and excursions thought to reflect major physical changes in the oceans. These events affected marine invertebrate groups, but their influence on marine vertebrates has not been fully explored. We compared species diversity of early Mesozoic (Triassic-Early Jurassic) marine reptiles to published records of marine 87Sr/86Sr, □13C and □18O through the same interval. Isotopic data suggest that taxonomic and ecological diversity of marine reptiles was influenced by changes in climate, tectonics, productivity and sea level.The earliest occurrence of marine reptiles in the latest Early Triassic is synchronous with the end of rapid □13C fluctuations during the delayed recovery from the Permo-Triassic mass extinction.Taxonomic diversity of Triassic marine reptiles peaked during the Middle Triassic-an interval of relatively stable □13C and □18O and falling 87Sr/86Sr. Marine reptile diversity declined steadily during the Late Triassic with the extinction of several clades during an interval characterized by rising 87Sr/86Sr and several abrupt shifts in □13C and □18O. Marine reptiles diversified again during the Early Jurassic. This interval shows steadily declining 87Sr/86Sr values until an abrupt increase at the end of the Early Jurassic accompanied by □13C and □18O excursions and another extinction event. We grouped marine reptiles according to tooth shape, limb shape and tail shape to test for ecologically selective extinction based on habitat or dietary preferences. Changes in substage 87Sr/86Sr negatively correlate with the proportion of durophagous taxa. This supports the hypothesis that long-term sea level decline in the Late Triassic drove the extinction of near shore groups while pelagic groups survived into the Jurassic. As sea level rose in the Early Jurassic new terrestrial groups invaded near shore environments. These results suggest that the physical factors that influence seawater chemistry such as climate, sea level and productivity may play an important role in shaping broad patterns of evolution and extinction among Mesozoic marine reptiles.

Technical Session X, Tuesday 8:00

PRELIMINARY NOTE ON LONG-TAILED PTEROSAURS FROM WESTERN LIAONING OF CHINA

KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; WANG, Xiaolin, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; JIANG, Shunxing, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology; Graduate University of Chinese Academy of Sciences, Beijing, China; MENG, Xi, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology; Graduate University of Chinese Academy of Sciences, Beijing, China

In the last two decades, no other part of the world has yielded so many pterosaur specimens than China. Particularly in western Liaoning, the quantity and diversity of those volant archosaurs have opened a new window for the study of the Pterosauria. Up to date, pterodactyloids by far outnumber non-pterodactyloid taxa, but recently several new specimens of the latter have been found in the Tiaojishan and the Daohugou formations. Here we present two long-tailed pterosaurs that shed new light on the rather enigmatic non-pterodactyloid clade Wukongopteridae. IVPP V16047 and 16049, both almost complete skeletons, share with *Wukongopterus* (Daohugou Formation) and *Darwinopterus* (Tiaojishan Formation - here regarded as a wukongopterid) a confluent nasoantorbital fenestra, elongated cervical vertebrae and an inclined quadrate - features typical of the Pterodactyloidea but quite unusual for non-pterodactyloids. The new specimens have the first two pairs of the premaxillary teeth protruding beyond the dentary, a characteristic of *Wukongopterus* but absent in *Darwinopterus*. IVPP V16049 shows a low cranial crest that does extend anteriorly to the same degree as in *Darwinopterus*. IVPP V16047 lacks a cranial crest and has a comparatively thick jugal. None shows the strongly curved second pedal phalanx of the fifth toe diagnostic of *Wukongopterus lii* and lack the thinner and spike-like teeth reportedfor *Darwinopterus*. The new specimens also differ from *Wukongopterus* and *Darwinopterus* and from each other in the wing and hind limb proportions. IVPP V16049 further shows a well preserved wrist clearly demonstrating that the pteroid bone is articulated to the proximal carpal, contradicting the long held view that this element was attached to the lateral (preaxial) carpal. The new specimens suggest that wukongopterids are a rather diverse Jurassic/Early Cretaceous non-pterodactyloid clade, so far restricted to China. Other briefly described taxa from China (e.g., *Changchengopterus*) might also be part or at least closely related to the Wukongopteridae.

Poster Session II, (Monday)

A HOLOCENE HERPETOFAUNA FROM NEW CALEDONIA: INSIGHTS INTO THE EFFECT OF HUMAN HABITATION ON INSULAR BIOTAS

KENNEDY, Alicia, Villanova, Villanova, PA, USA; BAUER, Aaron, Villanova, Villanova, PA, USA

Due to the geographic isolation of island biotas, the introduction of external pressures can have significant impacts on their taxonomic composition. Changes in the local flora or fauna of an island are often traced to human habitation and associated activity. In order to test hypotheses regarding the impact of humans on island biotas, however, fossil deposits which record their arrival and the period immediately preceding it are needed. Large fossil deposits recently excavated in the Pindaï Caves of New Caledonia, a large island in the South Pacific, meets this criterion. The Pindaï Caves localities contain the richest fossil deposits on the island and radiocarbon dates ranging from 4743+44 YBP to 1640+40 YBP spanning them were recently calculated. Humans arrived on the island between ca. 4000-3500 YPB and are present in the Pindaï region by ca. 2800 YBP. Excavations in the Pindaï Caves recovered a fossil assemblage rich in squamate remains. Approximately 25,000 squamate fossils, comprising numerous cranial and postcranial elements, were recovered. All are attributable to the lizard families Diplodactylidae and Scincidae, with the diplodactylid gecko taxa Bavayia sp. and Rhacodactylus trachyrhynchus most common. While the New Caledonian avifauna experienced elevated extinction rates upon the arrival of humans in New Caledonia, the Pindaï herpetofauna includes no obviously extinct squamate species. However, 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 the fossil sample. Gekkonids may have been introduced as recently as 235 years ago with the arrival of Europeans, but the arrival of melanesians ca. 4000-3500 YPB may have precipitated ecological changes that altered patterns of lizard abundance and possibly species composition.

Preparators' Session, Monday 9:30

CONTINUED IMPROVEMENTS IN THE USE OF ARCHIVAL MATERIALS FOR THE PADDED PLASTER JACKET STORAGE METHOD: WHAT WE HAVE LEARNED IN TWENTY YEARS

KEYSER, William, Contractor for Smithsonian, Arlington, VA, USA; KROEHLER, Peter, Smithsonian, Washington, DC, USA; JABO, Steven, Smithsonian, Washington, DC, USA

The use of plaster as a supporting cradle has been used by preparators for nearly as long as people have been collecting and storing vertebrate fossils. In the past many cradles have been bulky and nearly as heavy as the bones they were supporting due to the use of the materials available at the time. Ambient vibration common in large buildings in urban settings as well as the improper handling by museum staff and visitors has damaged many large verte-

brate fossils not properly cradled. We have reported on the use of stronger plasters reinforced with fiberglass cloth and a method of lining the cradles with one quarter inch ethafoam padding; further updated by the use of polyfelt as an alternative padding.This presentation demonstrates new archival methods of adhesion of the ethafoam and polyfelt, in addition to the use of nonmetal support structures as handles devised by William Keyser, a contractor at the Smithsonian's Vertebrate Preparation Lab. These nonmetal supports allow for CT scanning, X-raying, and magnetic resonance imaging of the fossil in it's cradle. There will be a series of photographs and a video presentation of early examples and the latest versions from our collections at Natural History as well as their use in exhibition and from the many collections moved to the Smithsonian's Museum Support Center in Silver Hill, MD.

Poster Session III, (Tuesday)

AUSTRALOPITHECUS SEDIBA: A TAPHONOMIC PERSPECTIVE

KIBII, Job, University of the Witwatersrand, Johannesburg, South Africa; BERGER, Lee, University of the Witwatersrand, Johannesburg, South Africa; DE KLERK, Bonita, University of the Witwatersrand, Johannesburg, South Africa

The discovery of a new hominid species, *Australopithecus sediba*, is set to provide new insights to human evolutionary history. The well preserved, minimally damaged and partially articulated *sediba* skeletons are argued to have been accumulated through a death trap. The diverse mammalian faunal assemblage associated stratigraphically with *Australopithecus sediba* is characterized by a number of partial skeletons and/or antimeric sets of bones across all taxonomic groups. Analyses of bone surface modification reveal no biotic or bone-accumulating agent damage. In addition to other taphonomic data, these observations suggest that the remains of animals recovered in context with *Australopithecus sediba* are from individuals that died in the cave either having accidentally fallen through vertical shafts that connected the cave to the ground surface or became trapped and were unable to escape after intentional entry.

Technical Session VI, Monday 3:15

THE SCALING OF LIMB ROTATIONAL INERTIA IN CURSORIAL MAMMALS: A PRECURSOR TO MODELING LIMB INERTIA IN EXTINCT TAXA

KILBOURNE, Brandon, University of Chicago, Chicago, IL, USA

Inferences into the locomotor biomechanics of extinct taxa first require studies of the locomotion and functional morphology in extant taxa. For studies of terrestrial locomotion, one trait that is poorly understood in both extinct and extant taxa is the rotational inertia of limbs and its relation to body size and locomotion. Therefore before modeling limb inertia in extinct taxa, the study of limb inertia in extant taxa is essential. To understand how limb rotational inertia is related to body size and locomotion, I examined the scaling of hindlimb rotational inertia with body mass across 20 mammalian species, including cursorial, scansorial, and aquatic species. For a subset of 13 cursorial taxa, I also examined the scaling of hindlimb rotational inertia to discern whether locomotor types may influence the scaling of limb inertia. For the full dataset of 20 taxa, hindlimb inertial properties (e.g., limb mass, center of mass position, moment of inertia, and natural frequency) scale according to geometric similarity, with small and large taxa having relatively equal inertial properties with respect to their body size. For cursorial taxa, hindlimb mass scales with isometry, indicating that small and large cursors have hindlimbs of equal mass with respect to body size. However, cursorial taxa exhibit negative allometry of hindlimb center of mass position, signifying that large-bodied cursors have hindlimbs with a relatively proximal concentration of mass. In cursors, hindlimb moment of inertia and natural frequency also scale with negative allometry, suggesting that the hindlimbs of cursors are relatively easier to swing and have a lower optimal frequency of oscillation for their body size. The low residuals and high coefficients of determination for these scaling relationships make them useful for modeling limb inertia in extinct taxa, particularly extinct mammals. Along these lines, differences in the scaling of limb inertia between cursorial mammals and mammals in general stress the need to pay close attention to anatomical function and specialization when choosing modern analogues as a basis for modeling the functional morphology of extinct taxa.

Poster Session II, (Monday)

A POSSIBLE ICHTHYODECTIFORM (PISCES, TELEOSTEI) FROM THE EARLY CRETACEOUS OF SOUTH KOREA

KIM, Haang-Mook, College of Sciences, Pusan National University, Busan, Korea, South; CHANG, Mee-mann, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; SEO, Seung-Jo, Chinju National University of Education, Chinju City, Korea, South; KIM, Yang-Hee, Pusan National University, Busan, Korea, South

Here we report the first possible ichthyodectiform in Chinju Biota from the Early Cretaceous Chinju Formation, Sindong Group, Gyeongsang Supergroup at Hyojagyo, Micheon-myeon, Chinju City, South Gyeongsang Province, southern Korea. It shows the following ichthyodectiform characters: 1) up to five long uroneurals are observed in the caudal skeleton: the first with enlarged anterior end and reaching anteroventrally to the posterior end of the third preural centrum, and the first two uroneurals covering the dorsolateral surface of the first and second preural centra; 2) corocoid expanded ventrally; 3) a long anal fin with more than 35 rays; 4) the dorsal fin situated posteriorly, with its origin opposite to that of the anal. Besides, the caudal skeleton also exhibits features often seen in ichthyodectiforms and some other primitive teleosts, e.g., six neural spines and five hemal spines are prolonged to support the procurrent caudal rays (12 dorsal and 8 ventral); all upper hypurals have thick bases, projecting out laterally and shown under the uroneurals; a urodermal is present. The fish is noticeably similar to the *Chuxiungichthys* species from the Early Cretaceous Kumagai Formation of the Kanmon Group in Kyushu, Japan, and the Jiangdihe Formation of similar age from Chuxiong, Yunnan Province, China. *Chuxiungichthys* was, in turn, comparable with *Mesoclupea shouchangensis* from the Shouchang Formation in Shouchang, Zhejiang Province, China. Although the materials of these genera are not well preserved and need to be restudied, they show certain ichthyodectiform characters mentioned above, such as 1, 3, and 4. Nevertheless, the fish from Korea and *Chuxiungichthys* from Japan and China can easily be distinguished from other ichthyodectiforms in the higher body depth and shorter length, longer dorsal fin, and oval-shaped opercle. The new materials from Korea are better preserved, allowing a relatively complete description of the fish, providing more information for discussion of its phylogenetic position, enriching the diversity of the local fish fauna, and helping us better understand the paleobiogeographical distribution of the group.

Poster Session IV, (Wednesday)

USE OF FINITE ELEMENT ANALYSIS TO DETERMINE THE OPTIMUM ANGLE OF THESCELOSAUR (_DINOSAURIA_) METATARSALS

KING, Leigha, East Tennessee State University, Johnson City, TN, USA; YACOBUCCI, Margaret, Bowling Green State University, Bowling Green , OH, USA; FARVER, John, Bowling Green State University, Bowling Green , OH, USA

It has been proposed that bipedalthescelosaur dinosaurs walked in a similar manner to emus and cassowaries. Such motion would result in their metatarsals being placed vertically in the foot. Through the creation of programs such as Finite Element Analysis (FEA), it is now possible to test this hypothesis by comparing how stresses are distributed over bones in both living and extinct fauna. Therefore, the question at hand was to determine, based on stress values and concentrations, if in fact that interpretation of the metatarsals of thescelosaurswascorrect. The specimen studied here was collected by the Museum of the Rockies in 2007 from Montana's Hell Creek Formation. Images of the four metatarsals were taken, and the medial view of Digits 1, 2, and 4 were studied as well as the lateral view of Digit 3 (deformation obscured the medial side). Images were placed in the freeware 2D FEA program LISA, where a mesh was created of each bone, and walking stresses were applied. Material properties of bovine bone were assigned to the meshes as is standard with most FEA. Images of both the tensile and compressive stress distributions, as well as the highest stress values created in MPa, were analyzed. Since bones are designed to be under constant compressive stresses, it can be assumed that the bones would not be able to withstand high tensile stresses. Therefore, tensile stress values would be a better approximation of what stresses would cause the bones to break. Based on the data collected from the tensile stress values, it was apparent that all four digits would have been optimally placed in the foot between 0 and 10 degrees toward the posterior from vertical. However, each digit had a unique angle that produced the lowest tensile stresses and therefore, the metatarsals have a high likelihood of being found at their respective optimum angle. Specifically, Digit 1 would be best placed to accommodate tensile stresses between 1 and 4 degrees from vertical; Digit 2 at 4 degrees; Digit 3 between 0 and 3 degrees; and Digit 4 between 0 and 7 degrees.

Technical Session IX, Tuesday 9:45

OSCILLATING ENVIRONMENTS, ORBITALLY-FORCED CLIMATE CHANGE AND PLIOCENE MAMMALIAN EVOLUTION IN THE BARINGO BASIN, KENYAN RIFT VALLEY

KINGSTON, John, Emory University, Atlanta, GA, USA; HILL, Andrew, Yale University, New Haven, CT, USA; GOBLE, Emily, Yale University, New Haven, CT, USA; DEINO, Al, Berkeley Geochronology Center, Berkeley, CA, USA; WILSON, Katy, University College London, London, United Kingdom

Ongoing field investigations in the Baringo Basin, Kenyan Rift Valley, have revealed abrupt and repeated cycling of major freshwater lake systems at 23 ka precessional pacing, occurring at the maximum of an Earth orbital eccentricity cycle between ~2.7–2.5 Ma. Recent research has revealed that fossiliferous sediments within this local basin can now be traced back to 5.7 Ma, providing an opportunity to extend the chronostratigraphic framework in which to explore multiple, independent proxies of local paleoclimatic and paleoecologic conditions at levels of resolution ranging from annual seasonal patterns to Milankovitch periodicities. Lacustrine facies documented in these older sediments of the Chemeron Formation indicate early Pliocene oscillating lake systems that may also be controlled by precessional insolation patterns and/or global climatic events, allowing us to develop long-term ecological profiles that span evolutionary time. Significant diatomite sequences (>50m) in the Lukeino Formation (ca. 6 Ma), also part of the Baringo Succession, indicate that these paleoclimatic fluctuations are pervasive and allow us to articulate more specifically the controls on lake regression/transgression sequences. Linking specific local environmental factors with shifting insolation patterns provides a means of calibrating environmental factors in local rift valley settings with insolation patterns that can be calculated theoretically for any time and location in the past. This allows us to generate an empirical 'scaling bridge' between local hominin ecosystems in the rift valley and environmental/climatic phenomena documented globally or regionally. About 100 vertebrate fossil localities can be tied into this sequence, providing an opportunity to assess specific ecological and evolutionary response of East African hominin terrestrial communities to this pervasive, short-term climatic flux and ultimately develop causal links between evolution and environmental change in equatorial Africa.

Poster Session III, (Tuesday)

VIRTUAL ENDOCAST OF *ROONEYIA VIEJAENSIS* (MAMMALIA, PRIMATES)
KIRK, Edward, University of Texas at Austin, Austin, TX, USA; DAGHIGHI, Parham, University of Texas at Austin, Austin, TX, USA; MACRINI, Thomas, St. Mary's University, San Antonio, TX, USA; BHULLAR, Bhart-Anjan, Harvard University, Cambridge, MA, USA; ROWE, Timothy, University of Texas at Austin, Austin, TX, USA

Rooneyia viejaensis is a fossil primate of uncertain phylogenetic affinities from the Sierra Veija of West Texas. Although frequently described as an omomyoid, various authors have claimed that *Rooneyia* is a stem primate or a stem anthropoid. The species is known only from the type specimen, which was recovered in 1966 from a 37 million year old horizon in the Chambers Formation. The *Rooneyia* holotype is an isolated cranium that preserves a complete and relatively undistorted natural endocast of the braincase. Previous estimates of endocranial volume in *Rooneyia* have ranged from 7.17 to 7.5 cm^3 based on modeling and double-graphic integration. Here we report the results of new analysis of endocranial size in *Rooneyia* based on micro-computed tomography. The *Rooneyia* holotype was scanned at the High-Resolution X-ray Computed Tomography Facility at The University of Texas at Austin, with an in-plane resolution of 39 microns and an inter-slice spacing of 87 microns. Data were thresholded using ImageJ software, and a virtual endocast was reconstructed using Amira v. 3.1.1. Based on this virtual endocast, we conclude that the endocranial volume of the *Rooneyia* holotype is 7.234 cm^3. Body mass for this specimen has been estimated to be 381 g based on cranial length. Comparisons with extant primates reveal that *Rooneyia* had a relative brain size that was comparable to those of some living strepsirrhines (e.g., *Phaner pallescens*) and callitrichine anthropoids (e.g., *Callithrix penicillata*, *Saguinus fuscicollis*). *Rooneyia* is thus unlike the early Eocene omomyoid *Tetonius* and most adapoids, in which relative brain size is estimated to have been smaller than those of extant primates. Based on olfactory fossa size, we further estimate that olfactory bulb volume in *Rooneyia* was 66.5 mm^3. As a percentage of endocranial volume, olfactory bulb size in *Rooneyia* (0.92%) is smaller than in plesiadapiforms, *Tetonius*, and adapoids and is most comparable to that in lemurs, tarsiers, the omomyoid *Necrolemur*, and the stem anthropoid *Parapithecus*. These results are consistent with the conclusion that *Rooneyia* is a crown primate.

Poster Session II, (Monday)

NEWLY RECOVERED SKELETAL ELEMENTS OF THE LATE JURASSIC DINOSAUR *MYMOORAPELTA* FROM ITS TYPE LOCALITY IN THE MORRISON FORMATION PERMITS REEVALUATION OF ANKYLOSAUR PHYLOGENY
KIRKLAND, James , Utah Geological Survey, Salt Lake City, UT, USA; HUNT-FOSTER, ReBecca, Museum of Western Colorado - Dinosaur Journey, Fruita, CO, USA; FOSTER, John, Museum of Western Colorado - Dinosaur Journey, Fruita, CO, USA; LOEWEN, Mark, Utah Museum of Natural History, Salt Lake City, UT, USA

With its description in the 1990s, *Mymoorapelta maysi* became the first well-documented Jurassic ankylosaur. This was soon followed by the description of *Gargoyleosaurus*. Although both are from the Morrison Formation and the preservation of *Mymoorapelta* is better, the nearly complete skull of *Gargoyleosaurus* made it favored with taxonomists. However, continued excavations at the type location, the Mygatt-Moore Quarry in westernmost Colorado, have resulted in the recovery of nearly every skeletal element of *Mymoorapelta*, including parts of the skull, making it the most complete Jurassic ankylosaur. Skull elements include jugal, postorbital, quadrate, braincase, and teeth and compare well with *Gargoyleosaurus*, whose jugals, quadrates, and braincase were damaged on discovery. Of the major postcranial skeleton only the pubis and femur are not represented, which are the only elements known from the hind-quarters of *Gargoyleosaurus*. All elements of the armor are well-represented including significant portions of both cervical rings (nodosaurids have three cervical rings). Clearly, *Mymoorapelta* and *Gargoyleosaurus* are very similar in nearly every morphological feature observed on the shared preserved skeletal elements. *Mymoorapelta* preserves a mosaic of characters relative to more derived ankylosaurs that may provide important information as to what are the primitive character states. The ischium is bent as in polacanthines and nodosaurids indicating to us that the straight ischium of ankylosaurids is actually derived. The scapular spine forms a vertical ridge opposite the glenoid in *Mymoorapelta* as in ankylosaurids and the only other Morrison ankylosaur scapula from the Dry Mesa Quarry in western Colorado. *Mymoorapelta* has short limbs with even shorter distal limb elements as in ankylosaurids and polacanthines. This new analysis indicates that *Mymoorapelta* and *Gargoyleosaurus* are outside of both Ankylosauridae and Nodosauridae and that the Polacanthinae should be restricted to *Polacanthus*, *Hylaeosaurus*, *Gastonia*, and *Hoplitosaurus*.

Poster Session III, (Tuesday)

RE-EVALUATION OF HOMINOID FACIAL SYNAPOMORPHIES WITH IMPLICATIONS FOR THE TAXONOMIC STATUS OF *AFROPITHECUS TURKANENSIS*
KNIGGE, Ryan, University of Minnesota, Minneapolis, MN, USA; MCNULTY, Kieran, Evolutionary Anthropology Lab, University of Minnesota, Minneapolis, MN, USA

Traditionally, Early Miocene non-cercopithecoid catarrhines were identified as hominoids, or apes, based largely on plesiomorphic craniodental evidence. More recent studies have defined hominoids almost exclusively from postcranial features, and on this basis a number of researchers now regard the Early Miocene "dental apes" as basal catarrhines. Nevertheless, four features in the hominoid cranium are still thought by some researchers to represent hominoid synapomorphies: inferior position of the upper extent of the premaxillary suture; a projecting interorbital bridge; a vertically expanded naso-alveolar clivus; and a wide anterior palate. Here we present a quantitative assessment of all four features based on a sample of 500 extant anthropoids in order to determine their reliability for distinguishing hominoids within this group. Clivus height and palate width were assessed using standard linear distances. We quantified the superior-most position of the premaxillary suture as its relative position when projected onto a line connecting nasion-rhinion. The shape of the nasal bridge was captured with a series of semi-landmarks collected in a line from right to left dacryon, and these configurations were superimposed using a generalized Procrustes analysis, allowing semi-landmarks to slide so as to minimize bending energy. Univariate and multivariate analyses demonstrate significant variation in each feature within each superfamily, but palate width and naso-alveolar height are the more reliable indicators of hominoid status. Finally, we used these measurements to determine the affinities of the enigmatic catarrhine primate *Afropithecus turkanensis*. Despite its primitive postcranial features, its cranial morphology falls comfortably within the hominoid range for each feature supporting its taxonomic status as an ape.

Poster Session III, (Tuesday)

WHAT IS "HALTICOSAURUS" ORBITOANGULATUS?
KNOLL, Fabien, MNCN-CSIC, Madrid, Spain

In 1932, F. von Huene described as "Cf. *Halticosaurus orbitoangulatus*" a fragmentary and largely disarticulated skull from the Norian (Stubensandstein) of Pfaffenhofen (Baden-Württemberg, Germany). He regarded it as belonging to a "podokesaurid" theropod. Whereas the precise systematic position of the taxon has been considered quite uncertain, its allocation to Theropoda has not been thrown into doubt until a dozen years ago when "*Halticosaurus*" *orbitoangulatus* was considered as probably a basal crocodylomorph. This was based on the degree of rostral tapering of the antorbital fenestra and the morphology of the teeth. However, the antorbital fenestra of "*Halticosaurus*" *orbitoangulatus* tapers quite like that of a theropod such as *Coelophysis bauri* and probably less than a "sphenosuchian" crocodylomorph like *Sphenosuchus acutus*. More importantly, the teeth of "*Halticosaurus*" *orbitoangulatus* bear two serrated carinae following the classic theropod style and are not circular in section, but rather oval. The ratio of mesial to distal serration density is equivalent to that seen in some theropods, such as *Dilophosaurus wetherilli*. Some teeth present apicobasal fissures on the crown surface, but none bear pronounced striations as in some crocodylomorphs. Additional characters suggestive of affinities with theropods rather than with crocodylomorphs include a labial parapet on the dentary (as in *Dilophosaurus wetherilli*). Admittedly, further studies are warranted to resolve the systematic position of "*Halticosaurus*" *orbitoangulatus* within archosaurs; however, its characters are consistent with it being a theropod dinosaur. The disarticulated state of the holotype specimen, as well as possibly the only slightly laterally compressed teeth, suggests that it is from an immature individual.

Technical Session XIV, Wednesday 11:15

A NEARLY COMPLETE SKELETON OF A NEW ORNITHOMIMID FROM THE NEMEGT FORMATION OF MONGOLIA
KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; LEE, Yuong-Nam, Korea Institute Geoscience and Mineral Resources, Daejeon, Korea, South; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; CURRIE, Philip, University of Alberta, Edmonton, AB, Canada

The remains of the Mongolian ornithomimids, *Gallimimus bullatus* and *Anserimimus planinychus* are common occurrences in the Upper Cretaceous Nemegt Formation. In 2006, the Korea-Mongolia International Dinosaur Expedition recovered a beautifully-preserved, uncrushed ornithomimid skeleton from Ulan Khushuu in the Gobi Desert, Mongolia. The almost complete skeleton has a disarticulated skull, but missing only the tail, and, is referable to a new taxon. The Ulan Khushuu specimen differs from all other ornithomimids in having an additional ridge along the deltopectral crest, nearly straight manual ungual phalanges, and an accessory ventral process on the lateral posterior condyle of the proximal tibia. It shows an affinity with the other two Nemegt ornithomimids in having a laterally displaced glenoid of the coracoid. Although it shares several derived characters present in the Qiupa ornithomimid from China and in North American taxa, such as the anterior extension of the pubic boot and large acute angle between the dorsal edge of the pubic boot and shaft, it is basal to all North American taxa due to its lack of the ventral expansion of the pubic boot. Cranial material, especially the braincase, is three-dimensionally preserved, and reveals important anatomical information. Similar to *Shenzhousarus orientalis* and *Sinornithomimus dongi* from China, the skeleton preserves a mass of gastroliths within articulated ribs and gastralia, the first such occurrence in a Mongolian ornithomimid. The possession of gastroliths has been suggested as evidence for herbivory in this group, but the presence of isolated fish vertebrae in the matrix of the gastrolith mass may represent in situ stomach contents. This would suggest that the new ornithomimid may have had a more omnivorous diet.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 8:30

TERRESTRIAL CARBON ISOTOPE PALEOECOLOGY IN A C3 WORLD
KOHN, Matthew, Boise State Unviersity, Boise, ID, USA

Modern carbon isotope compositions in all C3 plant types have been compiled from nearly 600 sites worldwide, about 6 times larger than any previous compilation. On average, these data show a monotonic increase in $\delta^{13}C$ with decreasing mean annual precipitation (MAP) that differs significantly in form from previous models. Corrections for temperature, altitude, or latitude are significant ($p<0.001$), but far smaller than previously estimated. The best-fit equation is: $\delta^{13}C(‰,VPDB) = -10.30+1.89x10^{-4}Altitude(m)-5.60log_{10}(MAP+300,mm/yr)-0.0124Abs(latitude,°)$As corrected for paleoaltitude, paleolatitude, and the $\delta^{13}C$ of atmospheric CO_2 (from marine foraminiferal records), this equation permits estimation of MAP from an ecosystem-averaged carbon isotope composition, e.g. from tooth enamel $\delta^{13}C$ of multiple taxa or soil organic carbon, with an uncertainty of approximately ±100 mm/yr at MAP<400 mm/yr, ±250 mm/yr at MAP=400-1000 mm/yr, and ±500 mm/yr at MAP>1000 mm/yr. These data permit refined interpretation of MAP, paleodiet, and paleoecology of ecosystems dominated by C3 plants, either prior to 7-8 Ma, or more recently at mid- to high latitudes. Twenty-nine published paleontological studies suggest preservational or scientific bias towards dry ecosystems, although wet ecosystems are also represented. Unambiguous isotopic evidence for C4 plants is lacking prior to 7-8 Ma, and hominid ecosystems at 4.4 Ma show no isotopic evidence for dense forests.

Physical Drivers and Marine Tetrapod Evolution, Monday 10:45

ENVIRONMENTAL CHANGES AND EVOLUTIONARY DIVERSIFICATION OF PINNIPEDS

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The pinnipeds (otariids, odobenids, phocids and their fossil allies) are fin-footed carnivores having been adapted to life in water since the Late Oligocene, ca 28 Ma or much earlier. Recent investigations on the phylogeny of the arctoid carnivores revealed that the Oligo-Miocene semi-aquatic mustelidans *Potamotherium* and *Puijira*, which still retained somewhat otter-like form, were recognized to have special affinities with the pinnipeds. However, the oldest known record (OKR) of these taxa dates back only to the Late Oligocene, ca 26-25 Ma. Therefore, the speciation event of the pinnipeds is thought to lie near the time of the pinnipeds' OKR. However, the fossil record in general does not point to the real timing of divergence because the first stratigraphic appearance of a taxon in the fossil record is subjected to the sporadic sedimentary hiatus due to erosion, no sedimentation during regression, or the type of sedimentary basin. In this regard, a recent investigation of pinniped phylogeny based on molecular evidence reveals new information on the divergence times of pinnipeds independently from such problems. When calculating the divergence times of each clade of the Recent pinnipeds based on molecular phylogenetics, it is suggested that the otarioid-phocoid split occurred at around 27.6 Ma and that the otariid-odobenid and monachine-phocine splits occurred at around 19.7 Ma. However, the OKR of morphologically distinctive otarioids dates back only to the late Early Miocene (ca. 16.6 Ma), and that of phocids is the early Middle Miocene (ca 16 Ma). Intriguingly, data from sequence stratigraphy suggest that these times suggested by molecules and morphologies correspond respectively to gradual marine transgression sequences and rapid marine transgression-regression fluctuation sequences. It indicates that the marine invasion of the pinnipeds and subsequent divergence may have occurred during the expansion of ancestral populations in the warm periods, but the morphological distinction of each clade of pinnipeds seems to have progressed simultaneously with the rapid climatic changes with transgression/regression fluctuations through the geological time periods.

Poster Session I, (Sunday)

DISCOVERY OF A LARGE REPTILIAN TRACKWAY FROM THE CRETACEOUS JINDONG FORMATION OF GOSEONG COUNTY, KOREA

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Korean footprints including dinosaurs, pterosaurs, and birds have been reported from the sedimentary sequences of the Cretaceous deposits. A large reptilian trackway was discovered in the black mudstone of the Cretaceous Jindong Formation, located along the beach coast of Deogmyeong-ri, Goseong County. This area was designated as a Natural Monument in 1999 and is one of the largest and most productive dinosaur tracksites in Korea. The Goseong site has yielded well preserved trackways including ornithopods, sauropods, and theropods since 1982. The new reptilian trackway is quadrupedal and the tracks are asymmetrical. The total length of the trackway is 13.5 m. The trackway width is 63.1 cm and the trunk length of the reptile is between 90 and 100 cm in length. A total of 72 footprints (36 manus and 36 pes) were found. The manus is well separated from the pes. The manus is 21 cm in length and 11 cm in width. The pes is 26 cm in length and 15 cm in width. The posterior border of the heel is not well preserved. The stride (79 cm) of manus and pes is identical which means the trackmaker walked with a constant stride. The manus is directed inward and claw impressions are very prominent. Digits are narrower than those of pes. The manus has deeper digit impressions at the distal end. Four out of five digits are clearly identified and sharply pointed at the end. Pace angulations are between 85-90°. The pes is directed with a strong outward rotation, lacks digit I, and the other three or four digit impressions are very elongated. The longest is digit II and digit impressions are not equal in length. Digit II and III are close together, lie parallel, and are longer than digit IV. Digit IV is slightly more separated from digits II and III. Pace angulations are between 101-110°. The step of the trackway (length between left foot and right foot) is 55 cm and wider than that of the largest sauropod dinosaur (34.6 cm) from Goseong County.

Based on the reptilian characteristics of the trackway, including the wide step, angle of footprints to the middle line, number and size of digits, the new trackway belonged to a giant reptile that lived alongside dinosaurs.

Poster Session II, (Monday)

TO TILT OR NOT TO TILT? A NEW WAY OF ORIENTING QUADRATES IN PLIOPLATECARPINES (SQUAMATA: MOSASAURIDAE), AND ITS IMPLICATIONS FOR STREPTOSTYLY IN THESE MOSASAURS

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Quadrates in mosasaurs have long served as the most diagnostic element of these giant, Late Cretaceous marine reptiles. For one thing, these elements preserve well as they are robust. When found in association with the skull however, mosasaur quadrates exhibit a variety of orientations due to the postmortem dislocation. Conventionally, skull restorations of mosasaurs have indicated that quadrates are upright in orientation, where the broadly convex cephalic condyle articulates with the suspensorium (i.e., the squamosal and supratemporal bones) at the posterolateral corner of the upper temporal fenestra. Examination of various isolated quadrates and well-articulated skulls of pliopletacarpine mosasaurs, however, suggests otherwise. In these mosasaurs, there are two longitudinally aligned eminences along the distomedial border of the long suprastapedial process of the quadrate. Each eminence then respectively fits into the ventrally-facing concavity of the squamosal and anteriorly-facing concavity of the supratemporal, each in a ball-and-socket fashion. This arrangement requires the quadrate cephalic condyle to tilt forward, in order to maintain the horizontal orientation of the upper temporal bar. Furthermore, the tight articulation among these three bones renders streptostyly in pliopletacarpines unlikely. In fact, the streptostylic rotation of the quadrate would cause the cephalic condyle to crush the upper temporal bar of those mosasaurs.

Technical Session III, Sunday 2:00

MIMOTONID TARSAL BONES FROM THE EOCENE OF CHINA AND THE EVOLUTION OF LOCOMOTION IN DUPLICIDENTATA

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Leporids are one of the few small mammals that exhibit a highly cursorial mode of locomotion. Osteological correlates to cursoriality and saltation, related to joint stabilization, have been identified previously within the tarsals of living and some fossil lagomorphs. The early evolution of the cursorial mechanism, however, remains poorly understood. Based on new mimotonid tarsal elements from the Eocene of China, and observation of various fossil and extant lagomorph specimens, we discuss the origin of these lagomorph tarsal features, their correlations to locomotion, and their significance for phylogenetic analyses in Duplicidentata (Mimotonidae + Lagomorpha). One mechanism of joint stabilization is the oblique nature of the transverse tarsal joint (TTJ), which minimizes transverse rotation via the additional contact of the calcaneus with the astragalus and navicular; some Middle Eocene mimotonids and all lagomorphs exhibit two related facets. The facets are confluent in mimotonids and separate in lagomorphs, yet did not evolve in the earliest mimotonids. In addition, the upper ankle joint (UAJ) of lagomorphs has an additional fibular facet on the calcaneus, a condition described here for the first time in mimotonids.

Our findings suggest that modifications to the TTJ and UAJ did not take place simultaneously. While modification of the TTJ appear in Middle Eocene mimotonids and lagomorphs, and indicates that cursoriality initiated at this time, it was likely of a different grade then observed in living leporids. Overall, the mosaic evolution of duplicidentate tarsals cautions their usage for high-level phylogeny such as the pairing of arctostylopids with gliroid Gliriformes. Lastly, we show that the living *Ochotona* and the fossil *Desmatolagus* share highly derived similarities in aspects of the peroneal process. This is strong support for their close relationship, and suggests that the locomotion of *Desmatolagus* was similar to that of modern pikas.

Poster Session I, (Sunday)

VERTEBRATE PALEONTOLOGY, BIOSTRATIGRAPHY AND BIOCHRONOLOGY OF THE PENNSYLVANIAN-PERMIAN CUTLER GROUP, CANYON DEL COBRE, NORTHERN NEW MEXICO

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For more than a century, fossil vertebrates have been collected from Pennsylvanian-Permian nonmarine redbeds of the Cutler Group (El Cobre Canyon and Arroyo del Agua formations) in Cañon del Cobre (El Cobre Canyon), Rio Arriba County, New Mexico. Megafossil plants,

palynomorphs and fossil vertebrates indicate that the Pennsylvanian-Permian (~Virgilian-Wolfcampian) boundary is stratigraphically high in the El Cobre Canyon Formation in Cañon del Cobre, though the exact position of the boundary is not certain. A detailed vertebrate biostratigraphy in Cañon del Cobre constructed from all localities that can be placed into precise lithostratigraphic position identifies three, temporally successive and distinct vertebrate fossil assemblages that represent three land vertebrate faunachrons (LVFs). The middle and upper assemblages belong to the Coyotean and Seymouran LVFs, respectively, and the lower assemblage is the characteristic vertebrate fossil assemblage of the Cobrean LVF, an older, entirely Late Pennsylvanian (Virgilian) LVF. The Pennsylvanian-Permian boundary is in the Coyotean LVF. The Cañon del Cobre vertebrate fossil record thus provides three, stratigraphically-successive vertebrate assemblages that support recognition of three time-successive LVFs across the Pennsylvanian-Permian boundary.

Poster Session IV, (Wednesday)

EVIDENCE FOR SPECIALIST FEEDING IN *HYPSILOPHODON FOXII*

KRAUSS, David, BMCC, New York, NY, USA; SALAME, Issa, CCNY, New York, NY, USA

Hypsilophodon is typically portrayed in reconstructions as a generalist herbivore, feeding on low vegetation. Compared to other herbivorous dinosaurs *Hypsilophodon* is unusual in having a heterodont dentition. It has occurred to us that its unusual dentition may be the result of specialist feeding on cycad seeds. In order to test the validity of this hypothesis we used cranial material from specimens of *Hypsilophodon foxii* at the Museum of Natural History, London and Dinosaur Isle, Sandown, Isle of Wight to produce estimates of the occlusive force that could have been generated by their jaws. Based on insertion points for the *adductor mandibulae externus* we were able to develop estimates of total occlusive force from 24-41N. In order to test the hypothesis that *Hypsilophodon* could have fed on cycad seeds we used elementary experimentation. We produced an epoxy model of *Hypsilophodon* jaws held together with surgical tubing scaled to various strengths within the range cited above. We then used the model to try to pry seeds from cycad cones. If the strength was insufficient the tubing would allow the model jaws to open and the seed would be left behind. If the force exerted by the jaws was sufficient the seed would be pried free. We found that at the maximum estimates of jaw strength seeds were easily pried from cycad pods while at the minimal estimates only smaller seeds could be removed from very ripe pods. At most levels an animal could have extracted seeds from cycad cones. *Hypsilophodon* could have fed on cycad seeds. It would have used its beak to pry the seeds loose from cones. The small anterior teeth could have been used to slice through the seed coat and then the pulp inside would have been masticated in the posterior dentary teeth. Furthermore, the flexibility of the small forelimbs would have allowed sufficient mobility to push thorny fronds out of the way allowing the animal access to the cones at the plant's center.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 10:15

HOLOCENE DIET AND SEASONALITY IN TROPICAL SOUTHEAST ASIA: INTEGRATING ISOTOPIC DATA WITH PALEOCLIMATE PROXIES

KRIGBAUM, John, University of Florida, Gainesville, FL, USA

□^{13}C and □^{18}O values are presented for vertebrate faunas, including humans, recovered principally from Niah Cave, a Late Pleistocene-Holocene site in Borneo. Samples analyzed to date include primates (*Homo*, *Pongo, Hylobates, Macaca*, *Trachypithecus*, *Presbytis* spp.), artiodactyls (*Bos, Cervus, Muntiacus, Tragulus, Sus*), perissodactyls (*Rhinoceros* and *Tapirus*), and carnivores (*Arctictus, Lutra, Helarctos, Neofelis*). Isotopic data of the fauna are derived from bulk tooth enamel bioapatite. For all fauna sampled, bulk □^{13}C values range from -21.6 to -9.9‰ and this variability reflects both 'total' diet during formation of the tooth sampled and the 'canopy effect,' whereby low □^{13}C values are characteristic of ground-level vegetation feeding in dense forest. □^{18}O values vary broadly by taxon, but are principally precipitation-dependent, with ranges from -12.8 to 9.9‰.

With respect to Holocene diet and seasonality, there are confounding variables in terms of paleoecological reconstruction using bulk data derived from vertebrate fauna. At Niah Cave, the chronology of human burials is well understood but associated fauna have poor temporal control due to extensive mixing. To address this issue, adult human third molars from Pre-Neolithic and Neolithic burial contexts were serially sampled along growth layers using a dental drill (7-10 samples/tooth) to assess subannual isotope patterns. Early Holocene pre-Neolithic adults (n=5) show □^{18}O values with low variability (0.93) and deviation (0.30) compared to Neolithic adults (n=7) with significantly higher variability (1.56) and deviation (0.51). The observed trend suggests a La Niña-like pattern associated with the Holocene thermal maximum (Pre-Neolithic) and an El Niño-like pattern (Neolithic) associated with increased ENSO variability ~4 ka. Collectively, these data mirror decadal-scale isotope trends derived from stalagmites in nearby Mulu National Park (Sarawak) and more regional Holocene proxies from the South China Sea. Serially sampling human tooth enamel offers a fresh perspective towards paleoecology and permits key questions to be addressed such as the ecological context associated with new modes of food production.

Poster Session IV, (Wednesday)

A NEW BASAL ORNITHOPOD FROM THE MID-CRETACEOUS WAYAN FORMATION OF IDAHO

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A small, possibly fossorial ornithopod represents Idaho's most completely known dinosaur. This taxon numerically dominates vertebrate fossils recovered from the Wayan Formation, which has a moderately diverse but poorly represented vertebrate fauna. The ornithopod is represented by nearly all postcranial elements and a few cranial elements recovered from multiple well–preserved but incomplete individuals.Diagnostic characters include elongate cervical and dorsal centra 1.6 times as long as tall, more than 55 elongate caudal centra encompassed by a sheath of ossified tendons, a robust coracoid, a scapula with an elongate scapular spine (as in *Orodromeus*), and a femoral head set on an elongate neck that projects medially well above the greater trochanter and at a ˜45° angle relative to the femoral shaft axis. Phylogenetic analyses indicate a close but unresolved relationship within the *Oryctodromeus–Orodromeus–Zephyrosaurus* clade.Taphonomic and geologic evidences of possible social and fossorial behavior include: 1) the occurrence of most specimens in calcareous paleosols (modern fossorial vertebrates prefer well drained soils), 2) the articulated to semi-articulated condition of most specimens and the absence of tooth marks, trample breakage, weathering, and abrasion (suggesting quick burial), and 3) close association of multiple individuals of various ontogenetic stages in a monogeneric fossiliferous pod (suggesting group behavior similar to the fossorial ornithopod *Oryctodromeus*). Biomechanical evidences suggestive of fossoriality include: 1) a robust shoulder girdle, 2) a well–developed olecranon process, 3) a high femoral head offset from the shaft (increased muscle attachments and hindquarter stability, possibly useful for digging) and 4) a possible sacro-pubic articulation.This new ornithopod demonstrates the potential for more discoveries in the Wayan Formation and suggests preservational and/or ecological differences from the coeval Cedar Mountain Formation of Utah, and similarities to the roughly coeval Blackleaf Formation of Montana.

Technical Session X, Tuesday 11:15

NEW SPECIES FROM THE LATE OLIGOCENE OF NEW ZEALAND REVEAL THE SKELETAL PLAN OF STEM PENGUINS (AVES: SPHENISCIFORMES)

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Three skeletons collected from the late Oligocene Kokoamu Greensand of New Zealand are the most complete Paleogene penguins yet reported. These specimens represent two new species and reveal for the first time the unique proportions of a giant fossil penguin taxon. Morphological details of many key elements of the stem penguin skeleton associated with underwater flight are illuminated, including the first reasonably complete sternum and pelvis, one of only two complete forelimbs and the first described pygostyle. The new species differ from all living penguins in possessing a straight, narrow beak, remarkably slender sternum, elongate flipper and very robust hindlimb. These features contribute to a graceful profile previously unrecognized in fossil penguins. The pygostyle lacks the derived triangular cross-section seen in extant penguins, suggesting the rectrices attached in a more typical avian pattern. Conservative reconstructions suggest the larger of the two new species had a standing height of 1.3m.New specimens detailed here help resolve several long-standing phylogenetic and biogeographic problems surrounding New Zealand penguin fossils. A phylogenetic analysis sampling 56 penguin species and 15 outgroup taxa for 238 morphological characters and including sequence data from five genes yields 90 most parsimonious trees of 5171 steps. The two new species form a small clade of stem penguins crownward to the late Eocene-early Oligocene giant penguin *Pachydyptes* but basal to the late Oligocene taxa *Archaeospheniscus* and *Platydyptes*. Polyphyly of the wastebasket taxon *Palaeeudyptes* in these results indicates the genus must be split. Re-examination of casually referred material also erases any evidence for cosmopolitan fossil penguin species distributed across multiple continents.

Technical Session II, Sunday 8:15

THE ROLLING MODE OF THE ACROPODIUM IN EXTINCT SYNAPSIDA

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The rolling mode of the acropodia in most extant reptiles is characterized by dorsal extension of the mid digital and basal digital joints. The ungual phalanges are flexed and cause friction on the substrate with the claws. In most mammals, however, the mid digital joints of the digits II to V are kept flexed during the propulsion phase and thus form a digital vault. Only at the end of the propulsion phase are the phalanges adjacent to the mid digital joints of the digits II-V are maximally extended to 180° against each other. Such a digital vault reduces the lever arm of the reaction force on the substrate but increases that of the profound flexor tendons. This saves muscular force and increases the pressure of the terminal sole pads or claws on the substrate. Friction is replaced by impulse and the claws dig into the substrate only in the terminal rolling phase or during acceleration.The presence of a digital vault among extant mammals is recognized by a flat trochlea on the basal phalanges and a weak or missing guiding sulcus on the dorsal face of the trochlea as well as significant foot prints caused mainly by the separated sole pads. According to the osteology of the mid

digital joints and ichnofossils most Mesozoic Mammaliaformes also walked with a digital vault. The articular heads of the mid-digital joints of non-mammaliaform synapsids and pelycosaurs (*Dimetrodon*, *Ophiacodon*) bear a dorsodistally facing process or a protruding lip emerging from the dorsal margin of the articular face. Both structures block dorsal extension of the adjacent phalanges and indicate the presence of a digital vault in the acropodia in these groups as well. In early synapsids, e.g. Pelycosauria, with a phalangeal formula of 2-3-4-5-3/4, the proximal medial phalanges can barely have a lever effect within the digital vault. With the reduction of the number of phalanges to three in the digits II to V the lever effect of the middle phalanges increases. The result is a Z configuration of acro- and metapodia, which acts as a spring that helps to economize the rolling movement.

Poster Session II, (Monday)

CARNIVORA ASSOCIATED WITH *AUSTRALOPITHECUS SEDIBA,* MALAPA, GAUTENG, SOUTH AFRICA

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Recent discoveries at the new site of Malapa (Gauteng, South Africa), have yielded a relatively rich faunal assemblage including the new hominin species *Australopithecus sediba*. Dating of this deposit using U-Pb and palaeomagnetic methods has provided an age of 1.95 my to 1.78 my, making it one of the best-dated deposits in the Cradle of Humankind. The faunal assemblage is relatively diverse and includes several carnivore species. To date 62 specimens have been identified as carnivore, of these at least five species have been positively identified. Most notably, the Malapa site has produced a number of extinct felid taxa including the genera *Megantereon* and *Dinofelis*, as well as representatives of modern hyaenas. Smaller carnivores are rare in the fossil record, but are also represented at Malapa, and include the genera *Atilax* and *Mungos*. The geochronological age of Malapa, the associated hominin taxa and extinct felids and hyenids provide a unique window of research into mammalian evolution during a relatively unknown period in South Africa and elsewhere. In particular, the fauna represented at Malapa has the potential to elucidate aspects of the evolution of *Dinofelis* and may help resolve competing hypotheses about faunal exchange between East and Southern Africa during the late Pliocene or early Pleistocene. We here present details of the carnivore assemblage, compare it with other carnivore assemblages from the Cradle of Humankind, and consider what the carnivores can tell us about the paleoecology of this site.

Poster Session II, (Monday)

PETROSAL ANATOMY AND INNER EAR STRUCTURES OF A NEW MULTITUBERCULATE MAMMAL FROM THE LATE CRETACEOUS OF CHINA: NEW DATA FROM MICRO-CT ANALYSIS AND PALEOBIOLOGIC INFERENCES

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The derived middle and inner ears of mammals are the major features distinguishing them from non-mammalian vertebrates. Among them, the multituberculate mammals represent an important transitional stage and a ground plan for the therian ear evolution. We present the reconstruction of petrosal features of a new multituberculate from the Late Cretaceous of Inner Mongolia (China) based on high resolution computed tomography and three-dimensional imaging analysis. This study reveals a combination of derived and primitive characters, such as a therian-like vascular and nervous pattern and internal acoustic meatus, and a monotreme-like inner ear, but with a derived semicircular canal planarity. The probable presence of a primary bony lamina for the basilar membrane suggests that the first step in the elaboration of a coiled cochlea might have been already present in multituberculates. Auditory capabilities can be induced for this animal, which was certainly terrestrial and possibly fossorial.

Technical Session XVII, Wednesday 2:15

FIRST NON-AVIAN DINOSAUR FROM THE LOWER CRETACEOUS (APTIAN) XIAGOU FORMATION OF THE CHANGMA BASIN, NORTHWESTERN CHINA

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Finely-bedded lacustrine mudstones of the Lower Cretaceous (lower-middle? Aptian) Xiagou Formation exposed near the town of Changma in the Changma Basin of northwestern Gansu Province, China have yielded approximately 100 exceptionally preserved avian specimens, many including carbonized remnants of feathers, keratin, or skin. All but one of these specimens (the holotypic distal pelvic limb of the ornithuromorph *Gansus yumenensis*) have been discovered since 2002. Despite this abundance of Early Cretaceous bird material, however, no other types of dinosaurs had been recovered from Changma until recently.Here we report the first non-avian dinosaur fossil from the Xiagou Formation of the Changma Basin. The specimen consists of an articulated, essentially complete and three-dimensionally preserved pectoral girdle and limb lacking the carpus and manus. Based on the presence of a very large, elliptical fenestra in the coracoid (termed the "supracoracoid fenestra" by previous authors), the fossil is referable to the dromaeosaurid theropod clade Microraptorinae. Uncontroversial representatives of Microraptorinae have been previously reported only from the Lower Cretaceous (Barremian-lower Aptian) Jehol Group of northeastern China (*Graciliraptor liujiatunensis*, *Microraptor* spp., and *Sinornithosaurus* spp.) and the Upper Cretaceous (middle-upper Campanian) Dinosaur Park and Oldman formations of Alberta, Canada (*Hesperonychus elizabethae*). Consequently, the new Changma specimen likely constitutes the geologically youngest record of the clade from Asia, and the second-youngest globally; moreover, its occurrence broadens the geographic distribution of Microraptorinae to include the central region of the Asian continent. The three-dimensional preservation of the specimen also promises to shed light on microraptorine pectoral girdle and limb morphology, mobility, and function.

Technical Session XI, Tuesday 2:00

TREE BALANCE AND MISSING DATA COMPLICATE BAYESIAN PHYLOGENETIC ANALYSIS OF FOSSIL TAXA

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When fossil-inclusive data sets are subject to Bayesian phylogenetic analysis, problematic results have been widely recognized but poorly characterized. In situations where there is a stem lineage leading to a crown clade, extinct taxa tend to group together, even when the available character data appear to unambiguously support a pectinate arrangement of stem taxa. This problem is encountered in both empirical and constructed data sets, and is not observed in maximum likelihood or parsimony analyses. Here, a novel method for simulating fossil-inclusive trees is presented. This is accomplished via birth-death process, followed by a fossil sampling step motivated by an understanding of taphonomy and geology. Patterns of tree balance are compared to those of commonly implemented and widely used tree priors. Trees that include extinct taxa are found to be less balanced on average than those that include only extant taxa. Because fossil-inclusive character matrices used in phylogenetic analysis tend to have a high proportion of missing data and a low number of informative characters, the influence of the tree prior on the posterior distribution has the potential to be non-negligible. If balanced trees are preferred under the tree prior and the data are weak, trees in which extinct taxa group together may be erroneously inferred. The need for methodological improvements in Bayesian analysis of fossil data is recognized.

Technical Session XV, Wednesday 10:15

THE ORIGINS AND EVOLUTIONARY RELATIONSHIPS OF HYBODONT SHARKS: NEW INFERENCES BASED ON SKELETAL MORPHOLOGY

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'Hybodonts' (Hybodontiformes) have been proposed to represent the monophyletic sister group to Neoselachii (extant sharks and rays). Hybodontiformes have previously been considered to include the suborder Hybodontoidei, as well as two problematic taxa, *Tristychius* and *Onychoselache*. However, classifications of Hybodontiformes have previously been almost entirely based on isolated dermal elements, and skeletal material is known from only 17 hybodontiform species and 11 genera (out of a total of over 44 recognized species). New, exceptionally well preserved fossil material of the Lower Cretaceous hybodontiform shark *Tribodus limae* allows for the first complete description of skeletal morphology in this genus, and affords the opportunity for the first-ever comprehensive phylogenetic analysis of hybodontiform sharks, thus shedding new light on hybodontiform diversity and evolutionary relationships. CT-scan based examination of a three-dimensional braincase of *Tribodus* (one of only a handful of complete fossil chondrichthyan neurocrania currently known), as well as reconstruction of its nerve and blood vessel foramina and cranial arterial circulation, provides new insights into the evolution of cranial morphology in crown-group chondrichthyans. A revised reconstruction of the pectoral fin skeleton of *Tribodus* resembles that of neoselachians, and numerous additional features strongly support a close evolutionary relationship between hybodonts and neoselachians. Examination of *Tribodus* also reveals the presence of supportive endochondral "struts" in force-bearing regions of the jaws (similar to those found in extant batoids).Parsimony-based phylogenetic analysis on a matrix of 33 total taxa and 129 skeletal characters strongly supports the monophyly of Hybodontiformes (including *Onychoselache*) above *Tristychius* and the sister-group relationship of hybodonts and neoselachians, but suggests that Hybodontiformes including *Tristychius* is paraphyletic unless Neoselachii is included. The monophyly of Hybodontoidei, Hybodontidae, and Hybodontinae is supported, as is the previously proposed sister-group relationship between *Tribodus* and *Asteracanthus*.

Poster Session I, (Sunday)

LATE CRETACEOUS CANADIAN SPECIMENS OF FAMILY SOLEMYDIDAE (TESTUDINES) WITH SPECIAL MENTION OF A NEW GENUS AND SPECIES

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Family Solemydidae is a group of probable basal cryptodires known from the Barremian to the Maastrichtian preserved mainly as isolated shells and shell fragments. Easily identified based on their distinct granulated texture and entoplastral (interhumeral) scute, most named species referred to the family are known from Europe. The single named North American species, *Naomichelys speciosa*, is known from the late Aptian Cloverly and Trinity formations. All other known specimens from this family in North America (identified by their unique sculpture) have been too fragmentary to adequately describe. Here, we report a relatively complete shell of a solemydid from the marine Haslam Formation (Santonian) of Vancouver Island. Based on characters of the shell, this specimen is not referable to *Naomichelys speciosa* and represents a new genus and species. Other new specimens of the family include a complete xiphiplastron, as well as fragmentary costal, peripheral, and suprapygal plates from the terrestrial Milk River Formation (upper Santonian), as well as a hyoplastron from the paralic-to-terrestrial Foremost Formation (middle Campanian), that are distinct from the Haslam specimen, although they may be referable to the genus *Naomichelys*, or at least a clade of endemic North American solemydids. A fragmentary solemydid xiphi-hypoplastron believed to be from the marine-to-nonmarine Dunvegan Formation (Cenomanian) would be the second documented species of turtle from this formation and among the oldest known in Alberta. These specimens extend the geographic and geologic range of the family and illustrate a greater potential North American diversity for this enigmatic family than has been previously documented.

Technical Session XVII, Wednesday 2:00

THE WINGED NON-AVIAN DINOSAUR *MICRORAPTOR* FED ON MAMMALS: IMPLICATIONS FOR THE JEHOL BIOTA ECOSYSTEM

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Direct evidence for predator-prey interactions in the fossil record are rare. Dietary regimes and trophic interactions within extinct communities are usually inferred based on indicators such as body size, tooth shape, and coprolites. While these lines of evidence are useful, only gut contents provide direct evidence for an individual's diet. We report here the first gut contents of a non-avian paravian within the small feathered theropod *Microraptor*. The holotype of *Microraptor zhaoianus* includes fragments of articulated dorsal vertebrae with regularly spaced ribs. Between the left and right ribs is preserved an articulated foot of a mammal. Other bones are also present and may include possible cranial, limb and axial elements of the mammal. The morphology of the foot is most similar to *Eomaia* and *Sinodelphys,* although this specimen lacks the level of arboreal adaptations seen in those taxa. The foot is relatively long, with a shortened first metatarsal and elongate phalanges possessing a phalangeal ratio of around 1. The preserved unguals are moderately recurved, the phalanges are straight and the ratio of proximal to distal phalanges does not indicate a dedicated arboreal lifestyle but suggests the animal was most likely scansorial. Body size and mass of the *Microraptor* and mammal specimens were calculated from metric comparisons to closely related taxa. The *Microraptor* specimen is estimated to have a snout-vent length of 140 - 150 mm and a body mass of between 100 and 150 g. The mammal is estimated to have had a snout-vent length of approximately 80 mm and a body mass of 20 - 25 g. We compare these values to those among extant tetrapod predators and prey. This new find provides valuable information regarding species interactions and trophic relationships within the Jehol Biota. This discovery, combined with other recent finds from these deposits, permits a more accurate reconstruction of the food web structure of this Lower Cretaceous fauna. These data suggest that unlike the earliest birds, which were either insectivorous or herbivorous (e.g. *Archaeopteryx, Jeholornis), Microraptor* was an active predator of agile, small-bodied vertebrates.

Poster Session III, (Tuesday)

THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSIS AND UNIVARIANT MEASUREMENT ANALYSIS ON AN UNDESCRIBED *ORNITHOMIMUS* MANUS

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An undescribed theropod dinosaur manus (Utah Museum of Natural History 16385), found in the Kaiparowits Formation of southern Utah, is hypothesized to be a new species of the genus *Ornithomimus*. The specimen consists of a complete metacarpal one and two (MC1, MC2), an incomplete metacarpal three (MC3) missing its proximal end, and eight phalanges including three complete unguals. Here we compare the manus of the Utah Museum of Natural History specimen to the smaller sized type specimen of *Ornithomimus velox*, the similar sized type specimen of *Ornithomimus edmontonicus*, and an ontogenetic series of *Alligator mississippiensis* manus (University of Michigan Museum of Zoology 238961, 238957, 238965, 238959). Univariant measurements including length, proximal width, distal width, and midshaft width were taken on the three ornithomimid specimens and the alligator ontogenetic series. The alligator ontogenetic series was evaluated as a relative growth rate model for the three dinosaur specimens. Width versus length regressions for MC1, MC2, and MC3 consistently place *Ornithomimus edmontonicus* as an outlier. Furthermore, *Ornithomimus velox* and the Utah Museum of Natural History specimen follow the same trajectory suggesting similar growth patterns. We used geometric morphometrics to analyze shape variation within the articular surfaces of the distal and proximal ends of MC2 and MC3 on *Ornithomimus velox,* the Utah Museum of Natural History specimen and the full alligator ontogenetic series. These data suggest that there is a significant difference in the shape of MC2 and MC3 in the oldest alligator compared to the younger alligators in the series. Our findings indicate that the manus of *Alligator mississippiensis* does not follow an isometric growth pattern. Moreover, our analyses indicate that neither ornithomimid specimen follows the same trajectory as the alligator series. We conclude that the allometric growth found in *Alligator mississippiensis* does not predict the metacarpal shape for the *Ornithomimus* specimens studied.

Technical Session IV, Sunday 4:00

MODELLING EFFECTS OF PLEISTOCENE CLIMATE CYCLES ON SPECIES' DISTRIBUTIONS: IMPLICATIONS FOR THE NEAR FUTURE

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The history of species' distributions through geologically recent interglacial-glacial fluctuations provides insight to how species may respond geographically and evolutionarily to anthropogenic climate change. To better understand how repeated climate cycles have affected species over the last 320 ky, we modelled the climatic niches of eleven species of rattlesnakes, ectotherms whose geographic distributions are known to be closely linked to climate. The models were projected onto 4 ky interval paleoclimate reconstructions covering four interglacial-glacial cycles. We modelled the adaptation of species' niches to climate change using phylogenetic regression to investigate the interplay of changes in global climate and evolution. Climate change has contributed to the model patterns more than evolution by 2-3 orders of magnitude. Our model results suggest the change in mean annual temperature is correlated with change in the position ($R = 0.40$) and areal extent ($R = 0.98$) of species' suitable habitats, which on average are expected to have changed respectively by 172 km and 56 km² per ºC.By the end of the 21st century, the mean annual temperature is projected to increase between 1.1ºC and 6.4ºC, corresponding in our estimates to an average displacement of a species' suitable habitat of at least 189 km up to 920 km and an increase in area of at least 59 km² up to 139 km². Although suitable habitat is predicted to increase, its position may be displaced faster or farther than a species is able to track. A pairwise comparison of change in geographic position of suitable habitat between all 4ky time intervals over the past 320ky (102080 comparisons) reveals only 9.9% have a displacement greater than 189 km and only 3.8% have a displacement greater than 920 km. Our models demonstrate the dramatic geographic responses of species to rapidly changing global climate and the more dramatic geographic responses that species will soon be required to overcome in order to escape extinction. This finding is crucial for conservation decisions, for predicting changes in biodiversity in the near future, and for understanding fundamental ecological and evolutionary processes.

Technical Session II, Sunday 11:15

MASTICATORY MOVEMENTS TRIGGER CUSP MORPHOLOGY IN MAMMALIAMORPHS WITH RODENT-LIKE DENTITIONS

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Rodent-like Mammaliamorpha have developed highly convergent dentitions, not only limited to the partially evergrowing incisors and a diastema. Very successful clades such as the Tritylodonta, the cimolodont Multituberculata and the murine Rodentia exhibit a longitudinal grinding cycle of mastication associated with upper cheek teeth displaying three longitudinal rows of cusps. However, Cenozoic multituberculates such as Cimolodonta display masticatory movements involving two distinct cycles that greatly differ from those observed in rodents: an original orthal slicing-crushing cycle associated with an enlarged lower fourth premolar precedes a palinal grinding cycle. With their plesiomorphic lower premolars and upper molars, the Late Jurassic/Early Cretaceous multituberculate family Paulchoffatiidae can provide the key for the understanding of the origin of the complex mastication cycle of the Cimolodonta.We digitized dental material of Paulchoffatiidae from the Kimmeridgian of the Guimarota Coal Mine (Leiria, Portugal) at the European Synchrotron Facility (Grenoble, France) using for the first time propagation phase contrast Synchrotron X-Ray microtomography to perform both microwear and topographic analyses.Paulchoffatiidae display two different cycles during their mastication, a puncture-crushing cycle (like in other Mammaliamorpha) and a grinding cycle that consists of two different phases. The first phase is oblique and can be interpreted, even if it is not orthally directed, as a precursor of the slicing-crushing cycle of the Cimolodonta. The second phase is fully palinal and is homologous to the grinding cycle of the Cimolodonta.A strong relationship between individual cusp shape and direction of chewing has been observed in most rodent-like Mammaliamorpha. This relationship is not evident in Paulchoffatiidae, they exhibit derived upper premolars with

three longitudinal cusp rows. This can be explained by the fact that the lingual row of upper premolar cusps is not involved in attrition in Paulchoffatiidae. The stronger the attrition, the more the direction of the masticatory movements influences the cusp morphology.

Poster Session II, (Monday)

POSTCRANIAL OSTEOLOGY OF *MINMI* SP., A BASAL ANKYLOSAUROMORPH (DINOSAURIA: ORNITHISCHIA) FROM THE EARLY CRETACEOUS (ALBIAN) ALLARU MUDSTONE OF QUEENSLAND, AUSTRALIA

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Minmi is the only known genus of ankylosauromorph from Australia. Seven specimens are known from the Early Cretaceous of Queensland. However, only two of these specimens have been described in any detail: the holotype *Minmi paravertebra* from Roma and a nearly complete skeleton preliminarily referred to as *Minmi* sp. from Marathon Station near Richmond. The Marathon specimen represents one of the world's most complete Early Cretaceous ankylosauromorphs and is the best-preserved dinosaur fossil of any age from East Gondwana. The majority of ankylosaurs have been found in Late Cretaceous sediments of Laurasian continents and thus the evolution of this group during that time and in this part of the world is well understood. Conversely, very little is known about ankylosaurs in the early stages of their evolutionary history (Jurassic-Early Cretaceous) and in the Gondwanan landmasses, due in part to the rarity and fragmentary nature of most known specimens. *Minmi* sp., with its Early Cretaceous age and unique state of preservation, is an ideal taxon with which to examine the early evolution of this distinct dinosaurian fauna.Previous work on the cranial osteology of *Minmi* revealed that the taxon is positioned basal to the traditional Ankylosauria (Ankylosauridae + Nodosauridae), but higher than Thyreophora. Phylogenetic analysis incorporating cranial data strongly supported the creation of the stem-based Ankylosauromorpha, which includes all eurypods closer to *Ankylosaurus* than *Stegosaurus*. The description of the postcranium of *Minmi* sp. has resulted in the reassessment of some previous characters and the formation of new ones relating to the phylogenetic relationships of Ankylosauromorpha. Preliminary results reaffirm *Minmi*'s basal position within Ankylosauromorpha. *Minmi* shows that basal ankylosauromorphs were similar to *Scelidosaurus*, in that they were proportionally smaller and less robust, with a less well-developed dermal skeleton than ankylosaurians.

Poster Session III, (Tuesday)

THE AXIAL SKELETON OF *GRACILISUCHUS STIPANICICORUM*: AUTAPOMORPHIC CHARACTERS AND ITS PHYLOGENETIC INFORMATION WITHIN THE CONTEXT OF CRUROTARSI

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Gracilisuchus stipanicicorum is a small suchian archosaur from the Middle Triassic Chañares Formation (NW Argentina), known from well preserved specimens but poorly studied anatomically. Since its description it has been related to different lineages of Archosauria and recently considered closely related to Crocodylomorpha, although a consensus is lacking about its relationships within Crurotarsi. The present study was performed on the basis of the axial skeleton of the holotype (PULR 08) and one referred specimen (PVL 4597). As a result of this study a unique combination of characteristics present in the axial skeleton of *Gracilisuchus* is identified (autapomorphies marked with a *): an horizontal postzygapophysial facet of the axis, posteriorly directed, and facing ventrally*; a high and vertical anterior border of the axial neural spine*; a concavoconvex posterior articular surface of the cervical vertebrae*; cervical vertebrae with a circular depression on the mid-dorsal region of the neural arch; absence of spine table in posterior dorsal vertebrae; two paramedian osteoderms per vertebra. Several axial characters support a relationship with Crocoylomorpha, such as the presence of a presacral vertebral count of at least 24, similar to some basal crocodylomorphs and crocodyliforms. A derived character state shared with the crocodylomorph *Hesperosuchus* is the presence of poorly developed ventral keels in the postaxial cervical vertebrae. Probable plesiomorphic features are the absence of a developed postzygapophysial process in the axis, shared with basal archosauriforms and *Parasuchus*; the presence of a ventral keel in the axis, shared with members of the archosauriform clade, whereas the absence of such a keel is found in some basal crocodyliformes (*Sphenosuchus*, *Junggarsuchus*). This information is added to a cladistic analysis within the context of Archosauriformes to test its phylogenetic affinities with the addition of the new information of the axial skeleton.

Technical Session I, Sunday 8:00

THE UNIVERSAL TEMPERATURE DEPENDENCE MODEL FAILS TO PREDICT BODY TEMPERATURES ACCURATELY FOR EXTANT AMNIOTES AND EXTINCT DINOSAURS

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The Universal Temperature Dependence (UTD) model, which relates growth rate to body temperature, purported to solve the question of non-avian dinosaur thermophysiology by demonstrating a pattern of increasing body temperature with size across several species. These data suggested that dinosaurs were ectothermic poikilotherms and that only the largest ones could use their mass to attain homeothermy. We first tested that model on living animals, using data from 302 species of lepidosaurs, turtles, crocodylians, birds, and mammals. We found that across this broad range of amniotes, the scaling trends of the actual data do not consistently match those predicted by the UTD model: there are significant prediction errors for 44% of extant non-avian reptiles and birds, and 67% of extant mammals. We also found that resting body temperature is independent of size in non-avian reptiles, birds, and mammals, regardless of their thermoregulatory strategies. Then, using recently revised estimates of non-avian dinosaur growth rates based on skeletochronologic data, we found that predicted body temperature was also size-independent for these taxa. This refutes the claim based on the UTD model that dinosaurs could attain homeothermy only by growing to large size. In contrast, the independence of size and body temperature in dinosaurs is consistent with published data on oxygen isotope fractionation and bone histology, together implying relatively tachymetabolic and endothermic homeothermy. The UTD model is insufficient to predict body temperatures and thermometabolic strategies for individual species and clades, either living or extinct. However, its results for non-avian dinosaurs are broadly consistent with other evidence that dinosaurs were tachymetabolic, endothermic homeotherms.

Poster Session II, (Monday)

THE FIRST CERATOPSIAN FROM KOREA

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In 2008, a new basal neoceratopsian was discovered in the Tando Formation (Cenomanian~Turonian) of Tando Basin in Korea. It represents the first ceratopsian dinosaur in the Korean peninsula and is an important datum for the paleogeographic distribution of ceratopsians. It represents the easternmost occurrence of basal neoceratopsians in Eurasia and comes from a time period with a very limited fossil record for the group. Autapomorphies of the new taxon include: very tall neural spines over 5 times as high as the vertebral centrum in the distal caudals, and a unique astragalus divided into two fossae by a prominent craniocaudal ridge on the proximal surface. A phylogenetic analysis indicates that the new taxon is more derived than *Archaeoceratops* and is the sister group to Leptoceratopsidae+ *Graciliceratops* and all more derived ceratopsians, and that the elongation of caudal neural spines is an important derived character in non-ceratopsid neoceratopsians. The very tall caudal neural spines of the new taxon, *Montanoceratops*, *Udanoceratops*, *Protoceratops*, and *Bagaceratops* appear to be homoplasious, suggesting an independently acquired adaptation that may be related to swimming. Skeletal evidence suggests that obligate quadrupedalism occurred gradually in neoceratopsians progressing from bipedal through facultative quadrupedalism, to complete quadrupedalism in Coronosauria with a progressive increase in body size and robustness, and a modification of unguals from claws to hoofs.

Poster Session IV, (Wednesday)

AVIAN EGGSHELL FRAGMENTS FROM A FRESHWATER FACIES OF THE SALINE WILKINS PEAK MEMBER OF THE EOCENE GREEN RIVER FORMATION

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Abundant avian eggshell fragments occur in a nearshore freshwater facies of the saline Wilkins Peak Member of the Green River Formation near the northwestern edge of Eocene Lake Gosiute. The eggshell fragments are associated with *Presbyornis* (Aves: Anseriformes) bones and occur in multiple stratigraphic intervals between the layered tuff (a well known Wilkins Peak marker bed) and the base of the Laney Member of the Green River Formation. The eggshell fragments are associated with ostracods, caddisfly larval cases, microbialites and intraclast micrite (both calcimicrite and dolomicrite). Mudcracks are common on the surface of the intraclast dolomicrite that contains the greatest concentration of eggshell fragments.

Several eggshell fragments were studied by light microscopy (LM), by polarized light microscopy (PLM) and by scanning electron microscopy (SEM). The resultant micrographs were compared with published reports of modern and fossil "ornithoid", "crocodiloid", "testudoid" and "geckoid" eggshell. The Wilkins Peak eggshell fragments show the following microstructure zones (from internal to external): 1) an organic core, 2) a zone of radial calcite plates, 3) a zone of tabular crystallite plates, 4) a zone of squamatic aggregates and 5) an external zone of vertical calcite crystals. Macrostructure zones (from internal to external) are: 1) wedges of the mamillary layer (diverging outward from the central core), grading into 2) long vertical columns of the prismatic layer. These findings are similar to the characteristics of modern neognathous eggshell.

The abundant avian eggshell fragments and the avian bones support a nesting site hypothesis for this study site. The caddisfly larval cases, microbialites, mudcracks, intraclast micricites and avian eggshell fragments are strong evidence for a lake margin depositional environment. The absence of oil shale and evaporite facies normally associated with the Wikins Peak Member of the Green River Formation indicates that this study site was close to a freshwater source (river or spring). It is likely that the birds that produced the eggshell preferred nesting sites close to freshwater sources.

Evolution of the Modern African Fauna, Wednesday 9:15

EVOLUTIONARY HISTORY OF TUBULIDENTATA (MAMMALIA, AFROTHERIA) AND THE ORIGIN OF THE LIVING AARDVARK

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The Tubulidentata is one of seven orders of placental Mammals grouped in the clade Afrotheria by molecular analyses. They are currently represented by a single living species: *Orycteropus afer*, the aardvark. The systematics of the Tubulidentata is poorly known because fossils of this order are scarce and only known for the last 20 million years (My). Over the last 30 years, several new fossils have been discovered in the Neogene of Eurasia and Africa but not extensively analysed. In addition, ongoing field work in Chad, Ethiopia, and Kenya continues to turn up new specimens. Finally, an extensive morphological database on the extant aardvark was built in order to study intra-specific variability. These advances enabled a morphological revision of each species and a study of their phylogenetic and paleobiogeographical relationships. Four major lineages are distinguished: *Amphiorycteropus*, *Leptorycteropus*, *Myorycteropus*, and *Orycteropus*. Whereas *Leptorycteropus* and *Myorycteropus* are strictly African taxa, the genus *Amphiorycteropus* is known from both Africa and Eurasia. Although the relationships between these lineages can not yet be clearly established, none of these three aforementioned genera can be an ancestor of the modern *Orycteropus* because each shows unique anatomical specialisations unknown in the living aardvark. Conversely, a fossil form found in Pakistan (lower Dhok Pathan formation, 8 to 10 My) is the oldest taxon to show the rectangular, large molars typical of the genus *Orycteropus*. The first African specimens assigned to this genus come from the Kenyan sites of Lothagam (7 to 5 My) and Lukeino (around 6 My). This suggests that the genus *Orycteropus* originated in Asia and only later colonised Africa. From the Pliocene onward, several *Orycteropus* taxa appears in East and Central Africa, and embody the total replacement of the earlier lineages by this genus in Africa during that time. However, the closest relative of the extant aardvark comes probably from Langebaanweg (Lower Pliocene, South Africa), and suggests that the last living member of the order Tubulidentata has its roots in the southern African sub-continent.

Poster Session IV, (Wednesday)

AN ARTICULATED SMALL JUVENILE HADROSAURID DINOSAUR (ORNITHISCHIA; ORNITHOPODA) FROM THE CAMPANIAN KAIPAROWITS FORMATION, UTAH

LEVITT, Carolyn, University of Utah, Salt Lake City, UT, USA; IRMIS, Randall, University of Utah, Salt Lake City, UT, USA

We report the discovery of a nearly complete articulated juvenile hadrosaurid dinosaur from the mid-Campanian lower Kaiparowits Formation in Grand Staircase-Escalante National Monument, southern Utah. This specimen preserves most of the postcranial skeleton, and is identifiable as a member of the Hadrosaurinae based on the presence of an ischium with a tapering distal end, in contrast to the hypertrophied foot in Lambeosaurinae. Although the specific identity of the specimen is indeterminate, it is likely an individual of *Gryposaurus*, the only hadrosaurine presently known from the formation. Comparison of limb bone dimensions between this juvenile and those of several adult hadrosaurines from the Kaparowits Formation indicates that it is approximately 15% the size of an adult *Gryposaurus*. The estimated body length for this animal, 120 cm, identifies it as a large nestling or an early juvenile based on ontogenetic stages defined for *Maiasaura*. Further comparisons with adult Kaiparowits specimens and other hadrosaurines provide insight into hadrosaurid limb bone allometry. Tibia/femur (0.86 to 0.93) and ulna/humerus (0.62 to 0.88) ratios increased from juvenile to adult *Gryposaurus*, indicating positive allometry for more distal limb elements relative to proximal limb bones. All forelimb elements experienced positive allometry relative to the femur, and the overall forelimb/hindlimb ratio (humerus + ulna/femur + tibia) increased slightly from 0.56 in the juvenile to 0.63 in the adult *Gryposaurus* specimens, with similar values in adults of other hadrosaurine taxa. In contrast, adult lambeosaurines examined have proportionally more elongate forelimbs, with forelimb/hindlimb ratios ranging from 0.8 to 0.99. These data suggest distinct ontogenetic trajectories for limb bones in these two major clades that compose Hadrosauridae.

Evolution of the Modern African Fauna, Wednesday 10:30

PATTERNS OF EVOLUTION IN EASTERN AND SOUTHERN AFRICAN CARNIVORA

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Previous studies have demonstrated that species richness peaks around 3.6-3.0 Ma in eastern African Carnivora and then declines gradually with peaks in origination of new species occurring at 3.9-3.3 Ma and 2.1-1.8 Ma. Carnivoran components of eastern (EA) and southern African (SA) faunas have also been shown to be more similar to each other through time than to those in the Chado-Libyan bioprovince. The present study compares origination/extinction events in EA and SA carnivorans to test whether the same ecological shifts occur given the general similarity of the carnivorans. The first EA origination peak is due to both local diversification and immigration from other regions. The most striking increase occurs in open/mixed habitat-adapted forms and extremely large aquatic forms. In contrast, the second event involves modest increases driven primarily by the appearance of more mixed/closed habitat viverrids and felids. The generalist sabertooth *Dinofelis* becomes the most diverse sabertooth genus in Africa with three relatively dissimilar species in this region. The numbers of more open/mixed habitat taxa are relatively stable at this point, although some archaic forms are replaced by modern forms. Large aquatic forms are all but extinct. Analyses of species richness within southern Africa show a superficially similar pattern. Like eastern Africa, southern Africa suffered extinctions, although slightly later in time. Once again, after the initial appearance of new taxa, a second, smaller origination peak occurs 2.1-1.8 Ma. However, SA canid and smaller felids are more diverse, while sabertooths and *Crocuta* are less diverse than in EA. Differences in site formation processes may explain some differences in diversity (e.g., lack of giant otters in SA), but do not necessarily explain why sabertooths and *Chasmaporthetes* persist for much longer in SA. In sum, EA and SA carnivoran faunas are generally similar in the timing of origination events, but differ in which ecomorphs are successful within a given time slice. This study demonstrates that guild dynamics were quite different in each region even before hominins entered the carnivore guild.

Poster Session III, (Tuesday)

NEW DINOSAUR TRACKSITE AND UNUSUAL THEROPOD FOOTPRINTS FROM THE CRETACEOUS OF KOREA

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Korean dinosaur trackways represent great opportunities to understand walking pattern and social behavior of Cretaceous dinosaurs.Recent fieldwork and excavation in the southeastern part of Korea reveals a new tracksite, including theropod footprints, sauropod trackways, and bird tracks. *Minisauripus* was also discovered near the site. The new tracksite was excavated from the Haman Formation of Gyeongsang Basin, which has produced many bird footprints at other sites.The new tracksite yielded more than 100 footprints and theropod tracks are the most abundant among footprints.The theropod footprints are well-preserved with sharp claw marks and show at least three types. A discovery of three types of theropod tracks in a small place is the first report in Korea. The theropod footprints have a different ratio of length and width from those of theropod footprints from other Korean tracksites including Goseong and Hwasun.Type I of the theropod footprints shows narrow total divarification and digit width compare to that of Type II. The total divarification of a Type I track is 31 while that of a Type II is 84. Digit divarification also indicates a different angle. The hip height of the most theropods from the new tracksite is between 45 to 80 cm. Type III has very thick digit width for digit 3.The width of digit 3 in a Type III footprint is two times thicker than those of digit 2 and 4. Several trackways of the theropods which went toward small sauropod trackways with a trackway of an adult sauropod are discovered in parallel.The stride length of the adult sauropod trackways composed of 12 tracks is between 239 and 247 cm. The pes are between 60 and 66.5 cm in width and between 82 and 85 cm in length. The new dinosaur tracksite indicates gregarious behavior and group hunting of small carnivorous dinosaurs.

Poster Session II, (Monday)

NEW FINDS OF THE SUBHOLOSTEAN GENUS *HABROICHTHYS* FROM MIDDLE TRIASSIC OF SOUTHWESTERN CHINA

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Habroichthys is a typical Middle Triassic small subholostean (basal Actinopterygian) fish, with a restricted Tethydian distribution from the Alps (Italy, Switzerland, Slovenia) now to the Southwestern China Provinces of Guizhou and Yunnan. *Habroichthys* was characterized by the single very deep scale-row occupying the whole flank and ending with a large semicircular scale, and by a shield-like skull-roof (frontals, parietals and dermopterotics fused together): these were so far the only available characters for the genus owing to the poor preservation of most specimens mainly from the Monte San Giorgio area. New finds from the Upper Member of the Guanling Formation (Middle Anisian) and from the Upper Zhuganpo Formation (Late Ladinian), in Luoping County, Yunnan Province, provide better information regarding both skull and body anatomy, but also to extend the stratigraphical and geographical range of the genus. In the Alps *Habroichthys* is quite common around the Anisian/Ladinian boundary, while in Southwestern China it ranges from the Middle Anisian to the latest Ladinian. The oldest record is not surprising as many Late Anisian western Tethys genera of actinopterygians are now considered as migrated from East during the Middle Anisian; more interesting is the upward extension as the genus has never been found in the Late Ladinian sites of western Tethys. Regarding the anatomy of the genus, the very nicely preserved specimens from Luoping possess maxilla is shorter than the lower jaw and it is free from the pear-like preoperculum, suborbitals are absent as probably is the case for supraorbitals and the tail is slightly asymmetrical, with a very small body lobe supporting few epaxial rays. This latter character, together with the very deep flank scales, supports the attribution of the genus to Peltopleuriformes even if Habroichthys shows a free posterior maxilla end, usually considered as a neopterygian character, but here seen as a biomechanical specialization related to trophism. Finally, the Late Ladinian species we now consider as belonging to *Habroichthys*, was originally ascribed to *Peltopleurus* as *Peltopleurus orientalis.*

Technical Session X, Tuesday 9:15

MASS PREDICTION IN CHINESE MESOZOIC FOSSIL BIRDS

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Body weight is a crucial biological parameter for an organism. Therefore, mass estimates for fossil species are important for many kinds of analyses. In this project, a bivariate regression analysis of different measurements of the appendicular skeleton plotted against live body weight in a data set of 422 individual birds, representing 254 species in 21 orders, revealed high correlations between several skeletal parameters and body mass. Bivariate equations were generated to describe the relationship between mass and each of twelve appendicular measurements. R-squared values for the equations ranged from 0.50 for tibiotarsal length, indicating a relative poor fit, to 0.91 for humeral diameter. To test the 12 equations empirically, they were used to predict the body masses of an additional 64 extant bird specimens, and the accuracies of the various equations were compared. This predictive test showed that three parameters are generally most accurate as predictors of body mass: humerus length, ulna diameter, and tibiotarsal diameter. However, the humeral length (HL) tended to give accurate results for particularly songbirds, raptors and climbing birds. The tibiotarsal diameter (TD) tended to give accurate results for terrestrial birds, such like chicken and doves. It is probable that HL is the more accurate parameter for arboreal taxa, while TD is more accurate for terrestrial ones. Closer examination of the results showed that different measurements correlated best with body mass in different avian orders. This variation appeared to result from differences in habitat and functional morphology across the avian orders represented in the data set. The weights of some Chinese Mesozoic fossil birds were estimated using the equations generated for humeral length (HL) and tibiotarsal diameter (TD), because ulnar diameter was frequently difficult to measure. HL and TD yielded dramatically different mass estimates for some taxa, with estimates based on HL generally being lower. The results indicate that these Early Cretaceous birds experienced a significant diversification in body mass during evolutionary process.

Technical Session XV, Wednesday 11:30

THE FOSSIL CATOSTOMID *JIANGHANICHTHYS* FROM CHINA AND IMPLICATIONS FOR THE EVOLUTION OF BASAL CATOSTOMIDS (CYPRINIFORMES, ACTINOPTERYGII)

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The Eocene cypriniform fish *Jianghanichthys hubeiensis* (Hubei Province, China) was originally assigned to the living genus *Osteochilus* within Cyprinidae. In subsequent revisions, *Jianghanichthys* was established as a distinct, monotypic genus, but its assignment to a family was left in doubt. A larger and more comprehensive collection from the type locality area now allows a re-examination of the morphology and taxonomy of *J. hubeiensis*. *Jianghanichthys* is represented by small individuals with body depth increasing through ontogeny (Body Depth/Standard Length ~0.35 in juveniles vs ~0.50 in adults). *Jianghanichthys* is attributed to Catostomidae by the following family-level synapomorphies: 1) mouth border partially formed by maxilla; 2) dentary short but posteriorly deep; 3) frontal broad anteriorly and narrow posteriorly, resulting in exposed sphenoid; 4) opercular arm and auricular process developed, creating concave dorsal opercular margin. *Jianghanichthys* differs from all known Eocene Catostomids in having 12–14 principal dorsal fin rays, far fewer than in *Plesiomyxocyprinus* (~50), *Vasnetzovia* (20) and all but a few fossil *Amyzon* (12–33); this range is close to that of modern Catostominae (10–18). This character is here interpreted as a convergence, because *Jianghanichthys* is differentiated from Catostominae by a shorter angular process of the dentary and a relatively deeper body. In addition, *Jianghanichthys* retains several basal cypriniform characters: 1) sensory canals embedded in the frontal bone, unlike all known catostomids, but shared with cyprinids, psilorhynchids, gyrinocheilids, and some cobitids; 2) plesiomorphic principal caudal fin ray count (10+9), higher than all modern catostomids (9+9), but identical to that of most lower teleosts including cyprinids. Lastly, a short and slender 4th pleural rib in the Weberian apparatus is uniquely shared by *Jianghanichthys* and cyprinids. These characters indicate that *Jianghanichthys* is arguably the most basal catostomid known to date, sharing a suite of plesiomorphic features with cyprinids and therefore a key taxon for future studies of cypriniform relationships.

Technical Session IV, Sunday 2:30

A SMALL PACHYPLEUROSAUR FROM THE LOWER MIDDLE TRIASSIC OF SW CHINA WITH COMMENTS ON THE PHYLOGENY OF EOSAUROPTERYGIA

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Recent discoveries of marine Triassic *Lagerstätten* from South China have greatly improved our understanding of the origin and early radiation of different lineages of aquatic reptiles. Here we report a pachypleurosaur from a newly discovered marine *Lagerstätte* in the Anisian Guanling Formation of Yunnan Province. In addition to its small size, the new pachypleurosaur differs from all other eosauropterygians with several autapomorphies including a broad skull table constricted in its posterior-most part, large posterior lappets of the frontal extending posteriorly well beyond the anterior margin of the upper temporal openings, and slight hyperphalangy in the pes. Its maturity can be confirmed by the well-ossified carpal and tarsal elements, the fully fused frontal and parietal, and the partially fused premaxillae. To establish its phylogenetic position, we slightly modified and expanded a data matrix previously used to clarify the interrelationships of sauropterygians. The first analysis was conducted with the inclusion of all terminal taxa. The strict consensus tree recognizes a monophyletic Pachypleurosauria nested within Eosauropterygia. The tree for Eosauropterygia reads as (Cymatosauridae, (*Kwangsisaurus*, (*Sanchiaosaurus*, (*Chinchenia*, (Pistosauria, (*Simosaurus*, (Nothosauridae, (*Hanosaurus*, Keichousauridae, (*Wumengosaurus*, Pachypleurosauridae))))))))). The new taxon and *Keichousaurus* compose the monophyletic Keichousauridae. All European pachypleurosaurs form the monophyletic Pachypleurosauridae. The topology of Eosauropterygia presented here with the paraphyly of Nothosauroidea and Pistosauroidea has not been recovered in any previous cladistic analyses. After deleting five taxa for which more than 50% characters cannot be coded, the strict consensus tree recognizes a fully resolved Eosauropterygia. The tree for Eosauropterygia reads as ((*Wumengosaurus*, (Keichousauridae, Pachypleurosauridae)), (*Simosaurus*, (Nothosauridae, Pistosauroidea))). This result restores the Pachypleurosauria to its traditional position as the sister group of the monophyletic Eusauropterygia and the monophyly of Pistosauroidea is also restored. However, the topology of Eusauropterygia with a paraphyletic Nothosauroidea is still different from traditional opinion. Both analyses show that Chinese pachypleurosaurs form the consecutive sister-groups of European pachypleurosaurs, supporting a previously proposed paleobiogeographic hypothesis of an eastern Tethyan origin of pachypleurosaurs. The new taxon and *Keichousaurus* always compose the monophyletic Keichousauridae. Thus, the discovery of the new taxon significantly shortens the existence of a ghost lineage as required by the previous paleobiogeographic hypothesis.

Technical Session XIV, Wednesday 11:00

TYRANNOSAURID EVOLUTION AND INTRACONTINENTAL ENDEMISM IN LARAMIDIA: NEW EVIDENCE FROM THE CAMPANIAN WAHWEAP FORMATION OF UTAH

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Tyrannosaurid theropods are a well-known component of late Campanian and Maastrichtian (Late Cretaceous) terrestrial strata of western North America and Asia. We report the discovery of a new tyrannosaurid taxon from the Wahweap Formation in Grand Staircase-Escalante National Monument, southern Utah, at a stratigraphic level dated to 80 million years ago (Ma). This taxon, the oldest member of Tyrannosauridae, is represented by a partial skeleton, including many cranial and postcranial elements that reveal unusual morphological features. The maxilla is short and robust, characterized by a reduced dental count (12 alveoli), with marked heterodonty between the teeth in the rostral and caudal halves. The nasal is strongly constricted along the rostrocaudal midpoint, and the jugal has the rostrocaudally broadest postorbital process within tyrannosaurids. The dorsoventral height of the dentary is less than one third the height of the post-dentary portion of the mandible. These features, along with other skull proportions, indicate a very robust, unusually abbreviated, tall, and broad skull closer in conformation to that of *Tyrannosaurus* than any other Campanian tyrannosaurid. An inclusive phylogenetic analysis of more than 350 characters across 27 taxa was conducted to test tyrannosaurid interrelationships and the position of the new Wahweap taxon. Results of this analysis place the Wahweap taxon among a regionally distinct southern clade of Campanian (80-72 Ma) tyrannosaurids and suggest a Laramidian (western North American) origin for Tyrannosauridae. This time interval also shows a remarkable degree of species richness, with up to four coeval tyrannosaurid species spanning New Mexico to Alberta at 76 Ma. Our results suggest that the Maastrichtian taxa *Tarbosaurus* and *Tyrannosaurus* are nested within the southern tyrannosaurid clade, rather than being more closely related to northern Campanian tyrannosaurids. This new taxon illustrates the presence of a previously unrecognized clade of tyrannosaurids living in the south of Laramidia and reveals a complex biogeographic history of tyrannosaurid evolution in western North America.

Technical Session VIII, Monday 3:15

PLACODERM COPULATION AND VIVIPARITY: IMPLICATIONS FOR PELVIC GIRDLE DEVELOPMENT

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Recent discoveries of well-preserved fossil embryos in Late Devonian ptyctodontid and arthrodiran placoderm fishes from the Gogo Formation, Western Australia, have demonstrated that internal fertilization and viviparity were much more widespread in basal gnathostomes (jawed vertebrates) than previously thought. Furthermore, new interpretations of the pelvic girdle structures in Gogo arthrodires (*Incisoscutum*) and in phyllolepid placoderms from the sites in south-eastern Australia show that the basic anatomical pattern for sexual dimorphism was already established at the basal gnathostome level with the presence of an elongated basipterygium (clasper). Patterning for the hind limb in vertebrates is known to result from

the biphasic and collinear expression of Hoxd13, which also regulates development of the genital buds and external genitalia in higher vertebrates (mammals) and is expressed in chondrichthyan cloaca. Sonic hedgehog (shh) is also expressed in the cloacal endoderm of chondrichthyans and teleosts and the cloaca-derived urethral plate of the mouse. Both Hoxd13 and shh are expressed in the distal tip of the posterior fin, the region from which the claspers. We propose that these genes were also expressed in the placoderm claspers and cloacal region, and support suggestions that the cloacal expression pattern is primitive relative to those required for external genital development, for example, in the mouse. Similarities in distal limb/fin and genital bud development and in regulation of genes associated with these structures, such as Hoxd13 and shh, are well known. However, phylogenetically basal placoderms such as the Antiarchi lack both claspers and pelvic fins, suggesting that this developmental and genetic similarity mayhave evolved in a stepwise fashion at the base of the gnathostome clade, first appearing in the cloacal region, and subsequently in the posterior fin/claspers of ptyctodont and arthrodiran placoderms and more derived gnathostomes.

Technical Session XI, Tuesday 3:30

SURVIVAL AND EXTINCTION AT THE K-T BOUNDARY: NEW EVIDENCE AND NEW PERSPECTIVES FROM THE VERTEBRATE FAUNA OF CONTINENTAL NORTH AMERICA

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The available evidence indicates that an asteroid was the primary, and probably exclusive, cause of the K-T mass extinction. However, the physical processes that resulted in the extinction remain poorly understood. A wide range of mechanisms have been proposed, including the cessation of primary productivity, cooling, a thermal pulse caused by reentry of ejecta, acid rain, and the breakdown of the ozone layer. These mechanisms must be tested against the fossil record. A new study of survivorship across the K-T boundary, drawing on the literature, collections study, and ongoing fieldwork, was undertaken to elucidate patterns of survival and extinction across continental North America, including sites from south Texas to central Alberta. The late Maastrichtian of western North America contains the most diverse known Mesozoic terrestrial biota, indicating that the ecosystem was not stressed prior to the impact. Previous estimates of extinction levels are too low; in particular the assertion that amphibians were unaffected is false, and avians are shown to have suffered severe extinctions. The overall extinction rate is 70% or more. Remarkably, herbivores suffer total extinction, suggesting a collapse of primary productivity. Geographic patterns in extinction rate are surprising. There is no evidence that northern biotas, farther from the site of impact, are less affected. Remarkably, the evidence instead suggests that more northern biotas may have suffered higher extinction rates. However, there is an unexpectedly weak correlation between geographic range and extinction. Freshwater vertebrates suffered lower extinction levels than terrestrial forms; this pattern probably results from the ability of water to resist short-term temperature changes. This study indicates that loss of primary productivity is a major if not primary mechanism in the extinction, but temperature changes may have played a more important role than previously appreciated; in particular, severe global cooling is consistent with a number of observed patterns.

Poster Session IV, (Wednesday)

A CLADISTIC ANALYSIS OF CTENODACTYLINE INTRARELATIONSHIPS

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The subfamily Ctenodactylinae is known from the Lower Miocene up to the present. Today, this group comprises five species, which are restricted to north equatorial areas in Africa. However, by Miocene time, the ctenodactylines experienced their greatest diversification and widest distribution from Asia, their land of origin, to Africa where they entered during the Middle Miocene at the latest. So far 24 species can be referred to this group: *Ctenodactylus gundi*, *C. vali*, *Massoutiera mzabi*, *Felovia vae*, *Pectinator spekei*, *Pellegrinia panormensis*, *Sayimys obliquidens*, *S. baskini*, *S. giganteus*, *S. assarrarensis*, *S. intermedius*, *S. sivalensis*, *Metasayimys curvidens*, *Africanomys pulcher*, *A. major*, *A. minor*, *A. kettarati*, *Irhoudia bohlini*, *I. robinsoni*, *Pireddamys rayi*, *Sardomys dawnsonae*, *S. antoniettae*, *Akzharomys mallos*, and *Prosayimys flynni*. We carried out a cladistic analysis involving all these species. *Prosayimys flynni* turned out to be the most basal species of the ingroup. The monophyly of the genus *Africanomys* is not well substantiated, whereas that of *Sayimys* is clearly unsupported. This analysis also provided information about the origin of not only the African ctenodactylines, which is to be found in the Indian subcontinent, but also of the European ones, which is diverse. Thus, the Early Miocene *Sardomys* and *Pireddamys* from Sardinia have a southwestern Asian origin, whereas the Sicilian Pleistocene *Pellegrinia* originated from an African ancestor. Interestingly enough, the ctenodactylines extinguished in Asia at the dawn of the Pliocene and never returned from Africa.

Technical Session XV, Wednesday 8:15

NEUROCRANIAL MORPHOLOGY OF A BASAL ONYCHODONT *QINGMENODUS* REVEALED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY

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The enigmatic sarcopterygian group Onychodontiformes (or Struniiformes) is only represented by a few genera that lived during the Devonian period. Although the wonderfully preserved specimens of *Onychodus jandemarrai* have greatly advanced our understanding of the Onychodontiformes, the scarcity of the neurocranial features in the group hampers morphological comparisons between onychodonts and other sarcopterygians. Recently, we described a new basal onychodont *Qingmenodus* from the Pragian (Early Devonian) of Yunnan, South China, which shows for the first time a well-ossified otoccipital braincase in onychodonts and casts light on the feeding mechanism of onychodonts. Here, we report a complete ethmosphenoid of *Qingmenodus*, which reveals general similarities with that of *Onychodus*. Its superb preservation renders us the possibility to utilize the new CT-scanning facilities at IVPP for the neurocranial anatomy. The digital endocast of the ethmosphenoid region provides the first comprehensive description of the anterior cranial cavity in onychodonts, and helps to understand the brain evolution among early sarcopterygians. The primary results indicate that *Qingmenodus* has a distinctive neurocranium, in which the nasal capsules are elongated, the hypophysial fossa is dominant, and the mesencephalon region is sloped. Noteworthy is that the dominant hypophysial fossa in *Qingmenodus* extends rostrally rather than caudally, which recalls the condition in living coelacanth *Latimeria*. The most striking feature of the *Qingmenodus* neurocranium is that several dendrite-shaped canals lie between two olfactory canals, and give off branches into the endocranial and ectocranial boundaries. The homology of these dendrite-shaped canals needs further investigation. Novel cranial architectures in *Qingmenodus* imply that onychodonts had differentiated from other sarcopterygians and gained their specialization in neurocranial morphology as early as the Pragian.

Poster Session III, (Tuesday)

A NEW BASAL THERIZINOSAUROID FROM THE LOWER CRETACEOUS YIXIAN FORMATION OF LIAONING, CHINA

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Therizinosauroids are an unusual group of theropod dinosaurs, found mostly in the Cretaceous deposits in Mongolia, China and western USA. The basal forms of this group are represented by fragmentary or disarticulated material. Here, we report a nearly complete, articulated skeleton of a new basal therizinosauroid from the Early Cretaceous Yixian Formation of Jianchang County, western part of Liaoning Province, which sheds light on understanding of anatomy of basal therizinosauroids. The new dinosaur shows some therizinosauroid features (e.g., dentary shelf, tooth morphology, edentulous premaxilla, down-turned symphyseal region, and large nares) and is characterized by 27 closely packed maxillary teeth, a large maxillary fenestra (separated from the antorbital fenestra by a vertical interfenestral bar similar to some troodontids), and short mandibular symphyses. This taxon bears many primitive characters, which are not seen in other therizinosauroids: closely packed maxillary teeth, consistent size of dentary teeth, weakly expanded proximal and distal ends of humerus, low ilium with horizontal dorsal edge, and the propubic condition with a shallow pubic boot. The combination of these plesiomorphic characters suggests that this taxon is placed as a basal therizinosauroid.

Poster Session IV, (Wednesday)

GIANT HADROSAUR FOOTPRINTS FROM THE UPPER CRETACEOUS FRUITLAND FORMATION, SAN JUAN BASIN, NEW MEXICO

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The Upper Cretaceous (Campanian) Fruitland Formation in the San Juan Basin of northwestern New Mexico yields many dinosaur skeletal remains, but few dinosaur footprints. This makes the recent discovery of numerous footprints as sandstone casts near the contact of the Ne-nah-ne-zad and Fossil Forest members of the Fruitland Formation on Split Lip Flats (Sec. 20, T23N, R12W) unusual. These are footprints of a biped that are tridactyl, as much as 91 cm maximum length, have broad, rounded heel imprints, and thick toes that terminate in short, narrow claw tips. Morphology supports assignment to the ichnogenus *Caririchnium*, and geologic age and size indicate a hadrosaur as the most likely trackmaker. Indeed, the Fruitland Formation hadrosaur tracks are among the largest hadrosaur tracks known, even though their size may have been partly exaggerated by extramorphological expansion of the viscous, sandy substrate in which the footprints were impressed. Skeletal remains of large hadrosaurs are known from the Fruitland Formation (femur length ~ 1350 cm), and these are among the largest known North American hadrosaurs, though smaller than the Chinese *Shantungosaurus*, which has a femur length ~ 1650 cm. The presence of giant hadrosaurs in the New Mexican upper Campanian strata represented by both bones and footprints is apparently unique in the North American Western Interior and may be explicable by local paleoecological conditions, though the exact nature of such conditions is unclear.

Poster Session IV, (Wednesday)

THE OREODONT RECORD OF THE UINTAN NALMA AND ITS IMPLICATIONS FOR THE BIOCHRONOLOGY OF THE MIDDLE EOCENE

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The Uintan NALMA includes a significant portion of the middle Eocene record of terrestrial North American fossils, and is important in ungulate palaeontology for having the first record of selenodont cetartiodactyls in North America. Recent publications have justified the existence of four distinct biochronological zones (Ui1a, Ui1b, Ui2, and Ui3) within the Uintan, including two (Ui1a and Ui1b) that are not well-represented at the namesake Uinta Formation. This reorganization of the Uintan provided an opportunity to re-examine the known temporal distribution of oreodonts to see if these highly abundant organisms provide additional faunal support for the recognition of biochronological zones.Ui1a does not have any record of oreodonts. Localities assignable to Ui1b from California, Colorado, Texas, and Wyoming only include specimens of *Protoreodon parvus*, although these specimens can be distinguished from the type population of the Uinta Formation by a more bunoselenodont aspect. Ui2 has been preserved in California, Utah, and Wyoming, with specimens identifiable as *P. parvus* and *P. pumilus* in the western interior and *P. walshi* on the Pacific coast. Ui3 is well-represented, including localities from Arkansas, California, Montana, Oregon, Saskatchewan, Texas, Utah, and Wyoming. Species included in these localities are *P. annectens*, *P. parvus*, *P. petersoni*, *P. pumilus*, *P. walshi*, *Diplobunops crassus*, *D. matthewi*, and an unnamed species of protoreodont. All other oreodont taxa previously reported from the Uintan appear to be junior synonyms of these taxa. From these records it appears that oreodonts were able to have a widespread spatial distribution before they diversified. Some patterns of endemism, particularly between the western interior and the Pacific coast, suggest that barriers to population-level genetic flow existed for these relatively medium-sized ungulates during the Uintan. Most species of *Protoreodon* are known from more than one biochronological zone, decreasing their potential utility as index fossils. A similar study for the Duchesnean would help calibrate the timing of the radiation of merycoidodontid oreodonts.

Technical Session I, Sunday 11:30

A NEW BASAL CENTROSAURINE DINOSAUR (ORNITHISCHIA: CERATOPSIDAE) FROM THE UPPER CRETACEOUS OF UTAH: EVIDENCE OF A PREVIOUSLY UNKNOWN CLADE OF SOUTHERN CENTROSAURINES FROM LARAMIDIA

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Despite the abundance and diversity of ceratopsid dinosaurs in western North America (Laramidia), the early evolution of Ceratopsidae remains enigmatic, particularly in the southern portion of the Western Interior Basin. Recent work in the Late Cretaceous (Campanian) of southern Utah has yielded the remains of a new centrosaurine ceratopsid dinosaur from the Kaiparowits Formation of Grand Staircase-Escalante National Monument (GSENM). The new Utah taxon retains several symplesiomorphic characters shared with basal non-ceratopsid neoceratopsians (e.g., *Magnirostris*, *Protoceratops*) including: low ridge on nasal rather than true horncore; ventral and caudal displacement of maxillary alveolar margin; hypertrophied epijugals; and rostrocaudally abbreviated, dorsoventrally deep craniofacial region of the skull. Additionally, the Kaiparowits taxon exhibits long robust supraorbital ornamentation, a character shared among basal centrosaurine ceratopsids (e.g., *Avaceratops*, *Albertaceratops*, and *Diabloceratops*). Autapomorphies of the Kaiparowits centrosaur include: an ectonaris that comprises 75% of the preorbital skull length; pneumatic nasals; a unique premaxilla-maxilla contact; a double faceted, medially directed flange on the maxilla contributing to a short hard palette; and supraorbital horncores that extend past the front of the skull and are rostrolaterally directed, rostrally curved, and torsionally twisted. Temporally, the new Kaiparowits taxon represents the youngest member of the long-horned centrosaurines, distinct from more derived coeval centrosaurines in Montana and Alberta. Thus, these data, considered in unison with Late Cretaceous dinosaur provinciality in Laramidia, provide direct insight into the mosaic evolution of characters early in the evolution of ceratopsids, and suggests the existence of a previously unknown clade of short-snouted, long-horned centrosaurines in the southern Western Interior Basin.

Technical Session XV, Wednesday 8:45

DIVERSITY AND DISTRIBUTION OF FISH IN A MISSISSIPPIAN BAY: THE BEAR GULCH FISH FAUNA

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This research reveals that the Bear Gulch Limestone of Montana provides an exceptional window into the ecology of Mississippian fish. The limestone lens preserves the highly diverse fish fauna of a small Late Mississippian soft bottom tropical marine bay. The lens is the last of a series of temporally and spatially separated bays that formed quickly under tectonic control before becoming geographically isolated. As such, the factors leading to the formation and preservation of this bay are analogous to those that resulted in the fluvial-lacustrine African Rift Valley lakes and helped drive the explosive adaptive radiations of their fishes. Quarrying of this bay from 1968-2009 permits a detailed examination of the habitats, patterns of occurrence, and the diversity of the fishes. This provides the basis for an investigation of the potential ecological drivers of the extensive speciation that underlies the fauna's high diversity. Here, we present an overview of the preserved alpha diversity (n~5700 specimens; 106 genera) within localized habitats and compare assemblage structure among a series of habitats within the bay. Despite striking trends in overall genus richness and total abundance across a geographic and ecological transect, individuals are remarkably evenly distributed (evenness >0.90) among genera in all localities. The large number of rare taxa (n<2 specimens) appears to reflect either the sparsity of the resources they were adapted for (cochliodonts, petalodonts) or their ecological roles (apex predators). To facilitate cross-locality comparisons, the Bear Gulch fishes have been coded for 13 functional characters that have potential ecological significance. Eco-coded genera (n=85) were clustered and those grouped by shared sets of characteristics were assigned to 13 nominal ecological "guilds," or groups of taxa that exploit the same class of environmental resources in similar ways. Taxonomic and guild associations were compared using standard measures of beta diversity to assess the similarity of local assemblages across the bay, revealing distinct differences in how the Acanthodii, Osteichthyes, and Chondrichthyes exploit the same habitats.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 9:00

MORPHOLOGICAL EVOLUTION OF THE DOUBLE CRANIOMANDIBULAR JOINT IN THE CYNODONT-MAMMALIAFORM TRANSITION

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The craniomandibular joint (CMJ) formed by the dentary condyle and the squamosal glenoid is the most important evolutionary innovation of mammaliaforms. This joint works with larger mandibular adductor muscles for more forceful action of the mandible, and for better control in the occlusion of the upper and lower teeth with matching crown surfaces. Characters of the dentary-squamosal joint are distinctive and reliable apomorphies for diagnosing all extant and fossil mammals. Since the discovery of the tritheledontid *Diarthrognathus*, several additional taxa through the cynodont-mammal transition, such as brasilodontids, have been shown to have the double craniomandibular joint, in which the primitive but nonetheless functional quadrate-articular joint co-exists, side-by-side, with the derived dentary-squamosal joint. The function of this double joint requires that both the quadrate-articular articulation and the dentary-squamosal articulation are co-axial, rotating around the same transverse fulcrum axis. This condition is retained in several Mesozoic mammaliaforms and in the eutriconodont *Yanoconodon*. Another biomechanical requirement for the double joint is that the quadrate is mobile with regards to its receiving structure in the cranium. The mobility of the quadrate was enhanced by the loss of the quadratojugal, a bone that reinforces the cranial attachment of the quadrate in cynodonts, and by a medial shift of the quadrate to be located on the crista parotica on the petrosal in mammaliaforms, from the quadrate's plesiomorphic location on the squamosal. In extant mammals, the craniomandibular joint is formed exclusively by the dentary and squamosal in adult, as the malleus and the tympanic (angular) have lost their embryonic connection via Meckel's cartilage to the mandible, by the re-absorption of Meckel's cartilage in late ontogeny. This is accompanied by a negative allometrical growth of the middle ear bones (incus, malleus and ectotympanic), and a medial displacement of the ear bones away from the mandible as seen in development in monotremes, or their posterior displacement away from the dentary-squamosal articulation as in development in didelphid marsupials, or both. If mapped on any well-resolved phylogeny of cynodonts and mammaliaforms, almost all characters of the craniomandibular joint show some degree of homoplastic evolution, due to convergent functional evolution, or homoplastic development.

Poster Session I, (Sunday)

EVIDENCE OF A BACTERIAL ORIGIN FOR DINOSAUR "BLOOD VESSELS" FROM UPPER CRETACEOUS DINOSAUR BONE

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Recent claims of blood vessels extracted from dinosaur fossils challenge classical views of soft-tissue preservation. Alternatively, these structures may be post-depositional, diagenetic biofilms grown on fossil vascular cavity surfaces. Well- and poorly-preserved Upper Cretaceous dinosaur fossils analyzed in this study produced similar hollow, tube-like structures. Integration of light and scanning electron microscopy, energy dispersive x-ray spectroscopy, and bacteria culture tests indicates that these "vessel structures" are derived from a red-orange, iron-rich material formed by bacteria that was observed to coat the fossil vascular cavities. That vessel structures are intact cavity coatings is supported by: their finely ridged exterior matches that of coatings, appearing to have formed as molds of the bone surface, and their textures and elemental composition are nearly identical to coatings. That vessel structures and coatings are formed of biofilm is supported by: 1) framboids, as well as spheres and rods (< 2 μm), diagnostic of bacteria are embedded in vessel structure surfaces and cavity coatings; 2) biofilms grown from fossils mimic the coatings within the fossils; 3) vessel structures and coatings are found in fossils of various taxa, geologic formation, geographic location, and taphonomy. That vessel structures and coatings are not dinosaur blood vessels is supported by: 1) coatings overlie secondary mineral crystals, confirming that they are secondary to the bone; 2) they show no layering consistent with blood vessels in cross-section; 3) no structures consistent with eukaryotic cells comprise them. Observed cross-cutting relationships, compositions, and textures at multiple scales indicate a diagenetic origin for vessel structures linked to bacterial processes and biofilm formation. This also

accounts for microstructures resembling osteocytes as some fossil lacunae are filled with the same iron oxide that comprises vessel structures and coatings. Results of this study show that systematic, high-resolution SEM analyses of vertebrate fossils can provide improved insight on microtaphonomic processes, including the role of bacteria in diagenesis.

Technical Session VII, Monday 2:30

VERTICAL SPLIT OF THE TURTLE SHOULDER GIRDLE PUSHES THE LIMITS OF MUSCULAR SCAFFOLD HOMOLOGY

LYSON, Tyler, Yale University, New Haven , CT, USA; BHULLAR, Bhart-Anjan, Harvard University, Cambridge, MA, USA; BEVER, Gabe, Yale University, New Haven , CT, USA; JOYCE, Walter, University of Tübingen, Tübingen, Germany; GAUTHIER, Jacques, Yale University, New Haven , CT, USA

Establishing primary homology between morphologically disparate structures remains a core issue in evolutionary biology. The "muscle scaffold" model proposes that whereas the topology and developmental history of a skeletal structure is relatively subject to evolutionary change, the identity of its muscle attachments are highly conserved, and thus a useful guide to homology. We apply this model to the anterior-most bones of the turtle shell and found the connections of the trapezius/sternocleidomastoid muscle complex to be highly conserved. The sternocleidomastoid originates from the epiplastron (clavicle) and entoplastron (interclavicle), inserts on the back of the skull, and is innervated by the spinal accessory nerve, as in other amniotes. The trapezius, which ancestrally originates from the cleithrum bone and is innervated by the vagus and spinal accessory nerves, extends from the nuchal bone of the carapace to its insertion on the back of the skull and exhibits the ancestral pattern of innervation. Thus, muscle connectivity supports the homology of the nuchal bone of turtles and the cleithra of other tetrapods. The nuchal bone and cleithra are both derived from the neural crest, have a similar topology, form from two separate anlagen and ossification centers, and have a similar overall development, all of which corroborates this hypothesis. According to this model the neural crest portions of the shoulder girdle migrate both ventrally (clavicle and interclavicle) and dorsally (cleithrum) to form a portion of the upper and lower turtle shell and frame the endochondral portion of the shoulder girdle.

Poster Session I, (Sunday)

NEW INFORMATION ON THE SKULL OF THE EARLY TRIASSIC PARAREPTILE *SAUROPAREION ANOPLUS*

MACDOUGALL, Mark, Cape Breton University, Sydney, NS, Canada; MODESTO, Sean, Cape Breton University, Sydney, NS, Canada

A partial reptile skull collected from Lower Triassic (Induan) Barendskraal locality of South Africa is referable to the procolophonid parareptile *Sauropareion anoplus*. The specimen preserves the left side of the skull roof, palate, and mandible, and preserves areas not preserved or accessible in the skulls of previously published specimens, including fragmentary remains of the premaxilla, the anterior end of the maxilla, and the anterior end and lingual aspect of the mandible. The maxilla exhibits a maxillary depression that is similar in both shape and relative size to that seen in *Procolophon trigoniceps*, an anterolateral maxillary foramen that is indistinguishable from those seen in other procolophonoids, and 11 conical teeth. The suborbital foramen is formed ventrally by the palatine and the ectopterygoid. The dentary and the coronoid are fused together indistinguishably in lateral aspect. *Intermandibularis oralis* and *caudalis* foramina are present. Tooth replacement is seen in the mandibular dentition, where the lingual surface of a single tooth crown base in the middle of the dentary series is excavated for the apex of a replacement tooth crown. The excavation does not extend ventrally onto the lingual surface of the dentary, giving the appearance of acrodont tooth implantation. Considering that no extant reptiles exhibit tooth replacement of acrodont teeth, we tentatively regard protothecodonty to be present in *S. anoplus*. None of the other marginal teeth show evidence of replacement suggesting that, as in other procolophonids, tooth replacement was infrequent in this Induan species.

Technical Session V, Sunday 2:45

MIOCENE MAMMALS OF PANAMA: TROPICAL REFUGIUM OR CRADLE OF BIODIVERSITY?

MACFADDEN, Bruce, National Science Foundation, Arlington, VA, USA

Recent excavations along the Panama Canal have recovered new faunal remains of Miocene mammals, now referred to the Centenario Fauna (CF, containing the previously reported Gaillard Cut L.F.). The CF consists of a dozen taxa within four orders of mammals from the Rodentia, Carnivora, Perissodactyla, and Artiodactyla that indicate exclusively North American affinities. More taxa will likely be added to this ancient biodiversity as field work continues, including surface prospecting and intensive screen-washing efforts. The biostratigraphy of the CF includes a temporally mixed fauna, although rare earth element (REE) geochemistry indicates sympatry. For example, as they are otherwise known from North America, the oreodont *Merycochoerus matthewi* from the CF indicates an Arikareean to early Hemingfordian age (~19.5 to 18.5 Ma), the rhinos *Menoceras barbouri* and *Floridaceras whitei* indicate a Hemingfordian age (~18 to 17 Ma), and the protoceratid artiodactyl *Paratoceras wardi* indicates an early Barstovian age (~16 to 15 Ma). How this temporally mixed, yet sympatric CF can be reconciled in terms of land-mammal biochronological theory is problematical. In a tropical refugium model, the age of the CF is Barstovian and the diagnostic Arikareean-early Hemingfordian oreodont is a relict that persisted in ancient Neotropical rainforests. In contrast, with a cradle of biodiversity model, the age of the CF is Arikareean and the early Barstovian taxa (e.g., *Paratoceras wardi*) originated earlier in Panama than they are known from North America. This paradoxical association will likely be resolved in the future with heretofore unsuccessful, yet ongoing high-precision geochronological determinations that will independently calibrate the Panama Canal stratigraphic sequence containing the CF. Regardless of which hypothesis (model) is ultimately corroborated, the CF and ongoing new discoveries along the Panama Canal will provide a Deep-Time perspective about the evolution, ecology, and biogeography of ancient terrestrial faunas located at the extreme range of their space-time distributions.

Technical Session VIII, Monday 1:45

UNCOVERING THE TAPHONOMY OF THE CHENGJIANG BIOTA USING GEOCHEMISTRY AND SEDIMENTOLOGY

MACKENZIE, Lindsay , University of Montana, Missoula, MT, USA

The Chengjiang Lagerstätte, containing soft-bodied fossils often found in situ, is found within the Early Cambrian Maotianshan Shale (Yunnan, China), a mudstone-dominated unit with inter-bedded layers of siltstone and sandstone. This fossil assemblage is similar to the Burgess Shale, but also includes the earliest chordates and vertebrates. The fossils are preserved differently than the Burgess Shale fossils, with the Chengjiang biota having a large non-mineralized component and being relatively unaffected by diagenesis and metamorphism. The taphonomy of the Chengjiang biota can only be explained by rapid burial with a unique combination of sedimentological and geochemical conditions, which may be met with a volcaniclastic flow such as a sub-aqueous ash-flow or a hyperconcentrated density flow. The high fidelity of the fossils suggests rapid burial and early mineralization of tissues and infilling of pore spaces. Samples collected from outcrops and drill cores were analyzed to determine the taphonomy of the Chengjiang fossils. Sedimentological data suggests the organisms lived in a near-shore environment and were affected by terrestrial sediment influx, as well as storm events. Unidirectional cross-beds, tool marks, and flute casts have similar paleodirection. Hummocky cross-beds indicate some of the sediments were affected by storms. X-ray fluorescence and inductively coupled plasma mass spectrometry analyses were conducted, giving whole rock composition. Ni/Co and V/Cr ratios suggest the sediments were buried under suboxic to anoxic conditions, and Ce values suggest sulfate reduction at time of burial. X-ray diffraction indicates the main mineralogical components include quartz, illite, clinochlore, and glauconite; unweathered samples also contain pyrite and carbonate. The sediments indicate an andesitic to basaltic-andesitic source. These initial analyses support the volcaniclastic depositional model, and additional analyses and a microcosm taphonomy experiment will be conducted for further confirmation. The multidisciplinary approach used in this study can be used in taphonomical analysis of any vertebrate assemblage.

Technical Session IX, Tuesday 11:30

AMERICAN MEGAFAUNAL EXTINCTIONS, ENVIRONMENTAL DNA AND THE CONTINUING SEARCH FOR A CAUSE

MACPHEE, Ross, American Museum of Natural History, New York, NY, USA; WILLERSLEV, Eske , University of Copenhagen, Copenhagen, Denmark; FROESE, Duane, University of Alberta, Edmonton, AB, Canada; ROBERTS, Richard, University of Wollongong, Wollongong, Australia; HAILE, James, University of Copenhagen, Copenhagen, Denmark

Causes of late Quaternary extinctions of large mammals continue to be debated, especially for continental losses, because spatial and temporal patterns of extinction are poorly known. Accurate latest appearance dates (LADs) for such taxa are critical for interpreting the process of extinction. The extinction of woolly mammoth and horse in northwestern North America is currently placed at 15,000–13,000 yr BP, or calendar years before present (i.e., not radiocarbon years), based on LADs from dating surveys of macrofossils (bones and teeth). Advantages of using macrofossils to estimate when a species became extinct are offset, however, by the improbability of finding and dating the remains of the last-surviving members of populations that were restricted in numbers or confined to refugia. Here we report an alternative approach to detect 'ghost ranges' of dwindling populations, based on recovery of ancient "environmental" DNA from perennially frozen and securely dated sediments. In such contexts, environmental DNA can reveal the molecular presence of species that appear absent in the macrofossil record. We show that woolly mammoth and horse persisted in interior Alaska until at least 10,500 yr BP, several thousands of years later than indicated from macrofossil surveys. These results contradict claims that Holocene survival of mammoths in Beringia was restricted to ecologically isolated high-latitude islands. More importantly, our finding that mammoth and horse overlapped with humans for several millennia in the region where people initially entered the Americas challenges theories that megafaunal extinction occurred within centuries of human arrival or were due to an extraterrestrial impact in the late Pleistocene.

Poster Session I, (Sunday)

PRELIMINARY REPORT OF NORIAN TRIASSIC AGE VERTEBRATE FAUNA FROM LANDS BELONGING TO THE PUEBLO OF JEMEZ, NORTH CENTRAL NEW MEXICO, INCLUDING AN UNUSUALLY LARGE TEMNYSPONDYL METOPOSAURID AMPHIBIAN

MADALENA, Kevin , Pueblo Of Jemez, Jemez Pueblo, NM, USA; ZEIGLER, Kate,

Zeigler Geologic Consulting, Albuquerque, NM, USA; SUMIDA, Stuart, California State University-San Bernardino, San Bernardino, CA, USA

The lands belonging to the Pueblo of Jemez in north-central New Mexico includes exposures ranging from the Mississippian to the Pleistocene, but very limited documentation of these exposures exist currently. Late Triassic sediments of the Petrified National Forest Formation (Chinle Group: Norian) are present in the Jemez Reservation.

Metoposaurid material was recovered from a grayish-purple paleosol horizon in the lower Petrified Forest Formation (Chinle Group: Norian), approximately 7-8 m above the underlying Poleo Formation, in an area riddled with faults. The fossil-bearing horizon is comprised primarily of calcareous nodules from 1-10 cm diameter and contains moderately abundant fragments of metoposaur and phytosaur material. Metoposaurid material includes cranial and shoulder girdle elements and teeth. Phytosaur material includes teeth and osteoderms with high dorsal ridges.

Taxa recovered from Jemez Pueblo Locality 15 (JP-15) include phytosaur material and postcranial materials of a metoposaurid temnospondyl amphibian. The metoposaurid specimens, though fragmentary are significant for their extraordinary size. A partial interclavicle is conservatively reconstructed as well over 450 mm in width. The largest specimen reported from Texas is 430 mm, whereas the largest known from New Mexico is 400 mm. in width. Published sizes of metoposaurid interclavicles from the Chinle Formation of New Mexico and the Dockum Formation of Texas average 307 mm and 313 mm respectively. Thus, the Jemez metoposaur is one of the largest ever reported, approximately 47-48% larger than those published averages, and approximately 5% larger than the largest one yet reported. Although measurements of the thickness of dermal elements of the pectoral girdle are not commonly available, the Jemez metoposaur also appears remarkable in this regard, measuring over 2.5 cm from deep to superficial surfaces.

Poster Session II, (Monday)

STASIS IN LATE PLEISTOCENE FELIDS (SABERTOOTH CATS AND ICE AGE LIONS) FROM LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

MADAN, Meena, University of California, Irvine, Irvine, CA, USA; PROTHERO, Donald, Dept. of Geology, Occidental College, Los Angeles, CA, USA; SUTYAGINA, Anastasiya, Dept. Geology, Occidental College, Los Angeles, CA, USA

One of the great puzzles of evolutionary biology is how organisms remain static in the face of dramatic climatic changes, contradicting the "Galapagos finch" model of organisms that are constantly changing in response to their environment. Such stasis was documented in Pleistocene mammoths as early as 1863, and is widely recognized among most Pleistocene large mammals. We examined the two common felids, the saber-toothed cat *Smilodon fatalis*, and the Ice Age lion, *Panthera atrox*, from the Rancho La Brea tar pits in the Page Museum in Los Angeles. We measured large samples (more than 100 of each element) of several dimensions of the most common bones (typically leg or foot bones) from all the pits with good radiocarbon dates. Even though pollen, plants, snails, and isotopic studies provide evidence of dramatic climatic and vegetational change from the previous interglacial (40 ka-20 ka) to the peak glacial (20 ka-15 ka) to the glacial-interglacial transition (15 ka-10 ka) to the Holocene, none of these taxa show any statistically significant differences in size or shape of their bones from one level to the next. Such dramatic stasis has been documented among all the common La Brea mammals and birds over the late Pleistocene-Holocene, despite dramatic climatic changes. This casts doubt on the responsiveness of birds and mammals to environmental change, and suggests that intrinsic rather than extrinsic factors are more important in evolution.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 9:45

EXPLORING THE INFLUENCE OF FOSSORIALITY ON TETRAPOD CRANIAL ARCHITECTURE, A FOCUS ON CRANIAL JOINTS

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The study of extant models to understand the correlation between form and function is critical to the formulation of paleobiological hypotheses involving the fossil record. Fossoriality, wherein the head is employed as the primary locomotor organ (i.e., head-first burrowing), has evolved multiple times independently within Tetrapoda. Among these, caecilians have been shown to exert some of the greatest forces against the substrate during burrowing, and this has been attributed to their unique mode of hydrostatic locomotion. Caecilian skulls are variously zygokrotaphic to strongly stegokrotaphic, but with at least limited kinesis involved. In order to gain a clearer understanding of the features associated with their forceful mode of fossoriality, the skulls of caecilians were examined from both morphological and mechanical perspectives. Examination of cranial architecture reveals elements of the dermal skull form lap joints with adjacent elements in the anteroposterior direction, whereas overlap between elements in the mediolateral direction is minimal or absent. Dense networks of collagen fibres span the joints surfaces, suggesting flexibility at these joints, albeit limited, in the direction of substrate penetration. Additional architectural features include nostrils that are rimmed in cartilage throughout life, and joints between certain elements (e.g., maxilla and braincase) that are filled with cartilaginous plugs. These plugs are also predominantly oriented in the anteroposterior direction. It is hypothesized that the cranial joints, together with cartilaginous plugs, form a complex dampening system, capable of reducing the transmission of compressive forces to the braincase and throughout the dermal skull produced during head-first burrowing. These features contrast somewhat with those known for other fossorial tetrapods, and may thus represent important adaptations associated with the style of burrowing and the greater forces being applied to the skulls of caecilians. Our observations document combinations of features that can be used to refine interpretations of behaviour, ecology, and general paleobiology of fossil taxa.

Poster Session III, (Tuesday)

MAMMALIAN RANGE DYNAMICS ACROSS THE MID-MIOCENE CLIMATIC OPTIMUM IN THE JOHN DAY BASIN, OREGON

MAGUIRE, Kaitlin Clare, University of California at Berkeley, Berkeley, CA, USA

The relationship between geographic range and habitat characteristics of a species has been used to predict range dynamics in extant taxa (species distribution modeling), and to infer species reactions to environmental change in the fossil record. It is unclear, however, how finely the link between geographic range and environment can be resolved in pre-Quaternary paleontological deposits. Here I examine that question, with the ultimate goal of using the range-habitat link to test ideas about ecological niche conservatism through pronounced environmental change over geological time. I use the richly-fossiliferous beds of the John Day Basin, which contain series of paleosols, each representing at least ~100,000 years of soil development and tuff deposits that provide refined age constraints. With this exceptional paleontological, temporal and paleoenvironmental data, I tracked Miocene mammal species distributions and changing local paleoenvironmental parameteres through successive time slices represented by horizons in the upper John Day Formation (Haystack, Balm Creek and Rose Creek members) and the Mascall Formation. These deposits span the Mid-Miocene Climatic Optimum (MMCO), a period in which global temperatures rose ~3-4 ºC, followed by decreasing temperatures and increasing aridification, thus providing an ideal setting for testing hypotheses about species-environment interactions in the face of pronounced climate change. Fossil localities were visited in the John Day Basin and placed within a recently published stratigraphic framework. Environmental parameters (e.g. precipitation, soil type) were collected from corresponding paleosols. Species distribution maps and environmental parameters were investigated to determine if and how the distribution of a species changed through time and whether there was a correlated environmental change. The use of a new analytical technique using GIS for reconstructing species distributions in the paleontological record is also demonstrated.

Technical Session I, Sunday 9:15

EVOLUTION OF LOCOMOTOR MUSCULATURE IN ORNITHISCHIAN DINOSAURS

MAIDMENT, Susannah, The Natural History Museum, London, United Kingdom; BARRETT, Paul, The Natural History Museum, London, United Kingdom

The earliest ornithischian dinosaurs were small and bipedal with forelimbs modified for grasping, but they radiated into a diverse range of body shapes. Quadrupedalism developed in three ornithischian lineages, resulting in profound musculoskeletal transformations. We use the extant phylogenetic bracket to reconstruct locomotor musculature in a range of bipedal and quadrupedal ornithischians to investigate musculoskeletal convergence and identify correlates for quadrupedalism. A well-developed scapula acromial process provides attachment for the deltoid musculature, which acts to protract the forelimb, while the prominent deltopectoral crest of quadrupedal ornithischians is a correlate of the pectoralis, the major humeral retractor and adductor. These features are well developed in quadrupedal thyreophorans and ceratopsians, but are less well-developed in hadrosaurs, suggesting that they relied upon the hind limb for locomotor propulsion with little input from the forelimbs. The development of a craniolateral process of the ulna rotated the radius medially, resulting in pronation of the manus. An elongate iliac preacetabular process is developed in all ornithischian taxa, but in quadrupedal forms it is broadened transversely, providing a large surface area for attachment of the puboischiofemoralis internus, the predominant femoral protractor. The elongate prepubis and transversely broadened ilium provides attachment for lower limb extensors, suggesting that protraction and antebrachial extension become more important in quadrupedal locomotion than in bipedal locomotion. The retroversion of the pubis in ornithischians would have resulted in the loss of the moment arm of the puboischiofemoralis externus for femoral protraction; the subsequent reduction of the postpubis in many ornithischians probably correlates with the loss of this muscle group entirely. This study is the first to reconstruct musculature in ornithischians from both a functional and phylogenetic perspective and is timely since biomechanical methods are being used increasingly to understand dinosaurian locomotion. It is essential to have a clear basis for myological reconstruction in such work.

Poster Session III, (Tuesday)

IMPLICATIONS OF A NEW LUNGFISH SPECIES (DIPNOI: CERATODONTIDAE) FROM THE CRETACEOUS (CENOMANIAN) WOODBINE FORMATION AT THE ARLINGTON ARCHOSAUR SITE, NORTH TEXAS

MAIN, Derek, University of Texas, Arlington, TX, USA; PARRIS, David, New Jersey State Museum , Trenton, NJ, USA; GRANDSTAFF, Barbara, University of Pennsylvania, Philadelphia, PA, USA

A significant number of new lungfish tooth plates are now known from the Cretaceous

(Cenomanian: 95 Mya) Woodbine Formation, primarily from one locality, the Arlington Archosaur Site (AAS) of Tarrant County, Texas. The AAS preserves a diverse mid-Cretaceous coastal ecosystem within the carbonaceous shales and mudstones of a delta plain environment. The new Woodbine lungfish pertain to previously undescribed species from the Cenomanian. Previously recorded from but one specimen, this taxon is now represented by both prearticular and pterygopalatine dental plates of sectorial aspect. The number of specimens recovered to date from the AAS is greater than that from any other single Cretaceous site in the eastern subcontinent.This species is similar to, and presumably descended from, another small species with sectorial tooth plate morphology that has been recovered from various formations of Albian age in eastern Texas. Measurements of the angles of the dental plate margins and crests confirm that the Woodbine species is distinct from all other North American lungfishes. Its general morphology is similar to *Ceratodus guentheri*, with obtuse inner angles, but lacks the flattened crushing platform associated with the third and fourth crests *C. guentheri.* All of the Woodbine specimens have high, sharp ridge crests that are interpreted as an adaptation for a slicing, or cutting feeding style. Two small specimens representing an earlier ontogenetic stage, display the same sectorial morphology as the larger specimens, suggesting that the diet of this small lungfish did not change ontogentically. Although dipnoan evolution generally appears to have proceeded slowly, the taxa from the Cretaceous (Albian – Cenomanian) of Texas display enough morphometric variation between the earlier and later species to have some biostratigraphic utility.

Poster Session III, (Tuesday)

DEPOSITIONAL SETTING OF FISH-PART SANDSTONES AND CONGLOMERATES: A TAPHONOMIC INTERPRETATION OF A RARE LACUSTRINE STRAND LINE

MALENDA, Helen, Kutztown University, Kutztown, PA, USA; SIMPSON, Edward, Kutztown University, Kutztown, PA, USA; SZAJNA, Michael, Reading Public Museum, Reading, PA, USA; FILLMORE, David, Kutztown University, Kutztown, PA, USA; HARTLINE, Brian , Reading Public Museum, Re, PA, USA

Fish parts preserved in sandstones and conglomerates were recovered from the Triassic Lockatong Formation of the Newark Supergroup. Data recovered from this unique lacustrine strandline setting were examined using sedimentologic and taphonomic methods to accurately interpret conditions that caused (permitted) accumulation.

Within the Lockatong Formation, reoccurring Van Houten cycles are subdivided into three divisions (D): lake transgression (D1), high-stand (D2), and regression or lowstand facies (D3). The Triassic fish-part sandstones and conglomerates are composed of disarticulated skeletal remains of multiple fish species.

The fish-part sandstones and conglomerates occur at the transition from D1 to D2 and are found above a fluvial intraformational conglomerate composed of diverse mudstone clast types derived from the underlying D3. Fish-part sandstones and conglomerates occur as continuous or lenticular graded beds. Normal graded beds are prevalent and consist of both sedimentary clasts and disarticulated fish parts. Within a bed, the clasts and fish parts do not grade synchronously due to density differences. Either wave ripples or current ripples cap the graded beds, indicating shallow water deposition. In addition, large fish pieces associated with rooted mudstones can be present in lieu of ripple facies, indicating subareal exposure. By using the fish kills in the Salton Sea as a modern taphonomic analogue we propose that a mass kill of Triassic fish species took place in the lacustrine Lockatong Formation. After death, decomposition and bloating of the fish led to floatation. Fish carcasses were driven shoreward by waves, probably storm-generated. The remains were disarticulated and reworked as lag concentrations that are recorded in the normal grading of the sediments and fish part clasts. The intermixing of interformational clasts and fish parts reflects the impact of the storm washover into the associated fluvial systems.

Technical Session I, Sunday 9:30

AN ASSESSMENT OF DIFFERENTIAL FEEDING SELECTIVITY AMONG THE MEGAHERBIVOROUS DINOSAURS FROM THE DINOSAUR PARK FORMATION (LATE CAMPANIAN) OF ALBERTA, CANADA

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The Late Cretaceous dinosaur faunas of North America contained a rich diversity of large herbivores, including ankylosaurs, ceratopsids, and hadrosaurids. It has been suggested that competition for food between and within these groups was alleviated by differential feeding selectivity, as evidenced by their different muzzle shapes. We tested these hypotheses as they apply to the herbivorous dinosaurs of the late Campanian Dinosaur Park Formation of Alberta in two ways. First, we applied a geometric model previously used to assess muzzle shape in ungulates, wherein the muzzle is fit within a triangle of fixed proportions and a muzzle shape index (MSI) is calculated. A one-way ANOVA showed that the MSI differs significantly between ankylosaurs, ceratopsids, and hadrosaurids ($n=51, F=220, p<0.05$), with the ankylosaurs having squarest muzzles and the ceratopsids having the most pointed ones. We found no differences within these groups, including among sympatric species, except between the ankylosaurs *Euoplocephalus* and *Edmontonia* ($n=12, t=3.99, p<0.05$), of which the former has a squarer muzzle.Second, we performed an eigenshape analysis on muzzle shape ($n=51$). The first two eigenvalues best describe the square-ness of the muzzle and together account for 25% of the shape variation. Taxa are best separated along the second eigenshape axis, particularly between the broad-muzzled ankylosaurs and narrow-muzzled ceratopsids. Resolution does not improve at lower taxonomic levels, even among sympatric species.The MSI and eigenshape analyses both suggest minimal ecological separation of the Dinosaur Park Formation herbivores except at the broadest taxonomic levels. Based on muzzle shape alone, ankylosaurs were the least selective feeders and ceratopsids were the most selective. Hadrosaurids were intermediate in their feeding selectivity. It appears that at lower taxonomic levels, sympatric species must have partitioned food in ways other than feeding selectivity, if they did at all.

Poster Session III, (Tuesday)

TOWARDS A STABLE PHYTOSAUR TAXONOMY: DISTINGUISHING CHARACTERISTICS BETWEEN *PSEUDOPALATUS* AND *REDONDASAURUS* (PHYTOSAURIDAE: PSEUDOPALATINAE)

MANCINI, Mark, Mesalands Community College, Tucumcari, NM, USA; HUNGERBUEHLER, Axel, Mesalands Community College, Tucumcari, NM, USA

The systematics of phytosaurs is a complex and confusing issue. The Pseudopalatinae, the stratigraphically latest and most derived clade within Phytosauria, is no exception. Known from dozens of skulls, the genera *Pseudopalatus* and *Redondasaurus* have been distinguished on the basis of the width of the squamosal bar and the visibility of the supratemporal fenestra. Nevertheless, the genera have been frequently confused. We demonstrate that the type species *P. pristinus* and *R. gregorii*, on the basis of their respective type specimens, can be distinguished by discrete states in a total of eight cranial characters: slope of the supraoccipital shelf; thickness of the parietal rim; extension of the parietal rim; degree of gradation between the dorsal and the ventral surfaces of the squamosal; degree of closure of the supratemporal fenestra; sharpness of postorbito-squamosal bar; width of the postorbito-squamosal bar; and shape of the posterior process of the squamosal. Hence, it is safe to conclude that on the basis of their type species, *Pseudopalatus* and *Redondasaurus* represent two distinct taxa. However, we show that skulls referred to other species of *Pseudopalatus* and new cranial material do not provide such easily recognizable distinctions. The data suggests that an evolutionary grade between *Pseudopalatus* and *Redondasaurus* exists. The findings of our case study may provide one reason with which to explain the confusing status of phytosaur taxonomy.

Poster Session III, (Tuesday)

DINOSAURS WALK TALL: A CROCODILIAN TRACE FROM THE LANCE FORMATION (UPPER CRETACEOUS) OF WYOMING

MANNING, Phillip, University of Manchester, Manchester, United Kingdom; MILAN, Jesper, University of Copenhagen, Copenhagen, Denmark; FALKINGHAM, Peter, University of Manchester, Manchester, United Kingdom

A 1.5 m long, double sinusoidal trace from the Lance Creek Formation (Wyoming) has been previously described as a potential dinosaur tail drag mark. The trace is located on a track-bearing outcrop in association with a number of dinosaur and bird tracks and trackways. The track assemblage includes large dinosaur tracks (> 60 cm), of both theropod and ornithopod origin, mid-sized (~30 cm) tracks of likely theropod origin, and small (~5 cm) bird tracks. The trace discussed here is closely associated with a trackway consisting of two tracks of probable hadrosaurian origin (ichnogenus *Hadrosauropodus)*. By comparing the fossil trace with trackways generated by extant crocodiles, we propose that the trace was made by another animal prior to the ornithopod traversing the substrate. The hourglass-shape trace, in association with two ornithopod tracks, is interpreted as the double sinusoidal trace from the tail and body of a crocodile, which was later crossed by the path of an ornithopod dinosaur. This double sinusoidal trace is preserved with scute marks and associated claw impressions as seen in modern crocodilian traces. This interpretation is further supported by the presence of crocodile fossils from within this facies in the Lance Formation. The hourglass-shaped trace from the Maastrichtian Lance Formation, is interpreted to be the trace of a crocodilian, rejecting the earlier dinosaurian origin. This expands the already diverse ichnofauna from the Lance Formation to include crocodile tracks as well as tracks from multiple taxa of dinosaurs and birds. Given the intimate association of dinosaur traces with river bank/lake shore facies, the authors also suggest caution when attributing similar hourglass-shaped traces to the tail drags of dinosaurs.

Technical Session III, Sunday 2:30

TARSAL BONES OF NORTH AMERICAN PALEOCENE *LEPTACODON* (MAMMALIA, EULIPOTYPHLA?) AND EVIDENCE FOR SCANSORIALITY IN NYCTITHERIIDAE

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Nyctitheriids are an extinct family of insectivorous mammals found in the Paleogene of Europe, Asia, and North America. They are known mostly by dentitions and have uncertain phylogenetic relationships within Eutheria, often linked to Chiroptera (bats) or Eulipotyphla (shrews, moles, hedgehogs, solenodons). Tarsals attributed to the late Eocene European nyctitheriid *Cryptotopos* were described to have scansorial morphology suggesting a close relationship to Euarchonta (tree shrews, flying-lemurs, primates). Here we describe the first

nyctitheriid astragali and calcanea from North America. Paleocene tarsals from the Bighorn Basin, Wyoming, are clearly associated with partial skeletons of *Leptacodon* and are similar to those of *Cryptotopos*. Scansorial features indicative of a mobile foot able to navigate substrates of variable diameters and orientations include 1) strongly curved, unequal areas of articular facets between the calcaneum and astragalus allowing a wide range of movement, 2) a rounded, concave calcaneal cuboid facet and a uniformly convex astragalar navicular facet allowing rotation at the mid-tarsal joint, 3) a strong groove for the flexor digitorum fibularis on the sustentacular process associated with grasping and 4) robust distal plantar and peroneal tubercles of the calcaneum for ligament attachment and tendon pathways, respectively, to help stabilize, evert and invert the ankle. Nyctitheriid tarsals have possible euarchontan synapomorphies including confluent sustentacular and navicular facets on the astragalar neck and a calcaneal distal sustentacular facet articulating with part of the astragalar navicular facet. Some of these traits are also in late Cretaceous *Deccanolestes* and Paleocene adapisoriculids, both proposed as euarchontans based on tarsal characteristics. Nyctitheriids differ in having a fibular facet, a more deeply grooved lateral tibial facet that forms a sharper angle with the fibular facet, and in lacking an astragalar foramen. Similarities between nyctitheriids and these taxa may be due to a close phylogenetic relationship, convergence, or even a shared primitive boreoeutherian morphology with scansorial adaptations.

Technical Session IX, Tuesday 9:30

LATITUDINAL DIVERSITY GRADIENT OF NORTH AMERICAN MAMMALS WAS NOT CONSTANT OVER THE CENOZOIC

MARCOT, Jonathan, University of Illinois, Urbana, IL, USA; FOX, David, University of Minnesota, Minneapolis, MN, USA

The latitudinal diversity gradient (LDG) is among the most salient biogeographic patterns of life on Earth. A decline in taxonomic richness from the equator to the poles characterizes a diversity of clades in marine and terrestrial environments at most spatial scales. A few studies have examined past LDG's using the fossil record of marine invertebrates and generally found it to be similar to gradients of extant taxa and consistent over time. Fewer studies have addressed the LDG of terrestrial vertebrates in the geologic past. Recent research demonstrates that the LDG of Paleocene mammals of North America differed from the modern gradient. We extended this research to the entire Cenozoic to determine how, if at all, the LDG of mammals changed over time. We estimated the LDG of all terrestrial North American fossil mammals throughout the Cenozoic using occurrence data from the Paleobiology Database. We estimated the slope of the LDG in each of 23 three million year intervals, controlling for variable sampling over latitudes. The LDG was calculated as the slope of a linear regression of the logarithm of (rarefied) taxonomic richness vs. the midpoint of the latitudinal band. Estimated slopes for each interval were compared statistically to that of the most recent interval. The LDG of North American mammals varied over time. Most notably, many intervals show a positive relationship between richness and latitudes – the opposite of the pattern seen today. LDGs become increasingly negative throughout the Neogene, broadly correlated with falling global temperatures over the same interval. Specifically, interval-to-interval variation in the slope of the LDG is correlated with □18O values of benthic foraminifera throughout the Neogene. This suggests an influence of global climate on the slope of the LDG, indicating that the LDG might be a more transient and labile feature than has previously been acknowledged.

Poster Session IV, (Wednesday)

RELIABILITY OF IMAGE BASED FINITE ELEMENT MODELLING IN VERTEBRATE PALEONTOLOGY

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Finite element analysis (FEA) is a computational method used by engineers to evaluate the response of a structure to a physical stimulus. Image based FEA uses finite element models that have been created from 3D X-ray computed tomography scans. In recent years, image based FEA has seen growing use in Vertebrate Paleontology, particularly because high resolution scans of fossil bones can reveal details of the internal microstructure. These details help interpret how the bone was loaded when the animal was alive.

The purpose of this paper is to report on the various factors that can affect the reliability of FEA results and therefore help assess their usefulness. There are three primary motivations for this study: (a) Biomechanical structures are more complicated than the engineering structures for which FEA has been traditionally used; (b) there is uncertainty regarding the properties of the original constituent materials in fossilized bones and (c) it is not possible to study in-vivo how the structures were originally loaded.

For two case studies, the humerus of *Tyrannosaurus rex* and a velociraptor claw, the authors will present a critical analysis of how finite element stress computations are affected by model resolution; accuracy of image segmentation into various structures; values for material properties and the type and location of boundary conditions. The authors also examine how the results of finite element simulations using micro-structurally faithful models compare with those obtained using abstract geometrical shapes: beams for the humerus and curved conical cylinders for the claw. Insights regarding form and function of these two examples will be presented in light of the study.

Poster Session IV, (Wednesday)

THE ZEGDOUMYIDAE (RODENTIA, MAMMALIA) FROM THE EARLY PALEOGENE OF ALGERIA: NEW DENTAL EVIDENCE ON STEM ANOMALUROID RODENTS

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The Paleogene fossil record of rodents in Africa is dramatically scarce compared to that of North America or Eurasia. Despite this, Africa has long appeared as being a centre of adaptive radiation of two different groups of Rodentia: Hystricognathi and Anomaluroidea. The >45-million-year-old enigmatic Zegdoumyidae is the oldest and only rodent family known of this age from Africa. Although poorly documented, zegdoumyids have been tentatively regarded as a possible early African stem group for Anomaluridae – a link that has never been clearly established because of major temporal and morphological gaps between zegdoumyids and the first anomaluroids from the late Eocene. Since 2003, we focused some of our African fieldwork in the Gour Lazib, a region situated in the Sahara of Western Algeria. About 200 rodent teeth have been sorted after acid-etchings of the indurate sediments of several new localities dating from the late early or early middle Eocene. These new fossils allow us to better describe the morphology of the Zegdoumyidae (especially *Glibia* and *Zegdoumys*) and to identify a new taxon. With this material, we investigated the phylogenetic position of the Zegdoumyidae in a high-level rodent phylogeny in performing a cladistic assessment of the dental evidence. Our analyses have yielded 40 equally most-parsimonious trees in which zegdoumyids represent the earliest offshoots (pectinately arranged) of a clade that embraces Eocene anomaluroids plus stem and crown Anomaluridae. This phylogenetic assumption underscores the great antiquity of the Anomaluroidea clade in Africa – an issue that was expected given the high morphological divergence of the late Eocene African anomaluroids. From a high-level phylogenetic perspective, the source of the Zegdoumyidae is still unclear inasmuch as there is no well-identified sister-group among early Paleogene rodents. Zegdoumyids seem to share a common ancestry with both stem Myodonta and North American sciuravids. Given the high degree of dental specialization of zegdoumyids, we cannot exclude the possibility that zegdoumyids are rooted in a more primitive, yet unknown, African rodent lineage older than the early-middle Eocene.

Romer Prize Session, Monday 9:30

AGE AND RELATIONSHIPS OF THE MODERN AMPHIBIANS (TETRAPODA: SALIENTIA, CAUDATA, GYMNOPHIONA, ALBANERPETONTIDAE)

MARJANOVI□, David, UMR 7207 (UPMC, CNRS, MNHN, Collège de France), Paris, France

Despite decades of intensive research, the origin of the frogs (Salientia), salamanders (Caudata) and caecilians (Gymnophiona), together with that of the extinct Albanerpetontidae, remains controversial. Three groups of hypotheses persist in the literature: the aforementioned taxa may form a clade (Lissamphibia, a crown-group of which Albanerpetontidae may be a member or the sister-group), which could be nested within the Paleozoic temnospondyls, making the lepospondyls stem-amniotes (temnospondyl hypothesis/TH), or among the coeval lepospondyls, making the temnospondyls stem-tetrapods (lepospondyl hypothesis/LH); alternatively, the frogs and the salamanders may be temnospondyls while the caecilians may be lepospondyls (polyphyly hypothesis/PH). I have tried to discriminate between these alternatives both directly (by phylogenetic analysis) and indirectly (the PH predicts a much older divergence date between the modern amphibians than the age implied by the TH as well as the LH). Three partly novel dating methods – a time-calibrated supertree compiled and analyzed with new software, molecular divergence dating with several maximum age constraints, and phylogeny-independent calculation of confidence intervals on the first appearance in the fossil record – support a Permian date, compatible with the TH and the LH but not the PH. All three hypotheses have been supported by recently published phylogenetic analyses. Having made changes to three data matrices that supported the TH or the PH to make them congruent with the descriptive literature and personal observations, ordered potentially continuous characters, merged correlated characters, and scored ontogeny-affected characters as unknown in morphologically immature specimens, I find that these matrices (including the largest one published to date, which bolstered the TH) support the LH upon reanalysis. This agrees with previous findings that small changes to a data matrix can cause large differences between the resulting trees. The TH is only a little less parsimonious than the LH in two of them, but the PH is much less parsimonious in all three. The phylogenetic position of Albanerpetontidae remains unstable.

Poster Session I, (Sunday)

THE BROMACKER HORIZON - THE MOST IMPORTANT SEQUENCE OF STRATA OF LOWER PERMIAN TERRESTRIAL VERTEBRATE FOSSILS OUTSIDE OF NORTH AMERICA

MARTENS, Thomas , Museum der Natur, Gotha, Germany; BERMAN, David , Carnegie Museum of Natural History, Pittsburgh, PA, USA; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA; SUMIDA, Stuart, California State University, San Bernardino, CA, USA

The Early Permian Bromacker Horizon, located in the middle part of the Upper Rotliegend Tambach Formation, near Gotha, central Germany, is a highly prolific site that yields terrestrially adapted invertebrate and vertebrate fossils. They far surpass in numbers of individuals, diversity of taxa, and quality of preservation those of all other European sites of comparable age. Whereas the Bromacker taxa are unique to Europe, they are identical or very closely related to forms known elsewhere almost exclusively from the Lower Permian of the U.S. To date, thirteen vertebrates, eight to ten invertebrates, and four invertebrate and six vertebrate traces have been identified. The unique commonality of all vertebrates with those of North America has been relevant in resolving important areas of inquiry: 1) accurately assessing the biostratigraphic position and age of the Tambach Formation and therefore the base of the Rotliegend; 2) providing the first irrefutable, biological evidence of a predrift, continuous landmass of Laurasia during the Early Permian; 3) contributing significant, new information about the global distribution patterns of Early Permian tetrapods across southern Laurasia; and 4) providing direct evidence that faunal interchange across southern Laurasia of many terrestrial species during this time was not impeded by biological, environmental, and physical barriers.

Geological evidence indicates that the Tambach Basin during Tambach Formation deposition represented a 'truly upland' paleoenvironmental setting, which is supported by the Bromacker Horizon fauna: 1**)** lack of any obligatory aquatic or semi-terrestrial forms (fish and most amphibians); 2) the amphibians, which include two to four dissorophoids and *Seymouria*, are widely viewed as highly adapted to an active, terrestrial existence; 3) presence of four taxa of terrestrial herbivores presumably capable of consuming high-fiber vegetation doubles that for any assemblage of comparable age; 4) herbivores outnumber the only two top predators by a ratio of 7:1; 5) herbivores represent nearly 50 % and top predators 7 % of the total number of specimens collected; 6) presence of the ephemerally-adapted invertebrate Conchostraca.

Poster Session III, (Tuesday)

THE YOUNGEST VERTEBRATE ASSEMBLAGE FROM THE ELLENSBURG GROUP, WILBUR LOCALITY (HEMPHILLIAN), CENTRAL WASHINGTON

MARTIN, James, SD School of Mines & Technology, Rapid City, SD, USA

The Ellensburg Group within central Washington consists of widespread sedimentary units interbedded with basalt flows but has produced relatively few vertebrate fossils compared to other sedimentary deposits in the Pacific Northwest. Most fossil assemblages known previously from the group have been considered to be Clarendonian (NALMA) in age. However, the uppermost lithostratigraphic unit appears to have been deposited during the Hemphillian NALMA. This unit is characterized by fluvial deposits dominated by basalt gravels, whereas the lower units are principally volcaniclastic deposits characterized by andesite and rhyolite clasts. The Wilbur Locality occurs in the uppermost lithostratigraphic unit west of the town of Selah, Yakima County, WA. The locality consists of a diatomite interbedded within the basalt gravels; derived from the diatomite is a diverse, although relatively small assemblage of vertebrate fossils. *Pliotaxidea nevadensis*, *Dipoides* sp. cf. *D. wilsoni*, *Pliosaccomys* sp. cf. *P. dubius*, *Paronychomys*, and *Castor* indicate a Hemphillian age. Reptiles are represented by a colubrid snake and a turtle that exhibits characters that suggest an ancestral position compared to extant emydids. Additional mammals include *Eucyon davisi*, *Hypolagus* sp., *Neotamias* sp. cf. *N. malloryi*, *Neotamias* large sp., *Spermophilus wilsoni*, *Perognathus* sp., *Copemys* sp., and *Metatylopus* sp.. The occurrence of this diverse assemblage in a diatomite suggests a concentration in a ponded paleoenvironment, but no fish or amphibians have yet been recovered.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

A NEW FOSSIL BALAENOPTERID (CETACEA, MYSTICETI) FROM THE LATE PLIOCENE SAN DIEGO FORMATION, CALIFORNIA

MARTIN, Jessica, San Diego State University, San Diego, CA, USA

A new species of fossil balaenopterid is described based on three specimens from the San Diego Natural History Museum collections. Though not from the same locality, the specimens were all found in the late Pliocene (~2-4 MYA) San Diego Formation. The late Pliocene has produced a variety of balaenopterids and appears to be a time of great diversification for the family. The specimens include nearly complete skulls with some associated postcrania although none preserve mandibles. Both adults and a juvenile (ie. unfused epiphyseal plates of the vertebrae) are represented. Preliminary work suggests these specimens represent a new species of Balaenopteridae, based on derived characteristics, such as a triangular supraocciptial shield, an anterolaterally directed zygomatic process and numerous characteristics of the squamosal/intertemporal region. An important derived feature for balaenopterids is the presence of a maxillary pocket, related to the interdigitation of bones in the cranial apex. This pocket is a space created by overlap of the posterior portion of the maxilla onto the anterior edge of the supraorbital process of the frontal. Another feature related to this interdigitation is the lateral most projection of the parietal and squamosal abutting the suture of the supraorbital shield. The species displays other derived balaenopterid conditions, such as long overlap of the anterior process of the maxilla, anterior wing of the parietal, narrowly rectangular anterior process of the maxilla and an abruptly depressed supraorbital process of the frontal.

One character of particular interest is the lack of a squamosal crease, a distinguishing feature of *Megaptera*; however this is a plesiomorphic character. The nasals of the new specimens most closely resemble that of *Megaptera*, sharing conditions such as a medial keel running the length of the nasal dorsal surface and the anterior part of the nasals coming to a sharp point.

Preliminary phylogenetic analysis positions the new fossil taxon within Balaenopteridae. A majority of trees reconstruct this taxon as close to '*Megaptera*' *hubachi*, outside of extant balaenopterid species including *Megaptera*.

Poster Session IV, (Wednesday)

PATTERNS OF SIZE CHANGE IN LATE NEOGENE POCKET GOPHERS (MAMMALIA: GEOMYIDAE) FROM THE MEADE BASIN OF SOUTHWESTERN KANSAS

MARTIN, Robert, Murray State University, Murray, KY, USA; PELÁEZ-CAMPOMANES, Pablo, National Museum of Natural History, Madrid, Spain

Remains of three genera and ten species of pocket gophers were recovered from sediments in the Meade Basin of southwestern Kansas spanning more than 5.0 million years. No more than two species are present in each sampling interval, and the body size distributions, as represented by mean length of the lower fourth premolar, are suggestive of character displacement: 1) the earliest gophers, *Pliogeomys buisi* (Buis Ranch) and *Pliogeomys* sp. nov. (Saw Rock Canyon, Fallen Angel B) are equal in size to each other and to the earliest *Geomys minor* (Fox Canyon, XIT 1B, Ripley B) when found alone,2) following the immigration of the larger *Geomys jacobi* in Wiens and Vasquez/Newt, *G. minor* begins a dwarfing trend, 3) a new, medium-sized species of *Geomys* enters the basin in the Sanders assemblage towards the end of the Pliocene, replacing the *G. minor* (diminutive)*/G. quinni* (large) pair, 4) when *G. quinni* returns to the basin and is sympatric with the new medium-sized *Geomys* in the Borchers local fauna, it is displaced to giant size. The diminutive, extinct *Geomys adamsi* and small, transient *Thomomys* are occasionally paired with medium-sized *Geomys*, presumably during cold periods.

Technical Session II, Sunday 10:30

NEW DATA ON TOOTH REPLACEMENT IN THE LATE JURASSIC DOCODONT MAMMAL *HALDANODON EXSPECTATUS*

MARTIN, Thomas, Universität Bonn, Bonn, Germany; NOWOTNY, Manuela, Universität Frankfurt am Main, Frankfurt am Main, Germany; FISCHER, Martin, Universität Jena, Jena, Germany

The docodont mammal *Haldanodon exspectatus* from the Late Jurassic of the Guimarota coal mine in Portugal has rendered important information on the cranio-mandibular and postcranial anatomy of mammals and mammalian evolution in general. Here we present new data on the tooth replacement of this important taxon obtained by high-resolution computed tomography scanning of maxillae and mandibles of differing ontogenetic age. Although it can be corroborated that *Haldanodon* had diphyodont replacement of incisors and premolars and non-replacement of molars, it likely had more than one replacement of the double-rooted upper canine. Deciduous upper canines that are preserved in the process of replacement differ considerably in size and therefore indicate that more than one generation of deciduous canines occurred (situation for lower canine is not clear). Upper and lower premolars were replaced sequentially from front to back. In the mandible, four deciduous premolar positions are present (dp1-4), but only three permanent premolars erupted with loss of the position of dp2. The anterior deciduous premolars (dp1-2) are very small and peglike, dp3-4 are much larger and molariform. The permanent lower premolars mainly consist of one large main cusp and are premolariform. The ultimate permanent lower premolar (p4) erupts at the same time as m4. The maxilla holds three deciduous premolar positions (dP1-3) and three permanent premolar positions (P1-3). As in the mandible, dP1 and dP2 are very small and peglike, and dP3 is large and molariform. Replacing P1 is small and tends to become vestigial or is even lost, P2 and particularly P3 are much larger. All permanent premolars are premolariform and differ clearly from the molars. Although the diphyodont replacement of antemolars of crown mammals was largely established in *Haldanodon*, it likely had retained the plesiomorphic multiple replacement of at least the upper canine as seen in more basal mammals such as *Sinoconodon*.

Poster Session I, (Sunday)

UNDERSTANDING AND UTILIZING DETAILED BIOSTRATIGRAPHIC DATA TO CHARACTERIZE LATE TRIASSIC FAUNAL CHANGE: EXAMPLES FROM WESTERN NORTH AMERICA

MARTZ, Jeffrey, Petrified Forest National Park, Petrified Forest, AZ, USA; PARKER, William, Petrified Forest National Park, Petrified Forest, AZ, USA

Late Triassic biochronology has been generally based on inaccurate, imprecise, and/or poorly documented stratigraphic models, taxonomic identifications based on biochrono-

logic convenience, and spuriously precise correlations. We have precisely plotted tetrapod biostratigraphic data on detailed and accurate Upper Triassic lithostratigraphic frameworks for two areas in the western United States: Petrified Forest National Park in northeastern Arizona, and southern Garza County in western Texas. These detailed and accurate biostratigraphic models provide the standard for how Triassic vertebrate biochronology must be approached to reliably answer questions about faunal change. The Late Triassic "land vertebrate faunachrons (lvfs)" are most useful when treated as provincial biozones (rather than global biochrons) incorporating precise biostratigraphic data with alpha taxonomy derived independent of stratigraphic information. It is important to distinguish between how the "lvfs" are defined (based on the superpositional relationships of first appearances for particular taxa) and characterized (based on overall faunal content). Confusing these concepts has caused the rejection by some of distinct Adamanian and Otischalkian "lvfs". Dense biostratigraphic sampling is critical for accurately placing "lvf" boundaries, and for understanding faunal changes. Due to patchy sampling, the apparent position of the Otischalkian-Adamanian boundary is probably too high in both localities. In Petrified Forest, the Adamanian-Revueltian transition seems most abrupt for the most common taxa with the densest sampling, making a mass extinction and rapid faunal replacement plausible. However, the general lack of detailed biostratigraphic range data, combined with the paucity of precise radioisotopic dates, currently makes it impossible to either identify or refute globally synchronous Late Triassic mass extinctions, or to reliably characterize faunal overturns as being either competitive or opportunistic.

Poster Session IV, (Wednesday)

TESTING THE CONSISTENCY OF THE LATERAL SEMICIRCULAR CANAL AS A COMPARATIVE COORDINATE SYSTEM FOR CRANIOFACIAL DESCRIPTIONS IN SAURISCHIAN DINOSAURS

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A long standing challenge in comparative morphology has been to find a coordinate system that helps make anatomical descriptions consistent among taxa. Craniofacial morphology in fossil dinosaurs has been described using the lateral semicircular canal—one of the three canals of the labyrinth within the inner ear—as a reference system for skull orientation. In land vertebrates, while the three semicircular canals are spatially nearly-orthogonal, available data from extant taxa do not support the assumption that their orientation as a whole is interspecifically constant (i.e., that the canals specify the same spatial directions within the skull in all taxa). Thus, using the lateral canal as a fixed orientation baseline, and consequently rotating a skull in a magnitude equivalent to the canal's real orientation, may yield an inaccurate perception of craniofacial organization. Here we argue that geometric morphometrics allows a more consistent coordinate system based on the superimposition of homologous landmarks. We illustrate this method by assessing the orientation of the semicircular canals in an inter-specific sample of fossil and extant saurischian dinosaurs including saurpodomorphs, and several theropods such as tyrannosaurids and maniraptorans (including modern birds). Our results show that fossil saurischians spanned a striking range of labyrinth orientations, even larger than what had been reported for extant birds (ca. 70º, ranging between 20º to -50º relative to the horizon). Our conclusions strongly demonstrate that in dinosaurs the spatial coordinates defined by the labyrinth are inter-specifically very variable, and indicate that the lateral semicircular canal is an inconsistent reference system for descriptive purposes

Physical Drivers and Marine Tetrapod Evolution, Monday 11:45

LEVIATHANS SPORTING ON THE FOAMING WAVES - AN INTEGRATED VIEW OF BALEEN WHALE DIVERSITY, DISPARITY AND EVOLUTIONARY RELATIONSHIPS

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Baleen whales (mysticetes) are some of the most conspicuous members of the Cenozoic marine ecosystem, and their evolution from four-legged land dwellers to the giant filter-feeders inhabiting the modern oceans provides one of the most impressive examples of adaptability in the evolutionary history of mammals. Yet, while much attention has been paid to the earliest origin and radiation of baleen whales in the latest Eocene and Oligocene, comparatively little is still known about the mode and drivers of their subsequent history during the second half of the Cenozoic. Similarly, while recent work has helped to shed some new light on baleen whale interrelationships and paleodiversity through time, progress has been hampered by conflicting results, low taxon sampling, and relatively poorly constrained temporal occurrences. Here, we present a synthesis of mysticete paleodiversity, phylogeny and morphological diversity (disparity) for a series of 16 Cenozoic (sub-) stages, based on the largest morphological dataset assembled so far, including 200 characters and 67 mysticete species. Our results indicate that the taxonomic and morphological diversity of baleen whales are mostly decoupled. Phylogenetically adjusted generic diversity peaked in the late middle Miocene and, to a somewhat lesser degree, the late Miocene and early Pliocene, followed by a decline towards the present day. By contrast, mysticete disparity reached two distinct maxima in the late Oligocene and the late Miocene/early Pliocene. The latter peak, common to both the diversity and disparity records, broadly coincided with a period of global enhanced marine primary productivity (the late Miocene-early Pliocene 'biogenic bloom') as indicated, for example, by phosphate and opal mass accumulation rates, whereas the earlier Oligocene disparity maximum may be the result of a small-scale equivalent of a mysticete 'Cambrian explosion', leading to the establishment of a number of distinct, and sometimes short-lived, body plans, such as aetiocetids, mammalodontids, and eomysticetids.

Poster Session III, (Tuesday)

SEXUAL DIMORPHISM IN THE HOMININE SUPRAORBITAL TORUS: IMPLICATIONS FOR IDENTIFYING SEX IN FOSSIL HUMANS

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The supraorbital torus is frequently used to assign sex in fossil humans. Unlike most hominoids where sex can be determined by canine size, the hominin clade is defined in part by reduction in canines and canine dimorphism. Thus, it is important to have alternate means, such as brow ridge morphology, for determining whether a specimen is male or female in order to distinguish small-canined hominins from female apes. Here, we test the hypothesis that supraorbital morphology in fossils is a useful indicator of sex. Torus morphology in gorillas, chimpanzees, bonobos, and humans was quantified using 10 landmarks and 11 semi-landmarks. Specimen configurations were superimposed using a generalized Procrustes analysis during which semi-landmarks were allowed to slide, minimizing Procrustes distance. Non-parametric permutation tests on aligned coordinates found that sexes were significantly different in each species; testing for overlap between sexes, however, found that up to 30% of males and females were more similar to the mean shape of the *opposite* sex. To compare patterns of sexual dimorphism in different species, vectors of sex-related shape change were computed using multivariate regressions on a dummy sex variable. Comparing these vectors revealed that patterns of dimorphism differ substantially in each species. Indeed, when discriminant functions were used to determine the sex of fossil specimens, the results depended largely on which extant taxon was used to model dimorphism. Together, these results argue against using supraorbital torus morphology as an indicator of sex. This is particularly true for fossil species represented by only a single specimen. Finally, we analyzed scaling patterns in supraorbital torus thickness, a feature that has recently been invoked to identify sex in the earliest hominins. While most of the sample followed a similar scaling pattern, the brow ridge of the probable hominin *Sahelanthropus* was remarkably thicker than expected for its size. This unique scaling pattern further weakens the case for diagnosing sex from toral morphology in this particular specimen, and raises questions about the taxonomic status of *Sahelanthropus*.

Poster Session III, (Tuesday)

A UNIQUE EOCENE CROCODYLIAN FROM THE UINTA BASIN, UTAH

MASTERS, Simon, Intermountain Paleo-Consulting, Vernal , UT, USA; SANDAU, Stephen, Intermountain Paleo-Consulting, Vernal, UT, USA; BURK, Daniel, Intermountain Paleo-Consulting, Vernal, UT, USA; KRUMENACKER, L.J., Intermountain Paleo-Consulting, Vernal, UT, USA

Late in 2009, a Crocodylian was collected during a reconnaissance survey in the Uinta Basin of northeastern Utah. The specimen was recovered from light-green floodplain deposits consisting of sandy siltstones and mudstones in the Uinta B (Wagonhound Member) of the Uinta Formation. Approximately 60% of the skull is present yet poorly preserved with substantial dorso-ventral crushing. The specimen consists of the sinistral premaxilla through anterior jugal, partial dextral premaxilla, maxilla, nasal, the greater portion of both dentaries with broken in-situ teeth, numerous isolated partial teeth, posterior pterygoid wing, numerous other cranial fragments, two near-complete articulated dorsal vertebrae, and associated vertebral and limb fragments. Partial fusion of the neural arches and centra of the articulated vertebrae suggest the animal was a subadult. The incomplete skull is 22 cm long with an estimated length of 32 cm. The measurement across the snout at the anterior edge of the naris is 4.5 cm and 6.5 cm near the distal end of the maxilla. Preserved length of the sinistral dentary is 22 cm with a total estimated mandible length of 35 cm. These measurements suggest an elongate skull in contrast to the more robust and triangular skulls of other Uintan Crocodylians. An additional difference from other Uintan Crocodylians includes: sculpted rugosity of the cranial elements as opposed to the pitted rugosity found in "*Crocodylus*" *affinis*, *Borealosuchus*, or *Procaimanoidea utahensis*. Dissimilar to known Uintan Crocodylians, the teeth are diminutive, blade like, and splayed laterally beyond the anterior margins of the dentary and premaxilla. We interpret this specimen to be an undescribed Crocodylian. Preliminary morphological comparisons suggest a close affinity to *Listrognathosuchus*. This specimen has been reposited in the Brigham Young Museum of Paleontology.

Poster Session I, (Sunday)

A NEW, NEARLY COMPLETE SPECIMEN OF *PETROLACOSAURUS KANSENSIS* (DIAPSIDA: ARAEOSCELIDAE) THE EARLIEST KNOWN DIAPSID FROM THE UPPER PENNSYLVANIAN OF KANSAS

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The rich Pennsylvanian faunal assemblage of the Garnett locality, in central Kansas, continues to provide important information about the morphology of early terrestrial amniotes and their environment. This locality has yielded the skeletal remains of six synapsids as well as the diapsid reptile *Petrolacosaurus kansensis*. Trackways have also provided evidence for the presence of at least two more terrestrial tetrapods: a tiny captorhinomorph reptile and

a large diadectid cotylosaur. Earlier descriptions of *Petrolacosaurus kansensis*, the oldest known diapsid, were based on 26 incomplete specimens, many of them representing immature individuals. For the first time, a nearly complete mature skeleton of this taxon has been discovered, providing an opportunity to analyze the anatomy and body proportions in a single individual of this important reptile. The skeleton consists of a complete, flattened skull, complete presacral vertebral column, and one complete semi-articulated fore and hind limb. Although clearly an adult, the long neck and the elongate, slender limbs underscore the overall gracile configuration of this species. Precise skeletal measurements taken from a single adult individual are particularly important for determining overall body and limb proportions, making it possible to compare this basal diapsid with other basal amniotes. For example one characteristic feature of early amniotes is the 20-30% greater length of the femur than the humerus, probably associated with front and hind limb stride length. In this regard, *Petrolacosaurus* is distinct from most other early amniotes in having femora and humeri of equal lengths. This suggests that these proportions may be related to increased agility in this basal diapsid reptile, yet it is surprising to find that humeri of equal or even greater length than the femur is a characteristic feature of another groups of early amniotes, the large, barrel-shaped herbivorous caseid synapsids.

Poster Session III, (Tuesday)

DISCOVERY OF THE JUGAL BONE IN THE HAITIAN GROUND SLOTH *NEOCNUS* (MAMMALIA. PILOSA. MEGALONYCHIDAE) AND THE IMPLICATIONS FOR DIETARY RECONSTRUCTION

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The jugal bone is a diverse element within sloths that fails to form a complete zygomatic arch in all but the largest forms of extinct ground sloths and exhibits a variety of elaborations in the projections for muscle and ligament attachment. The varied patterns of this bone are linked to adaptive shifts in the musculature lines of action for feeding, which specifically affects M. masseter and M. zygomaticomandibularis. The Haitian species of the Pleistocene ground sloth *Neocnus* heretofore lacked known jugal elements and it was predicted to be greatly reduced in size and shape, giving the sloth a weakened mandibular closing or bite via the masseter. The discovery of jugals with an associated skull, along with numerous individual jugals, provides the first basis for description of this element in the Haitian species of *Neocnus* and enables analysis of potential feeding mechanisms for this taxon. Reconstruction of masticatory musculature follows muscle patterns for the extant tree sloths, *Bradypus* and *Choloepus*. Analyses of estimated bite forces were carried out via calculation of moment arms for M. temporalis and M. masseter, which were compared against the lever arm forces applied at each tooth in the mandibular series. The jugals in *Neocnus* are larger than predicted with a slender, elongate dorsal process extending nearly to the postorbital bar, a middle process that is blunt and that nearly merges with the short ventral prong that sweeps posteroventrally and does not extend below the mandible. Bite force analyses and muscle reconstruction portray *Neocnus* as a strong masticator that emphasized crushing-grinding movements over speed, via a more vertically aligned M. temporalis, M. zygomaticomandibularis, and M. pterygoideus medialis. During the masticatory cycle, *Neocnus* had greater anterolingual movements due to the horizontal alignment of M. pterygoideus lateralis in a pattern more reminiscent of *Bradypus* than the labiolingual movements employed by *Choloepus*. Overall patterns of bite force and dental wear suggest *Neocnus* had a folivorous diet, like *Bradypus*, preferring older shoots and leaves that are more effectively processed by strong, grinding bite forces.

Poster Session II, (Monday)

A NEW FOSSIL SNAKE ASSEMBLAGE FROM THE LATE EOCENE OF THE FAYUM DEPRESSION, EGYPT

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The Fayum Depression in northern Egypt is well known for its Paleogene mammalian faunas, but ongoing fieldwork has expanded our comparatively limited knowledge of the non-mammalian fauna. A new collection of snakes from the earliest late Eocene (earliest Priabonian, ~ 37 Ma) Birket Qarun Locality 2 (BQ-2) greatly increases our knowledge of snakes from this time period in Africa. At least six species have been recovered from BQ-2. Two of these, the madtsoiid *Gigantophis* and the palaeophiid *Pterosphenus*, are already known from younger horizons in the overlying Qasr el-Sagha Formation. Three basal alethinophidians and a colubroid have also been identified. Most are represented by multiple vertebrae, including vertebrae from overlapping regions, thereby allowing direct comparison of the species. Included in the basal alethinophidians are a possible pythonid and erycine boid. The majority of the material comes from the pythonid and *Pterosphenus*, with the remaining species being comparatively rare. A small portion of the material is too fragmentary for positive identification. Of particular interest is a specimen representing a juvenile madtsoiid. The specimen has characters obviously related to an early ontogenetic stage, including a very large neural canal and a very wide, gracile zygosphene. Its large size is consistent with assignment to the only known madtsoiid in the fauna, the giant snake *Gigantophis*. Taken together, these fossils present evidence of an ecologically diverse snake fauna in the earliest late Eocene of Egypt. *Pterosphenus* is a highly derived aquatic snake, usually associated with marine faunas. The remaining snakes show no aquatic tendencies. In fact, the erycine is likely a burrowing snake, inferred from the dorsoventrally compressed vertebral morphology and the habits of extant snakes in this clade. The remaining snakes have a generalized morphology suggesting no particular ecological specializations, although they differ considerably in size. This apparent ecological diversity suggests a complex snake fauna in the Eocene of the Fayum with niche partitioning allowing a diverse snake assemblage.

Romer Prize Session, Monday 9:45

INTERPRETING RECENT SMALL-MAMMAL RANGE SHIFTS IN YOSEMITE IN LIGHT OF THE QUATERNARY FOSSIL RECORD

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Paleontology provides a historical record to test the significance of modern reactions to climate change. A central challenge in interpreting recent, short-term changes in species distributions is setting them in the context of past reactions to climate change, critical for testing 1) whether changes are in fact climate-driven and 2) whether historic rates of range change exceed background rates. In recent surveys of Yosemite National Park's mammal fauna, three species in the genus *Microtus* (voles) each exhibited a different response to climate change over the last 100 years. The upper range boundary of *M. californicus* moved 500 m upslope, the lower boundary of *M. longicaudus* ascended 600 m, and *M. montanus* did not change. Here I use the fossil record to test the significance of these changes. While a rich paleontological record of *Microtus* exists, resolving species-level changes has remained difficult due to the challenge of identifying fossil specimens (usually isolated teeth) to species. Using geometric morphometrics of tooth shape for identification, I track the presence of five *Microtus* species across western North America throughout the Quaternary. This provides a high-resolution map of their reactions to past climate change, identification of the first fossil *Microtus oregoni* and *Microtus townsendii,* and the first firm Quaternary extra-limital records of *Microtus* species in California. All five species demonstrate range retractions that reflect prehistoric climate shifts and document patterns that help sort the signal from the noise in recent range shifts. *M. longicaudus* is today exhibiting similar response to climate warming as it did in the past. However, the historic shift is apparently exceeding past rates. The average rate over the past century has been ~6 m/yr in Yosemite, whereas the rate approximated during Pleistocene warming is ~0.1-1.2 m/yr. These results suggest that climate change in the past century alone is already having biological impacts comparable to those of the end-Pleistocene warming. Overall, the use of quantitative, highly resolved morphological data provides a powerful tool to assess species responses to past environmental events.

Technical Session XVIII, Wednesday 2:00

A SPECIES-LEVEL PHYLOGENETIC ANALYSIS OF TEMNOSPONDYLI (VERTEBRATA: CHOANATA)

MCHUGH, Julia, University of Iowa, Iowa City, IA, USA

Temnospondyli was the most speciose group of non-amniote tetrapods during the late Paleozoic and early Mesozoic. They achieved a worldwide distribution early in their history and crossed two major mass extinction boundaries: the Permo-Triassic and Late Triassic. Previous attempts to describe temnospondyl evolutionary history have predominantly focused on the intrarelationships of subclades (e.g. Brachiopoidea, Dissorophoidea) or higher-level interrelationships amongst these subclades for either a portion or for the entire group. In doing so, exemplar taxa or composite taxa were used to streamline analyses. These methods are advantageous when the goal is a broad look at relationships between groups, but they cannot account for large areas of evolutionary history, minimize morphological complexity, and require specific assumptions of monophyly, all of which are disadvantageous when trying to reconstruct a comprehensive understanding of the entire group and its evolution. Here, results are presented from a species-level phylogenetic analysis that is exhaustive in scope and does not rely on exemplar or composite taxa. A maximum parsimony analysis of 53 taxa coded for 295 characters supports the monophyly of a number of clades, including Eryopoidea, Dissorophoidea, Brachyopoidea, Stereospondyli and Archegosauriformes, but the monophyly of Euskelia and Rhinesuchidae are called into question. These results have serious implications for the use of exemplar and composite taxa. These patterns are also corroborated with stratigraphic range data to illustrate ghost lineages and speciation events spanning the Late Permian and Early Triassic, with direct implications to the stress levels of terrestrial ecosystems at the Permo-Triassic boundary.

Poster Session IV, (Wednesday)

THE POSTCRANIAL SKELETON OF *EMBOLOTHERIUM* (BRONTOTHERIIDAE) FROM THE MIDDLE AND LATE EOCENE OF CENTRAL ASIA

MCLAUGHLIN, Benjamin, New York College of Osteopathic Mediciine, Old Westbury, NY, USA; MIHLBACHLER, Matthew, New York College of Osteopathic Medicine, Old Westbury, NY, USA; ELLISON, Mick, American Museum of Natural History, New York, NY, USA

In the 1920s, the American Museum of Natural History amassed a large collection of Eocene Brontotheriidae from Inner Mongolia, a family that had not previously been documented in Asia. Current hypotheses of brontothere phylogeny are driven solely by craniodental data, largely because there is a dearth of literature on the postcrania of Asian brontotheres. The unstudied AMNH collection of Asian brontothere postcrania is an untapped resource for needed data. Here we describe, for the first time, postcranial elements representing a very large brontotheriid from the middle Eocene Shara Murun Formation and late Eocene Baron Sog Formation of Inner Mongolia. The only brontothere identified (from a skull) in the Baron Sog unit is *Embolotherium andrewsi*. Giant postcranials from this unit that undoubtedly belong to *Embolotherium* include an atlas, a partial femur, several ulnae, patellae, and a large

assortment of manus and pes elements. Shara Murun deposits contained forearm, manus, and pes elements of a morphologically similar brontotheriid, probably also representing *Embolotherium*. *Rhinotitan*, also common in the Shara Murun Formation, and known from articulated skeletons, can be distinguished from *Embolotherium* by its more slender limb bones and metapodials, its more elongate astragalar neck, and other features characteristic of a more cursorial animal. The postcranial skeleton of *Embolotherium* suggests a powerful, graviportal animal with close resemblance to the late Eocene North American brontothere *Megacerops*. Remarkably, previous phylogenetic analyses, based on craniodental data, suggest that *Embolotherium* and *Megacerops* were distantly related genera, having evolved very large body size and exaggerated cranial appendages independently. However, the numerous derived postcranial similarities shared by these two taxa, and not seen in *Rhinotitan* or other brontothere species, seem to support a different phylogenetic arrangement in which *Embolotherium* and *Megacerops* are more closely related. A possibly closer relationship between these two taxa, from separate continents, has important implications for North American-Asian faunal relationships during middle Eocene time.

Poster Session IV, (Wednesday)

MORPHOMETRIC ANALYSES OF TITANOSAUR CAUDAL VERTEBRAE: IMPLICATIONS FOR NAMING "MALAGASY TAXON B"

MCNULTY, Kieran, University of Minnesota, Minneapolis, MN, USA; CURRY ROGERS, Kristina, Macalester College, St. Paul, MN, USA; RUDLOFF, Owen, Macalester College, St. Paul, MN, USA

Caudal vertebrae have played an important role in the identification of Malagasy titanosaurs since the first discoveries of procoelous caudal centra in Madagascar more than a century ago. Fieldwork in the Upper Cretaceous Maevarano Formation has since yielded more than 100 caudal vertebrae and vertebral fragments. Preliminary identifications recognized two separate morphotypes, one corresponding to the known morphology of *Rapetosaurus krausei* and the other thought to belong to the still unnamed "Malagasy Taxon B." Here we present the first statistical support for the existence of two or more titanosaurs in the Maevarano Formation. To quantify vertebral shape, 3D landmarks and semi-landmarks were collected from the centra and neural spines of 85 titanosaur caudal vertebrae. Only posterior caudal vertebrae were represented by both morphotypes, so these were subjected to a generalized Procrustes analysis to superimpose all configurations within the same shape space; aligned coordinates were then used in multivariate statistical analyses. Principal components analysis confirms two distinct vertebral morphs corresponding to the preliminary morphological identifications. This was tested statistically using a non-parametric permutation test of the Procrustes distance between group means, which found significant differences between two morphotypes. Interestingly, despite morphological indications that all of these specimens were from posterior-most positions among posterior caudal vertebrae, those attributed to "Malagasy Taxon B" were substantially more variable than those of *Rapetosaurus*. This was confirmed by a second permutation test based on difference in the morphometric equivalent of group variance: average Procrustes distance of all specimens in a group to the group mean. These results, along with new discoveries of braincase and appendicular material, support the designation of at least two titanosaur taxa in the Maevarano Formation. They also highlight the fact that, unlike caudal vertebrae in *Rapetosaurus krausei*, posterior caudal vertebrae in the mysterious "Malagasy Taxon B" exhibit substantially greater morphological diversity.

Technical Session XIII, Tuesday 3:00

CHANGES WITHIN CARNIVORE GUILDS FROM THE PLEISTOCENE AND HOLOCENE OF NORTH AMERICA

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Guilds are made up of species within a community that perform similar ecological roles. Competition among guild members can bring about character displacement through morphological changes or resource partitioning. Mammalian carnivore guilds partition their ecological niches by diet specialization, but also by body size or habitat separation. Here, I examine the niche partitioning that occurs in carnivore guilds from contemporary communities, and use these findings to examine patterns of guild structure and niche partitioning in carnivores from the early Holocene and Pleistocene of North America. Extant localities examined include: Serengeti of Africa, Yellowstone of the U.S., Kanha of India, and the Pantanal of South America. Fossil localities include: Rancho La Brea Tar Pits in California (40-9 Ka), Middle Butte Cave (> 8 Ka) and Moonshiner Cave (< 8 Ka) in Idaho. Morphological measurements of crania, postcrania, and average species masses (or mass estimates) were gathered for each species. Analysis of variance (ANOVA) and linear regression were used to examine the degree of morphological separation between co-occurring carnivore species in extant and fossil sites. Additionally, species that are present in Pleistocene, early Holocene, and contemporary communities were compared using ANOVA to examine if their morphology has changed over time due to competition pressures or faunal turnover. Results show extant carnivore guilds display similar structures despite having distinct taxa. Additionally, within dietary categories, niches are not always separated by size, but more often are distinguished by postcranial morphology, indicating habitat partitioning. In North American guilds, coyotes and brown bears show morphological differentiation through time, with the larger and more specialized individuals occurring in the Pleistocene. This was most likely in response to competition or antagonistic interactions with a more diverse Pleistocene carnivoran fauna, dominated by more species with larger body sizes. Smaller carnivores, such as badgers and bobcats showed no morphological differentiation between contemporary, early Holocene, and Pleistocene populations.

Poster Session IV, (Wednesday)

MASS DEATH ASSEMBLAGES OF *HYPERTRAGULUS CALCARATUS* (ARTIODACTYLA: RUMINANTIA)

MEEHAN, TJ, Marquette University, Milwaukee, WI, USA

The extant Tragulidae is the most primitive living ruminant artiodactyl, and its sister group, the extinct Hypertragulidae of North America, is the most primitive ruminant family. A common species of the White River Group (latest Eocene-Early Oligocene), *Hypertragulus calcaratus*, is known from a few blocks with many individuals. *Hypertragulus* is a bullet deer ecomorph with an arching back and gracile, saltatorial limbs, as in modern chevrotains. Three fossil blocks with more than 10 individuals each from the White River were studied for information on cause of death and accumulation mode. These blocks are monotypic with individuals that are partially articulated and associated; the bone surface is smooth with little to no desiccation cracking and exhibits no predatory or scavenging marks from insects or vertebrates.

A Carnegie Museum block specimen that had been mostly prepared has a right mandibular MNI of 32 and a right tibial MNI of 30. Other MNIs from skulls and limb elements, including carpals and tarsals, range from 12-24. Individuals are jumbled and tightly packed with small and large bones, indicating little to no transport. This block was collected and prepared decades ago, and unfortunately, there is little sedimentary and taphonomic information preserved. Except for one specimen, these individuals are all young adults. The third molar is erupting or erupted and exhibits no to little wear. Epiphyseal lines, such as in the distal femur, are distinct, or in some, the epiphysis has not fused to the shaft. Tooth morphology in specimens from the other two blocks indicate a range of adult ages. The high concentration and consistent taphonomy indicate mass death, but likely not predatory. The hypertragulid *Hypisodus* of the White River is known from burrows, but whether *Hypertragulus* used burrows is not known. The three monotypic blocks suggest that at least seasonally, *Hypertragulus calcaratus* was social, while modern bullet deer are solitary. Few upper canines were preserved, but there is no indication of sexual dimorphism in tooth size (or in other skeletal morphologies).

Poster Session IV, (Wednesday)

TURDS OF A FEATHER

MEHLING, Carl, American Museum of Natural History, New York, NY, USA

Coprolites are often neglected in phylogenetic studies. They are characterized as cladistically uninformative specimens because their animal-of-origins can only rarely be ascertained with confidence. Even if the coprolite maker can be discerned, little of its morphology is ever offered by its feces. However, when viewed as a sort of biomatrix, they can be seen as valuable sources of fossil remains that have little hope of being preserved in the background matrix. Thus, coprolites can often act as sheltering time-capsules for remains too-fragile to survive entombment in the surrounding sediments.Reviewed here are two coprolites containing feather inclusions from the East Coast of the US. There is almost no chance that these feathers would have been preserved in the sediments which preserved the coprolites. Their passage through the guts of some other animal ensured their passage through time. Based on coprolite size, morphology, and provenience, whales are a strong possibility for the coprolite producer, although fish or crocs are other possibilities previously proposed for the Maryland specimen.If either of the coprolites turns out to be from a mysticete, a caveat for coprolite studies is exposed: what an animal ingests is not necessarily part of its diet. Several possible reasons for animal misingestion include accidents, mistaken identities, teething, gnawing, or diet of the prey. Care should be taken with the interpretation of animal diet based on feces.

Technical Session XV, Wednesday 9:15

HIGH RESOLUTION EXAMINATION OF THE ECOLOGY, EVOLUTION AND BIOGEOGRAPHY OF MARINE VERTEBRATES IN THE POST KT-EXTINCTION INTERVAL IN EASTERN TEXAS

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The basal 5 meters of the Kincaid Formation exposed on the Brazos River preserves rocks from the first ~300,000 years of the Paleocene (P0-P1b foraminiferal zones). Intensive screen-washing of every lithological bed has produced over 1600 chronostratigraphically controlled, identified vertebrate specimens from >30 taxa of sharks, batoids, and teleosts (17 sharks, 4 batoids, 9 teleosts). Using an apomorphy-based identification approach, approximately 15 of those taxa are new undescribed species (9 sharks, 2 stingrays, and 4 fish) and include a new species of *Dasyatis* (represented by over 700 teeth of both sexes) that is the most common single taxon. The teleosts exhibit a mixture of albuliform, percomorph, and amiiform taxa, and percomorphs are not the most diverse clade (as they are by the end of the Paleocene). Only albuliforms and possibly one species of *Enchodus* appear to have survived the end of the Cretaceous locally. The abundance of vertebrate specimens (and individual taxa) appears to correlate with the sequence stratigraphy (i.e. relative water depth). Marine vertebrate alpha diversity rebounds to Cretaceous levels within 200,000 years, and that fast recovery appears to be related to regional and possibly more widespread post-extinction dispersal into Texas. That is demonstrated by the presence of *Phyllodus paulkatoi* and *Dasyatis puercensis* in Texas beyond their Cretaceous limits in Montana. Cretaceous seas were dominated by lamniforms (e.g., *Squalicorax*), but that changed in the early Paleocene to small-bodied carcharhiniforms (triakids locally; 77% of all shark specimens). That taxonomic shift should reflect the change in marine vertebrate foodwebs with the loss of Cretaceous

top predators and the expansion of diversity at lower intermediate trophic levels (of much smaller body sizes). The Texas vertebrate fauna exhibits relatively low evenness similar to other early Paleocene faunas around the world. However, differences in taxonomic composition among Paleocene marine vertebrate faunas seem to indicate that survivorship increases with distance from the Chicxulub impact as observed in other marine and terrestrial taxa.

Technical Session XVIII, Wednesday 3:45

WHEN IS AN ASTRAGALUS NOT AN ASTRAGALUS? TARSAL FUSION IN *HYLONOMUS*, THE EARLIEST KNOWN AMNIOTE

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A key synapomorphy of amniotes is the presence of an astragalus (fusion of three tarsals: intermedium, tibiale, and proximal centrale). Amniotes display a fused astragalus, but sutures indicating a multipartite origin have been described in several Palaeozoic sauropsid taxa, in particular the captorhinids, where the composition has been interpreted as large, proximal intermedium and smaller, distal tibiale and proximal centrale. Interestingly, no cases of astragali demonstrating sutures have been reported for the synapsid or parareptile lineages. The tendency towards tarsal fusion has been documented in a number of tetrapod lineages in addition to amniotes, including gephyrostegids and microsaurs; however, only in the microsaur *Tuditanus* can the astragalus be shown to comprise the same three tarsals as amniotes. A variety of tarsal fusions have been described for diadectomorphs, including the progressive fusion of an amniote-style astragalus.

As the earliest known amniote, *Hylonomus* has the ability to provide insight into the early evolution of the amniote astragalus. Surprisingly, there have been conflicting reports in the literature regarding the nature of the astragalus in *Hylonomus*, including suture presence as well as suture absence. We re-examined the holotype specimen of *Hylonomus* and found clear evidence of sutures dividing the astragalus into three portions; interdigitation and surface detail confirm that these are sutures, not cracks. There are two large adjacent components and a single smaller, terminal component. However, the relative proportions of the contributing bones are different from those in captorhinids and most closely resemble the pattern described for the microsaur *Tuditanus* (large proximal intermedium and tibiale, and smaller distal centrale). We conclude that astragalus morphology and composition varies both between and within cotylosaur lineages, and this variation may influence assessments of the homology of fused tarsal complexes. The evolutionary history of the astragalus remains incompletely known; however, in light of the data presented here, it appears this history is more complex than previously thought.

Poster Session I, (Sunday)

COMPARISON OF TWO PLIOCENE (BLANCAN) VERTEBRATE FOSSIL ASSEMBLAGES: PANACA LOCAL FAUNA (LINCOLN COUNTY, NEVADA) AND HAGERMAN LOCAL FAUNA (TWIN FALLS COUNTY, IDAHO)

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The Pliocene Epoch was a significant time in North America for intercontinental dispersal of mammals and climatic fluctuations. The Pliocene transitioned from a warmer to cooler climate, which influenced environmental changes from an open forest to grasslands in the continental mid-latitudes of North America. The Panaca local fauna within the Panaca Formation of southeastern Nevada and the Hagerman local fauna within the Glenns Ferry Formation of south central Idaho are inland mid-latitude terrestrial Pliocene fossil sites. The Hagerman fauna within the Hagerman Fossil Beds National Monument (HAFO) is well known and significant in its diversity, quantity, and quality, while the Panaca local fauna has been sporadically studied. The Panaca Formation in Nevada represents an excellent interval to compare Blancan faunal assemblages in diversity, community structure, and paleoecology. The Glenns Ferry Formation is a continuous section of lacustrine and fluvial strata spanning one million years, while the fluvial, lacustrine, and eolian Panaca sediments are discontinuous. The Panaca fossils are found in the fine-grained fluvial sands on the outer margins of the basin. Many HAFO fossils are concentrated in sand channels, but a variety of fossils are found stratigraphically throughout the ~4200 acre monument. A preliminary comparison shows the Panaca fauna of Meadow Valley to represent a less diverse ecosystem, but with greater diversity of cricetid rodents. Seasonal climates of both localities are probable, but the Panaca Formation likely represents a drier climate. HAFO probably experienced a wetter climate than Panaca, providing more habitats along a meandering stream and lake ecosystem, which was able to support a more diverse fauna of birds, fish, amphibians, and mammals. Large mammals common to both localities include equids, camelids, tayassuids, canids, and felids. Small mammals common to both localities include soricids, leporids, heteromyids, geomyids, and cricetids. Mammals found only at HAFO are castorids, megalonychids, ursids, mustelids, mammutids, antilocaprids, and cervids, while families exclusive to Panaca area are bovids and procyonids.

Poster Session II, (Monday)

REVISITING THE ACTINOPTERYGIAN PREOPERCULUM

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The preoperculum has been considered an important bone in the evolution of actinopterygian fishes. It has been proposed that there are different configurations of preopercular bones in palaeoniscoids, more advanced subholosteans, and holosteans. Palaeoniscoids are described as the most "primitive," with a tight association between an inclined preopercular bone, maxilla, and palate. It has been hypothesized that this tight association was gradually lost allowing for a change in the jaw suspensorium, and in turn, feeding mechanisms. A problem with this hypothesis is that it has never been examined in a systematic fashion. Past publications dealing with the preopercular bone provide few examples of the condition of Paleozoic, Mesozoic, and Recent fishes and do not fully investigate the diversity of the preoperculum. To test the strength of this hypothesis, the preopercular bones of a broad array of fishes have been examined. Preliminary work has shown that the preoperculum is characterized by a staggering diversity of shapes, inclinations, and associations. These findings reveal that the conventional wisdom that there is a gradual and progressive change from the palaeoniscoid condition of an inclined preoperculum with a close association to the maxilla to a more advanced condition in holostean and teleost fishes is an oversimplification. For instance, there are numerous palaeoniscoid fishes with vertical preopercula. The preopercular bones of these fishes, and a subset of Paleozoic, Mesozoic, and Recent fishes, will be presented in order to discuss the diversity of preopercular conditions in actinopterygians. Results include summaries of the number, shape and inclination of preopercular bone(s), associations to the maxilla, suborbital and infraorbital bones, and paths of sensory canals. The hypothesis regarding the evolution of the actinopterygian preoperculum will be critiqued by mapping the preopercular condition for various fishes onto previously published phylogenetic trees.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 11:15

EXPLORING THE INFLUENCE OF OBSERVER BIAS IN DENTAL MICROWEAR ANALYSIS

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In dental microwear (DM) analyses of fossil taxa, DM features are categorized by size and shape, counted in a standard area at a standard magnification, and their average frequencies are commonly compared to data from extant taxa with known diets. DM features are generally categorized without explicitly defined size or shape criteria, and the data are often collected by multiple observers. For these reasons, observer bias is a potential source of error. We investigated the influence of observer bias by comparing DM data collected by 5 individuals complied from the identical set of digital images of molar wear surfaces from a variety of extant browsing and grazing ungulates. Photos were taken at 100X through a light microscope and DM features were identified and traced by each observer in identical areas. DM features were classified by each observer into standardized scratch-width and pit-diameter categories. Three of the observers had no previous experience with DM and were required to work through a tutorial before beginning. None of the observers were aware of the species identity or diets of the specimens. Correlation coefficients of interobserver data were initially low and often insignificant. After undergoing an extended training session, in which all 5 observers were present, correlation coefficients improved significantly for DM features of all size- and shape-categories. However, the numbers of DM features of all categories counted in each photo significantly differed even after extended training. These results suggest that experienced observers may be able to consistently find relative differences between species, however the total number of DM features identified in each specimen can be heavily influenced by observer bias. Statistical comparisons of fossil and extant DM data are questionable when the data are collected by multiple observers. We caution investigators against comparing their data with other published data without considering observer bias. We further suggest that researchers adopt the practice of tracing or labeling DM features on photographs and making them available when the data are published so that observer bias can be evaluated.

Poster Session I, (Sunday)

ACTUALISTIC TAPHONOMY OF COLD AND TEMPERATE CLIMATES: APPLICATIONS FOR PLEISTOCENE PALEONTOLOGY

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Abstract The field of actualistic taphonomy has an extensive body of well-established data for the analysis of paleontological and archaeological sites. Data include bone weathering patterns, carnivore bone damage, and bone accumulation and dispersal models on modern tropical and temperate landscapes. Climate can substantially affect taphonomic pathways; I am thus performing actualistic research in temperate cold climates which is relevant for Pleistocene paleontology and archaeology in North America and Eurasia. My research for this project focuses on decomposition, scavenging and dispersal of white tail deer carcasses in central Pennsylvania (PA). Scavengers include turkey vultures, American crows, coyotes, and various insects. This research began in January 2010 and continues to date. I am also

studying an actualistic assemblage from the ecologically- and climatically-different Black Hills (South Dakota - SD). Mountain lions are among the scavengers here and absent in PA; bears are absent in SD but black bears are present in PA. Carcasses in SD include bison, mule and white tail deer, pronghorns and elk. Taxa in this study are analogous to many of those in the North American Pleistocene. Both identity of scavengers and order of access are significant in determining how a carcass is processed. Season of death affects the speed and nature of scavenging; insects are inactive in winter but may be the sole scavengers of spring- and summer-derived carcasses. Decomposition processes occur more slowly, or are suspended, in colder weather. In warmer weather, processes occur rapidly; a carcass may be consumed within days in summer, whereas a winter-derived carcass may remain essentially intact for months. Once scavenging commences, however, it will continue despite cold and snow. Snow cover up to 13" deep does little to deter scavenging if scavengers had already discovered a carcass prior to burial. In contrast, even if turkey vultures or crows have begun consuming a carcass, insect infestation will curtail all other scavenging activities.

Poster Session III, (Tuesday)

PALEOENVIRONMENTAL RECONSTRUCTION OF BULUK, EARLY MIOCENE, KENYA

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Early Miocene deposits at Buluk, northern Kenya, contain an important record of mammalian evolution during the initial stages of East African rifting. Buluk is a well known site for primate evolution, as the locality yields remains of primitive Old World monkeys and apes. In addition, recent work at Buluk has documented the presence of several productive vertebrate aggregations, or bone beds, which both further characterize the mammalian fauna and also help refine the paleoenvironmental reconstruction of Buluk. The bone beds are matrix-supported conglomerates with vertebrate remains, occasional plant fragments, and reworked tuff and paleosol deposits. Collections from these bone beds include disarticulated elements of gomphotheres, deinotheres, rhinocerotids, suoids, small artiodactyls, carnivores, creodonts, and primates (both cercopithecoid and hominoid). Preliminary work indicates that each bone bed represents a high magnitude fluvial discharge, perhaps implying seasonal, or longer term patterns in precipitation associated with changing topography during early stages of East African rifting. Isotopic analysis of large mammal dentitions is underway to detect potential seasonal patterns in stable isotope composition, testing this hypothesis inferred from the sedimentological record. Work at Buluk forms part of the Turkana Basin Institute's larger initiative into the "Origin of Rift Valley Ecosystems" (ORVE), a research program comprising a number of paleontological projects sharing data to address larger, regional issues in mammalian, primate and human evolution. Studies at Buluk contribute to the goals of ORVE by providing: 1) a more comprehensive understanding of the effects of rifting on the distribution of Miocene mammalian and primate faunas; 2) better documentation of the transition from archaic to modern African animals; and 3) a more complete understanding of the origin and evolution of apes and catarrhine monkeys. Results from work at Buluk are important because tectonically-driven habitat fragmentation during the Miocene may be at the root of the evolution of modern primate and human forms.

Technical Session IX, Tuesday 11:15

SPATIAL DYNAMICS AND STRUCTURE OF THE NORTH AMERICAN PLEISTOCENE MEGAFAUNAL EXTINCTION

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Changes in the geographic distributions of taxa prior to extinctions can provide insight into the mechanisms and velocities of those events. Here, we investigate the spatial structure of Pleistocene megafauna for significant changes in the distributions of genera (and species of *Mammuthus*) across the contiguous United States immediately prior to their extinction. Analyses concentrate on genera with the most prolific record at the terminal Pleistocene (*Nothrotheriops*, *Camelops*, *Equus*, *Mammut*, *Mammuthus*). Stratigraphic and radiocarbon-dated occurrences of extinct genera are obtained from the Neotoma and Paleobiology Databases. Radiocarbon-dated occurrences defining the terminal Pleistocene are collected from the literature and vetted for temporal reliability. Occurrence data are divided into three periods; Early/Middle Pleistocene, Late Pleistocene, Terminal Pleistocene (TP; 12,000 - 10,000 radiocarbon years), and spatially standardized to remove geographic biases. We use Monte Carlo simulations to test the spatial distribution of genera in the TP relative to earlier periods, allowing differentiation of biological processes from sampling effects. Simulations develop null expectations for changes in range size (minimum convex polygons), location, and range overlap between taxa. Ecological Niche Models (MAXENT) provide a separate test of the ecological (environmental) significance of range divisions/overlap among taxa. Simulations show that many previously reported species range shifts leading to the TP are indistinguishable from changes in sampling. Large-scale spatial reorganizations at the TP are evident, however, particularly for species within *Mammuthus* and an abrupt, significant geographic differentiation between *Mammuthus* and *Mammut*. Niche models support these ecological divisions. For many genera, spatial distributions at the terminal Pleistocene are not distinguishable from earlier times. While further work is required to test for finer-scale shifts in distribution, many non-Proboscidean taxa may not have had a significant geographic response prior to the TP; experiencing spatially-uniform extinction across baseline Pleistocene ranges.

Poster Session IV, (Wednesday)

SAMPLE ANALYSIS OF *ARCHAEOTHERIUM* (ARTIODACTYLA: ENTELODONTIDAE) FROM THE CONATA PICNIC GROUND "BIG PIG DIG", BADLANDS NATIONAL PARK, SOUTH DAKOTA

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Cranial variation in members of *Archaeotherium* (Mammalia, Entelodontidae) has caused wide discrepancies in the diagnoses of many included species. Since 1993, thousands of associated elements of *Archaeotherium* have been excavated from the lower Scenic Member of the Brule Formation (Orellan North American Land Mammal Age) at the Conata Picnic Ground "Big Pig Dig" site in Badlands National Park, South Dakota. Better understanding of the variation in *Archaeotherium* from the Conata Picnic Ground, through principle component analysis (PCA), revealed new insights into the taxonomy of the genus. The specimens of *Archaeotherium* represent a sample population and were analyzed utilizing PCA and statistical analyses, and given ontogenetic stages based on tooth wear. Morphologic features previously thought to be taxonomically significant (shape and size of the suborbital process, and mandibular tubercles) are discussed and refuted to be of any taxonomic importance for *Archaeotherium.* Rugosity above the orbits and on the frontals is thought to be characteristic of "male" *Archaeotherium* and is absent in "female" specimens. Crania from the "Big Pig Dig" have been referred to *Archaeotherium mortoni* and *Archaeotherium wanlessi.* This analysis indicates the first instance of multiple species of Entelodontidae from a single locality.

Technical Session VII, Monday 2:15

ONTOGENY AND PHYLOGENY IN PROCOLOPHONIDS - EVIDENCE FROM A NEW LEPTOPLEURONINE FROM THE MIDDLE TRIASSIC OTTER SANDSTONE OF SIDMOUTH, DEVON

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A new procolophonid specimen raises the possibility that some characters used in phylogenetic analyses of the group may changeduring ontogeny. It comprises an isolated small skull and attached mandibles from the Middle Triassic Otter Sandstone Formation near Sidmouth, Devon, England. The specimen was partly prepared and then studied using X-ray microCT imaging. The taxon appears generally similar to the later *Leptopleuron* from the Lossiemouth Sandstone Formation of Scotland. The presence of quadratojugal and supratemporal spikes, the massive first dentary incisor and the absence of maxillary depression, all suggest a derived leptopleuronine. However it is more primitive than all other leptopleuronines in the possession of rows of vomerine teeth and the absence of the jugal spikes found in some derived taxa. The small size of the specimen, together with the open sutures and absence of jugal spikes suggest that it may be a juvenile, although the supratemporal and quadratojugal spike array is fully developed. The presence of vomerine teeth may thus also be a juvenile character. The absence of the back of the skull, combined with the mandibles clamped in place, suggests that it may have been bitten off and rejected during predation.

Poster Session IV, (Wednesday)

NEW EARLY EOCENE PERISSODACTYL FAUNAS FROM THE CONTINENTAL UPPER GHAZIJ FORMATION OF BALOCHISTAN, PAKISTAN

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The phylogenetic and biogeographic origins of the mammalian order Perissodactyla remain elusive despite a long history of research. Many studies have focused on Asia, with at least some recent hypotheses suggesting a prominent role for poorly known faunas of the Indian subcontinent. Two or possibly three early Eocene perissodactyl faunas are known from the upper Ghazij Formation in Balochistan (Pakistan), and these include both dental and post-cranial remains.The most abundant are small forms, including 108 dental specimens from a single locality, Gandhera Quarry, that belong to two closely similar species of Isectolophidae. Among larger taxa, the most common elements represent a puzzling group of bunodont perissodactyls that display some similarities to both the supposed anthracobunid *Nakusia* from the marginal-marine middle Ghazij Formation and to the enigmatic middle Eocene perissodactyl *Hallensia* from Europe. Brontotheriidae are represented by three species in two genera that are morphologically similar to primitive forms known from the North American middle Eocene (Bridgerian). A *Lophialetes*-like ceratomorph and *Litolophus*-like chalicothere are rare elements in the faunal assemblage, but they do indicate affinities with middle Eocene Asian assemblages.Ghazij mammals, together with those from Vastan (India), are currently the only early Eocene taxa from the Indian Subcontinent. With the possible exception of the Cambaytheriidae described from Vastan, the Ghazij material represents the oldest known perissodactyls from this region. Taken as a whole, the new Ghazij perissodactyls represent a broad taxonomic diversity, and further study promises to increase our understanding of perissodactyl phylogeny. Ghazij perissodactyls clearly suggest faunal exchange between the Indian subcontinent and most or all of the northern continents, and they thus have biogeographic importance as well.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

THE FUNCTION AND EVOLUTION OF CANALS IN THE TEETH OF THE TRIASSIC ARCHOSAURIFORM *UATCHITODON*

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A rash of recent discoveries has revolutionized our understanding of the evolution of oral toxins, showing that these complex biological systems are far more widespread than previously appreciated. Despite this increase in research, the driving forces behind the evolution of such costly systems are still poorly understood. I report here on a detailed analysis of the venomous archosauriform *Uatchitodon*, known only from teeth from the Upper Triassic of Virginia, Arizona, and North Carolina, with comments and comparisons on the variation seen in tooth shape between the three sites from which it is known, and rigorous statistical analyses of the coordinated morphological characters within the teeth from the Moncure, North Carolina locality. The new material from North Carolina allowed the confirmation of three autapomorphies of the genus (teeth that are three times taller than wide, compound serrations, and a medial infolding on the lingual and labial surfaces) that support the previously suggested assignment of the Arizona specimens to the genus *Uatchitodon* but not to the species *Uatchitodon kroehleri.* The different hypotheses for the origin and function of the canals in *Uatchitodon* and several other taxa were rigorously evaluated, and several explanations (wear, developmental, and mechanical) for the canals in *Uatchitodon* were rejected, leaving venom-conduction as the most likely hypothesis. A methodology was established to quantify relative tooth position in the jaw based on the angle of the carinae, and this measure was used to reject a positional explanation (N: 20, R^2-adj: 8.7%, p: 0.730). Further, a model was created to predict total tooth size in *Uatchitodon* from fragmentary teeth and used this to reject an ontogenetic/developmental (N: 25, R^2-adj: 9.0%, p: 0.140) explanation for the observed canal shape variation. The only remaining hypotheses are thus regional differentiation or evolutionary adaptation, though qualitative evidence suggests regional differentiation should be rejected. As such, I propose that the morphotypes of *Uatchitodon* represent a good model for testing hypotheses about the evolution of venom delivery systems in amniotes.

Technical Session XV, Wednesday 11:45

MICRO-CT SCANNING TECHNOLOGY REVEALS DEVELOPMENT OF DIPLOSPONDYLY IN *AMIA CALVA*

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Amia calva is a modern representative of largely extinct fishes that have two centra per vertebral segment (=diplospondyly) in the posterior part of the trunk. Diplospondyly is also prominent among basal tetrapods, and developmental understanding of this morphologymay enlighten the origins of tetrapod lineages that independently achieved a monospondylous axial column. We used a Micro-CT (CT=X-ray computer tomography) scanner to image skeletogenesis of *Amia*. The CT technique provides the following advantages that complement classic staining methods: 1) 3D data for purposes not restricted to the detection of a single tissue type; 2) slice-by-slice digital imaging as a non-destructive alternative to histological sectioning; and 3) quantitative comparison of tissue densities. In *Amia*, a morphological identity between the pre- and postcentra suggests that morphogenesis of individual centra is independent from the axial patterning. Therefore, this is not a homologous condition with basal tetrapods, in which vertebral morphogenesis requires information from the axial patterning. The pre- and postcentra are already separate at the initial stage of ossification. The vertebral centra form from the dorsal and ventral centres that are eventually connected by the chordacentral layer.We hypothesize that the diplospondyly of *Amia* arises from delayed resegmentation of sclerotomic halves. Vertebrate axial morphogenesis undergoes resegmentation, during which the posterior half of one sclerotome and the anterior half of the next join to make a vertebral segment. *Ephrin* (*eph*) establishes the polarization within a somite and promotes the epithelial boundary between the sclerotomic halves. Therefore, prolonged expression of *eph* may delay resegmentation with respect to vertebral skeletogenesis, and each ossification centres in an isolated sclerotomic half would take on the morphology of a centrum. A further test would be to stain the motor neurons, which are morphological markers for *eph*-mediated somite polarization, and to line this up with the clear-stained vertebral column. Over-expression of *eph* in zebrafish may induce diplospondyly, which would also support our hypothesis.

Poster Session III, (Tuesday)

FIRST DISCOVERY OF EOCENE PRIMATES FROM JAPAN: THE EARLIEST RECORD OF SIVALADAPIDAE

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The oldest known Cenozoic mammals from Japan are recorded from the Eocene Akasaki Formation (Amakusa area, Kumamoto Prefecture) and the stratigraphically equivalent Nakakoshiki Formation (Koshiki Islands, Kagoshima Prefecture), western Kyushu. The fossiliferous horizons in these rock units are close to the early/middle Eocene boundary in age. Recent fieldwork has revealed a high level of diversity in the mammalian assemblages from these formations, including at least 18 species from nine orders: Tillodontia, Pantodonta, Condylarthra, Perissodactyla, Artiodactyla, Insectivora, Carnivora, Rodentia, and Primates. The new adapiform primate reported here is represented by an isolated right lower molariform tooth (either m1 or m2) from the upper part of the Akasaki Formation. This is the first Eocene record of primates from Japan. The tooth (approximately 4.3 mm in length) has an anteroposteriorly narrow trigonid with distinct protoconid and metaconid. The paraconid is reduced, sharp and crestiform; it is situated anterobuccal to the metaconid. The talonid is broad with an open talonid notch and a roughly V-shaped buccal wall formed by the straight cristid obliqua and postcristid. A distinct shelf forms the base of the hypoflexid. The hypoconulid and entoconid are similar in size, and both cusps are situated close together ("twinned") at the posterolingual corner of the crown. There are pre- and postcingulids, but no continuous buccal cingulid is present. These features, particularly the strongly twinned hypoconulid and entoconid, indicate a taxonomic assignment to the Sivaladapidae. The Japanese taxon has a more derived molar morphology than that of the primitive sivaladapids *Rencunius* and *Hoanghonius* from the late middle Eocene of China, being more similar to the later occurring sivaladapines *Sivaladapis* and *Sinoadapis*. The specimen also possesses a cristid obliqua that extends anterolingually to meet the metaconid, which is a character unknown in any other sivaladapid taxon. Although further material clarifying its phylogenetic position is required, the new specimen indicates an earlier diversification of sivaladapids than has been suspected previously.

Poster Session I, (Sunday)

THE POSTCRANIAL SKELETON OF THE AQUATIC PARAREPTILE *MESOSAURUS TENUIDENS* FROM THE GONDWANAN PERMIAN

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The postcranial skeleton of *Mesosaurus tenuidens*, a reptile from the Lower Permian of eastern South America and southern Africa, is redescribed and illustrated in detail. A new skeletal reconstruction of *M. tenuidens* is presented. The number of presacral vertebrae varies in *M. tenuidens* from 29 to a maximum of 33, which falls just short of the maximum (34–35 presacrals) known in its close relative *Stereosternum tumidum*. A cleithrum is reported for the first time in a mesosaur. The head of the interclavicle is triangular, rather than diamond-shaped as in other basal reptiles, including *S. tumidum*. The carpus of *M. tenuidens* is apomorphic in that the intermedium and the lateral centrale are co-ossified. The lateral centrale pedis is absent. Reappraisal of the aquatic adaptations of *M. tenuidens* suggests strongly that this reptile was fully dedicated to an aquatic lifestyle. Pervasive pachyostosis of the postcrania probably allowed animals to maintain neutral buoyancy in the uppermost 3–4 m of the water column. Additionally, such pachyostosis may have helped to control rolling at the surface, or perhaps served to maintain forward momentum during periods of gliding while moving underwater. Limited movement at the elbow and the ankle suggests that *M. tenuidens* could not walk on land, but individuals may have been able to push themselves across terrestrial substrates, perhaps in a manner analogous to that seen in female extant marine turtles on nesting beaches.

Technical Session XVII, Wednesday 4:00

LATE CRETACEOUS PALEOENVIRONMENTS OF THE GOBI DESERT: RECONSTRUCTIONS FROM STABLE ISOTOPES OF DINOSAUR FOSSILS

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Lithological descriptions indicate that the depositional environment of the Late Cretaceous Djadokhta Formation of the Gobi Desert of Mongolia was a sparsely vegetated, semi-arid dune field. The relatively structureless red sandstones of this formation have yielded a high diversity of exquisitely preserved Cretaceous reptiles (including dinosaurs) and mammals. To date, the remains of most Mesozoic vertebrates, especially dinosaurs, have not been analyzed using oxygen and carbon stable isotopes, despite the fact that this method is commonly used to help determine the paleoecosystems of Cenozoic mammals. To begin remedying this deficiency, we analyze carbon and oxygen isotopes ($\delta^{13}C$ and $\delta^{18}O$) of dinosaur tooth enamel and eggshell, composed of bioapatite and calcium carbonate respectively, from the Djadokhta Formation. Specifically, we analyze eggshells of predominantly herbivorous oviraptors, including eggs associated with skeletal specimens of *Citipati osmolskae*, and the teeth of ubiquitous herbivorous dinosaurs such as *Protoceratops andrewsi*. Carbon isotope values provide information about the local vegetation structure through diet (plant consumption), while oxygen isotope values indicate the characteristics of the dinosaurs' drinking water sources, which reflect regional precipitation and climate. Statistical comparisons of the isotope ratios between different types of material, such as tooth dentine, tooth enamel, bone, and eggshell, along with cathodoluminescence analysis of dinosaur eggshell are used to demonstrate that primary isotopic data are preserved in these samples and that diagenesis has not overwhelmed the original isotopic signals. Carbon isotope values indicate that the dinosaurs were subsisting on plants that fall within the $\delta^{13}C$ range of modern C_3 plants and drinking from pools with highly evaporated water, both of which are potential indicators of a semiarid climate.

Technical Session XII, Tuesday 2:15

A NEW BAURUSCHID (CROCODYLIFORMES, SEBECOSUCHIA) FROM THE BAURU GROUP, LATE CRETACEOUS OF MINAS GERAIS, BRAZIL

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Baurusuchids are deep-snouted crocodyliforms typical of the South American continental Late Cretaceous. They are traditionally included in Sebecosuchia, a group with controversial composition and phylogenetic relations. This leads to ambiguity in the establishment of their temporal and geographic ranges, hampering evolutionary inferences. The new baurusuchid reported here was collected near the town of Campina Verde, Minas Gerais, Brazil, from sandstone deposits that may be assigned to the Vale do Rio do Peixe Formation. This stratigraphic unity corresponds to most of the Adamantina Formation in more traditional subdivisions of the Bauru Group, which has been alternatively dated as Turonian-Santonian or Campanian-Maastrichtian. Among other possibly associated specimens, the material comprises a nearly complete skull, lacking only the premaxillary portion of the rostrum. It can be assigned to Baurusuchidae based on traditionally recognized traits of the group, i.e.: deep and laterally compressed rostrum, reduced maxillary dental formula, and ziphodont dentition (teeth strongly compressed laterally, with finely serrated mesial and distal carinae), as well as on putative synapomorphic traits, such as a median crest in the posterior portion of frontal, a median approximation of the prefrontals, a distinct depression on lateral surface of the quadrate body, and the existence of a median depression on the palatine flanked by rows of foramina. These shared traits correlate the new taxon to forms such as *Baurusuchus pachecoi*, *B. salgadoensis*, *Stratiotosuchus maxhetchi*, and *Wargosuchus australis*. In addition, the skull exhibits a combination of features not previously recognized among sebecosuchians, including a depression on the anterior portion of frontal, a foramen between the palpebrals, the ectopterygoid reaching the posterior margin of the pterygoid wings, one ventral pterygoid fenestra, and two ventral pterygoid depressions. Finally, a remarkable autapomorphy (a deep depression on the dorsal surface of the pterygoid wings) justifies the referral of the skull to a new species of Sebecosuchia, enlarging the available morphological data for this group of Crocodyiformes, the understanding of which has been considered to suffer from the paucity of well preserved fossil material.

Poster Session III, (Tuesday)

ASSESSING THE CHARACTERISTICS DEFINING THE TAPHONOMIC MODE OF VERTEBRATE FOSSIL ASSEMBLAGES USING ORDINATION ANALYSIS

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A taphonomic mode has been defined as a recurring pattern of preservation of organic remains in a particular sedimentary context, accompanied by characteristic taphonomic features, produced by the sum total of the taphonomic processes acting on a particular fossil assemblage. By examining the suites of taphonomic characteristics shared by all fossils preserved in assemblages from a range of different sedimentary contexts, it is possible to identify which, if any, taphonomic signatures are characteristic of those sedimentary contexts. With this information it becomes possible to test whether the concept of taphonomic modes can be applied to vertebrate fossil assemblages, or whether the taphonomic histories of each fossil assemblage are so unique that every assemblage must be treated as a separate taphonomic entity. Using non-metric multidimensional scaling (NMDS) ordination of taphonomic characteristics from five samples drawn from the Scenic Member of the Brule Formation, the Wayan, Blackleaf and Judith River Formations, it is possible to show that the assemblages that were preserved in point-bar or other channel deposits do show a different taphonomic signature to the assemblages deposited on floodplains. Much of this difference, however, is attributable to the differing size of the taxa comprising the assemblage, a characteristic that is at least partially a product of ecological rather than preservational factors. In addition, despite potential variation in palaeosol style and development, the ranges of taphonomic characteristics shown by all of the floodplain assemblages are very similar.

Technical Session XVI, Wednesday 3:45

SACRAL FUSION IN MODERN AND FOSSIL CETACEA

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The functional morphology and vertebral fusion pattern of the mammalian sacrum changed during the evolution of marine mammals from land mammals. We use paleontological and molecular data to analyze the morphological and genetic changes in the evolution of the cetacean sacral region in fossil and modern cetaceans. The sacrum in land mammals plays a major functional role in anchoring the hindlimb to the vertebral column. Cetaceans lack a functional hindlimb, lack articulation between the pelvis and the vertebral column, and the vertebrae of the sacral region are not fused together. Paleontological evidence for the evolution of the sacrum in cetaceans abounds. The artiodactyl relatives of cetaceans had four firmly synostosed vertebrae, with a large auricular surface (joint for the pelvis) attached to the centrum of the first sacral vertebrae.This morphology also occurs in the lowest branches of the cetacean cladogram: *Pakicetus*, *Ambulocetus*, and *Kutchicetus*. In basilosaurids, the sacrum consists of a single vertebra lacking a bony connection to the pelvis. In some remingtonocetids and protocetids, sacra with fewer vertebrae occur, and with auricular surfaces placed laterally, far from the centrum. Some modern cetacean species, such as *Stenella attenuata* (pantropical spotted dolphin), at fetal stage 21/ 22, exhibit larger vertebral ossification centers adjacent to the pelvis in the spinous processes and centra. This vertebral ossification pattern is continued through fetal stage 23. This suggests that the molecular signals responsible for forming the sacrum are still present in the modern cetacean vertebral column, advancing the ossification in the sacral region, without ever developing a sacrum. The gene expression responsible for sacral development can be identified using molecular techniques, such as immunohistochemistry, on modern cetacean vertebral samples. Combining paleontological, embryological, developmental, and anatomical evidence can greatly improve our understanding of functional pattern and process in whale evolution.

Technical Session XVII, Wednesday 3:30

PRELIMINARY DETRITAL ZIRCON AGES FOR THREE STRATIGRAPHIC UNITS OF THE CEDAR MOUNTAIN FORMATION AND STATISTICAL ANALYSES OF ITS FAUNAS

MORI, Hirotsugu, Brigham Young University, Provo, UT, USA; BRITT, Brooks, Brigham Young University, Provo, UT, USA

The Cedar Mountain Formation (CMF) spans some 25 Ma and contains a diverse record of Early Cretaceous dinosaurs that records a shift from a North American/European fauna to an Asian influenced fauna. Studies of the formation's faunas, however, are hindered, in part, because the stratigraphy and geochronology are in the early stages of development. The CMF has been parceled into five members. The basal members (Buckhorn Conglomerate, Yellow Cat and Poison Strip Sandstone) represent different facies of a single depositional system, which is overlain by a middle member (Ruby Ranch), and an upper member (the Mussentuchit). To help resolve correlation problems LA-ICP-MS detrital zircon (DZ) ages were obtained. Ages indicate basal strata in eastern Utah are no older than 124 to 122 Ma (early Aptian) and contain *Utahraptor*, *Falcarius*, *Gastonia* and diverse sauropods. Preliminary data suggest the Ruby Ranch Mbr. with a sparse fauna that includes a brachiosaurid (e.g. Long Walk Quarry) ranges from ~116-112 Ma (early-mid Albian). The Mussentuchit fauna is diverse and includes, in part, *Abydosaurus*, *Eolambia*, and large ankylosaurs (e.g., *Cedarpelta* & *Peloroplites*). The basal Mussentuchit is no older than 104.5 Ma (late Albian) and the upper Mussentuchit dates to 97 Ma (early Cenomanian) or younger based on DZ and 40Ar/39Ar dates.Faunas of each member were analyzed by multivariate analyses utilizing Simpson and Raup-Crick similarity index and pair-group moving algorithms resulting in the recovery of only two faunas – a basal fauna and a Ruby Ranch+Mussentuchit fauna. These faunas were compared with coeval faunas from North America, Europe and Asia as well as the Morrison Fm. Results indicate the basal CMF fauna shares a weak link with the Morrison and corroborates long-standing hypotheses that the Yellow Cat fauna has European ties and the Mussentuchit fauna has ties with other North American faunas and Asia. The Yellow Cat equivalent European fauna is characterized by Spinosauridae and Polacanthidae, while Mussentuchit-North America equivalent Asian fauna is characterized by Tyrannosauridae, Troodontidae, Ornithmimosauria, Nodosauridae, Ankyrosauridae, and Ceratopsia.

Poster Session II, (Monday)

PALEOECOLOGY OF LATE PLEISTOCENE SNAKES AND SALAMANDERS FROM PARKER'S PIT CAVE IN THE BLACK HILLS, SD

MOSCATO, David, Penn State University, University Park, PA, USA; GRAHAM, Russell, Penn State University, University Park, PA, USA

Parker's Pit, located in the Black Hills of South Dakota, is a natural trap cave that is rich in vertebrate fossils from the Holocene and Late Pleistocene. This cave fauna is useful for studying community responses to the dramatic climate fluctuations that are characteristic of the Pleistocene-Holocene transition. This type of faunal change is well-documented in mammals; however, relatively little research on this topic has been directed toward reptiles and amphibians. Parker's Pit contains an abundance of herpetological material which provides an opportunity to study these fauna in the context of Pleistocene-Holocene climate change. In this study, analysis of the snake and salamander fossils from this cave site reveals a paleoherpetofauna similar to what one would find in the southeastern grasslands of modern-day South Dakota. These data also provide evidence for range adjustments in certain snake taxa in response to environmental change. Furthermore, dominance of northern-dwelling taxa in older sediments is consistent with current knowledge about the warming climate at the end of the Pleistocene. A prominent spike in the abundance of northern-dwelling taxa in certain Parker's Pit sediments may represent the Younger Dryas cooling event.

Technical Session XI, Tuesday 3:15

EXPERIMENTAL DIAGENESIS OF BONE: IMPLICATIONS FOR RARE EARTH ELEMENT UPTAKE AND STABILITY

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Geochemical taphonomy of vertebrate fossils is a growing field in the disciplines of geology and paleontology. Proper experimental characterization of the early stages of fossilization and diagenesis is required to make accurate interpretations when studying fossilized vertebrate remains. The primary goal of this research was to characterize the early fossilization process with respect to rare earth element (REE) uptake and stability in bioapatite. To investigate the early fossilization of buried bone, an 18-month, controlled taphonomic experiment was conducted. Sections of *Bos taurus* femora were prepared and processed into experimental reactors (32 oz. sealable jars) containing artificial soil and buffered to a range of pH conditions. REE chemistry of bioapatite samples at the termination of the experiment were compared to initial conditions so that interpretations could be determined regarding uptake rates and stability of REE in bioapatite samples. Results suggest that REE concentrations in

fossil bone are not stable if it is subjected to a new diagenetic environment. However, the primary REE signatures and their usefulness as taphonomic proxies may be retained. The pH conditions of the sediment pore water upon immediate burial have a greater influence on the REE concentrations and signatures than do the pH conditions at the end of the experiment, indicating that the initial conditions fractionated and controlled the availability of REE and the interactions between bone and the burial microcosm for the duration of the experiment. Noticeable elevation in REE concentrations in fresh bioapatite samples occurred between the 6th and 9th months of the experiment, coinciding with the diminishment of obvious microbial activity and the beginning of slow and steady increases in pH. This study demonstrates the importance of experimental studies in geochemical taphonomy and has important implications for interpretations utilizing the geochemistry of bioapatite.

Technical Session I, Sunday 8:45

PHYLOGENETIC BIAS IN FORM-FUNCTION RELATIONSHIPS AND ITS IMPLICATION TO THE FREQUENCY OF NOCTURNAL DINOSAURS

MOTANI, Ryosuke, University of California, Davis, Davis, CA, USA; SCHMITZ, Lars, University of California, Davis, Davis, CA, USA

Phylogeny is deeply pertinent to comparative biology because common ancestry mandates that characters in sister species covary at least partly. This violates the regular statistical assumption that data points are independent of each other, requiring bias removal using methods such as Phylogenetically Independent Contrasts or Phylogenetic Generalized Least Square. Functional morphologists often assume that functional characters are devoid of phylogenetic biases because the morphology of such characters is strongly governed by physical 'requirements' to perform functions. We tested this hypothesis by using the relationship between eye morphology and Diel Activity Patterns (DAP, such as diurnal versus nocturnal) in amniotes. It is known that ocular morphology reflects the typical light level of the animal. We previously found that a tight correlation between the two allowed discrimination of DAP based on ocular dimensions of amniotes. Soft tissue dimensions in particular revealed a very high discrimination success rate, suggesting an unusually tight form-function correlation.

We devised a phylogenetically informed discriminant analysis and measured the strength of phylogenetic bias using Pagel's □. Results suggest that a small degree of phylogenetic bias exists in this form-function relationship. Soft-tissue dimensions exhibited the highest correlation with DAP when 6% of phylogenetic bias expected from Brownian motion was removed. The value for hard-tissue data was 10%, indicating a slightly stronger bias. Given that even the soft-tissue data had phylogenetic bias, the hypothesis was rejected.We further examined how much effect such a small degree of phylogenetic bias may have on discrimination of DAP. Using the hard tissue data, we found that discrimination success rate did not improve when phylogenetic bias was removed but the membership of each functional category in the resulting classification changed. This affected our inference of DAP in fossil archosaurs. Most significantly, the number of nocturnal dinosaurs increased from one to eight. It now appears that it was not uncommon for dinosaurs to utilize the nocturnal niche.

Technical Session IX, Tuesday 10:45

EARLY HOLOCENE FAUNA FROM A NEW SUBFOSSIL SITE: CHRISTMAS RIVER, SOUTHCENTRAL MADAGASCAR

MULDOON, Kathleen, Dartmouth Medical School, Hanover, NH, USA; RASOAMIARAMANANA, Armand, Université d'Antananarivo, Antanananarivo, Madagascar; ARONSON, Adam, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Duke University, Durham, NC, USA; WRIGHT, Patricia, Stony Brook University, Stony Brook, NY, USA

The subfossil record of Madagascar demonstrates that several extant species currently restricted to humid forests once had more widespread geographic distributions. An east–west distance effect in extant mammal distributions has likewise been interpreted as evidence that faunal exchange routes once crossed the southern portion of the Central Highlands, although no subfossil localities have previously been known from this region of the island. We report on faunal remains recovered during recent exploration at Christmas River, south-central Madagascar. Christmas River is the only subfossil locality known from Madagascar's south-central plateau. All fauna recovered from this locality are therefore first known regional occurrences. Christmas River is also unique among previously known subfossil localities because it offers stratigraphic resolution. The deepest stratigraphic layer reached was a grey-green clay containing the bones of several extinct taxa dated to approximately 10 thousand (kyr) B.P., including crocodiles, tortoises, the elephant bird *Aepyornis*, and abundant remains of the dwarf hippopotamus, *Hippopotamus lemerlei*, a subfossil species previously recovered almost exclusively from coastal areas in eastern and western Madagascar. The extinct lemur *Megaladapis* was recovered from lower levels, but did not have enough collagen to produce an accurate date using radiocarbon methods. The presence of coastal (*H. lemerlei*) and forest-adapted (*Megaladapis* sp.) species at Christmas River supports the hypothesis that forest once extended across the Central Highlands towards the west. It has been hypothesized that this corridor was fragmented by shifts in vegetation associated with climatic change, but given that much of the natural habitat across this zone no longer exists, it is difficult to reconstruct its former extent. The faunal material from Christmas River thus provides a remarkable opportunity for deciphering ecological changes that have taken place in south-central Madagascar during the Holocene.

Poster Session IV, (Wednesday)

NEW FUNCTIONAL SIGNIFICANCE OF THE PREDENTARY BONE IN HADROSAUROID MASTICATION

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The predentary is a single bone found in all ornithischian dinosaurs. Located anterior to the paired dentary bones of the mandible, it occludes with the premaxilla (or rostral bone in ceratopsians). Although universally accepted that the predentary was used like the lower incisors of herbivorous mammals in nipping vegetation before processing it, its absence in fossil and extant herbivorous mammals and many other fossil herbivores (including sauropodomorphs) indicates that we have yet to fully understand the functional significance of this element. The articular surfaces between the predentary and dentary and other mandibular elements as well as tooth wear orientation under light microscopy were examined in various hadrosauroids. Widened expansions and bifurcated processes on the predentary as well as an absence of a firm, clasping junction with the dentary (or between the dentaries themselves) permit mobility at this junction. A distinct medial curvature of the anterior portion of the dentary, medially recurved coronoid processes, and ball-and-socket articulation between the quadrate and mandible suggest a rotating surface and range of movement with cartilage or ligaments at the predentary-dentary junction, which in turn allow medial torsion or rotation of both dentary bones independent of the predentary. Two different orientations of tooth wear on the serrated edges and occlusal surfaces suggest both propalinal jaw movement to shear vegetation initially and a bolt-cutter-like medial rotation of the dentaries against the maxilla. This would maneuver the vegetation into the oral cavity independently on both sides for more efficient processing. To simulate this mechanism, casts of *Parasaurolophus* tooth batteries were manipulated to recreate this motion using a cedar branch as modeled food. This showed positive results in simultaneously shearing bark and phloem, much like a circular saw blade, as well as cutting the needles and manipulating them into the mouth. Predentary evolution, at least in hadrosauroids, is likely linked to selection for more efficient oral processing.

Technical Session III, Sunday 3:15

NEW PRIMATES (OMOMYIDAE) FROM THE GREAT DIVIDE BASIN, WYOMING

NACHMAN, Brett, The University of Texas at Austin, Austin, TX, USA; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA; ANEMONE, Robert, Western Michigan University, Kalamazoo, MI, USA

Recent fieldwork by a team of paleontologists and geologists working in Eocene deposits of the Great Divide Basin (GDB), Wyoming, revealed an exceptional new locality preserving a large and diverse mammalian fauna. This new locality (WMU-VP-2009-01) preserves a rich primate assemblage that consists of more than 30 jaws and numerous isolated teeth. Taphonomically, the locality is unique in the GDB. The vast majority of GDB localities are comprised of isolated teeth and fragmentary jaws, with the presence of small-bodied mammals being rare. This locality, in contrast, is dominated by small-bodied mammalian fossils and the preservation quality is excellent, with most of the jaws preserving 3-5 teeth. Geologic study of the locality suggests rapid deposition in a high-energy flood environment. In addition to the differences in taphonomy, there are also differences in faunal composition. WMU-VP-2009-01 is quite different from other Wasatchian localities in the GDB in that the primate fauna is not dominated by adapids. Though one species of adapid is present (*Cantius cf. mckennai*) the overwhelming majority of the primate fossils are omomyids. Taxonomic study of the omomyid fossils recovered from WMU-VP-2009-0 has identified three distinct species of omomyid. The first of these is a primitive, possibly new species of *Anemorhysis* (n=4). The second species is similar to *Teilhardina* (n=9), though it shows some intriguing similarities to the washakiins. The third, *Tetonius sp.* (n=19), closely resembles Stage 2 of the proposed anagenetic *Tetonius-Pseudotetonius* transition. Placement of the *Tetonius* specimens within Stage 2 is an important biostratigraphic marker for this assemblage. In the Bighorn Basin, located to the NE of our study area, Stage 2 of the *Tetonius-Pseudotetonius* transition is located in the lower part of Wa-4.

Poster Session I, (Sunday)

FOSSIL MARINE VERTEBRATES FROM THE UPPER CRETACEOUS HARTLAND SHALE IN SOUTHEASTERN COLORADO

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The Hartland Shale Member of the Greenhorn Formation is a sedimentary rock unit that was deposited under the middle of the Western Interior Seaway in North America approximately 94.3 Ma (Late Cretaceous: middle Late Cenomanian). Fossiliferous rock samples were collected from the Hartland Shale in southeastern Colorado in order to analyze the taxonomic composition of its vertebrate fauna. Vertebrate remains were extracted through acid treatment of rock samples. Twenty-six marine vertebrate taxa are identified including chondrichthyan, osteichthyan, and reptilian taxa. Chondrichthyans are represented by eight species: *Ptychodus anonymus*, *Squalicorax curvatus*, *S. falcatus*, *Carcharias saskatchewanesis*, *Aechaeolamna kopingensis*, *Cretoxyrhina mantelli*, *Cretomanta canadensis*, and *Rhinobatos* sp. Osteichthyan fishes consist of 17 taxa, including *Micropycnodon kansasensis*, *Palaeobalistum* sp., *Protosphyraena* sp., Plethodidae indet., *Eloposis* sp., *Pachyrhizodus minimus*,

Pachyrhizodus sp., Albulidae indet., Caturidae indet., *Cimolichthys nepaholica*, *Enchodus gladiolus*, *E. shumardi*, *Apateodus* sp., and four unidentified teleosts. The only reptilian so far recognized is a small aquatic lizard *Coniasaurus crassidens* (Dolichosauridae). Most of these taxa have been reported from the basal Greenhorn Formation (Lincoln Limestone Member) in Kansas and Colorado in which the Kansas fauna is chronologically comparable to the Hartland Shale of Colorado. Because the identified vertebrates are mostly carnivores, including forms that fed on fishes and shelled animals, the trophic structure of the paleocommunity must have been complex.

Poster Session IV, (Wednesday)

AN ANKYLOSED MIOCENE MYSTICETE UPPER LIMB FROM THE CALVERT FORMATION OF CALVERT CLIFFS, MARYLAND

NANCE, John, Calvert Marine Museum, Solomons, MD, USA; GODFREY, Stephen, Calvert Marine Museum, Solomons, MD, USA

A left humerus, radius, and ulna of a small cetothere-grade mysticete was collected from Bed 10 (Plum Point Member, Calvert Formation, lower middle Miocene, Langhian stage) south of Plum Point, Calvert Cliffs, Maryland, USA. This specimen exhibits polyarticular ankylosis at the elbow joint; the first such report in a cetacean. The humerus and radius exhibit a seamless fusion of compact bone that completely obliterates any evidence of the articular joint. To a lesser degree, responsive bone growth at the proximal end of the ulna results in its fusion to both the humerus and radius. CT scan images of the radius show medullary necrosis within the metaphysis, presumably the result of an infarct at the time of the originating trauma. The level of maturity of the responsive bone growth suggests injury to the elbow joint early in ontogeny. Although the nature of the originating trauma is unknown, the present manifestation likely had its origin as a fractured joint and/or septic arthritis. Comminuted fractures of joints can result in destruction and fusion across those surfaces. Likewise, septic arthritis of synovial joints and epiphyses, if unrelieved, will often terminate in bony ankylosis as in this specimen. Because of the thickness and maturity of the abnormal cortical bone enveloping the elbow joint, these synostoses do not appear to have been life threatening. Immobilization of this joint would not be expected to have as detrimental an effect, if any, on the whale's overall mobility and well-being as compared to that of a terrestrial tetrapod.

Poster Session II, (Monday)

HOW A SABER-TOOTHED "CAT" GOT ITS SMALL BRAIN

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Dirk-toothed carnivores like *Barbourofelis fricki* have unexpectedly small brains for their body size. This raises an interesting evolutionary question. How does evolution produce a smaller brain over time? At least for *Barbourofelis* the answer is clear. As is the case for many other vertebrate lineages wherein early members are small-bodied and have small brains, early barbourofelins are about the size of a large lynx, with a brain size that would be expected for their body size. In contrast, the brain of *B. fricki,* the largest and latest representative of this lineage, with a body size close to that of an African lion, *Panthera leo,* is similar in size to that of the earliest small barbourofelins. Through time, the brain of barbourofelins remained largely unchanged in size, while there was an enormous increase in body size, resulting in a very low brain-to-body ratio. This suggests that the relationship between body and brain size is not automatic, but has to be maintained through natural selection. We have argued elsewhere that the hunting strategy of dirk-toothed carnivores did not require a large brain, and hence one did not evolve. The scimitar-tooth cat *Homotherium* actually has elongated legs, and must have been well-adapted for the pursuit of prey, and is more like the modern African lion in this respect. Its brain-to-body size ratio, unlike that of *Barbourofelis fricki*, is closely similar to that of *Panthera leo*. We suggest that a survey of relative brain sizes across a variety of related taxa, both fossil and living, would make it possible to tease out the ecological/behavioral component in brain evolution.

Poster Session III, (Tuesday)

A REAPPRAISAL OF BIOPROVINCIALITY IN MIDDLE AND LATE MIOCENE EURASIAN MAMMALS

NARGOLWALLA, Mariam, Department of Anthropology, University of Toronto, Toronto, ON, Canada

Previous studies of Miocene land mammals have identified a number of bioprovincial regions dividing Europe and Western Asia. The most recent of these studies was published 14 years ago and a significant number of new localities have been recognized since. Here, the results of these studies are reconsidered in light of new data. Relative completeness (CI) of Eurasian Middle and Late Miocene mammals was calculated to evaluate sampling quality, and data independence was assessed to ensure that the CIs were in fact reflective of data quality, rather than a proportionate measure of sampling interval duration or number of localities per interval. Faunal similarity was measured to determine the distribution of bioprovinces and changes in constituent faunas over time in response to environmental conditions, including regression and transgression of the Paratethys, orogeny and climate. The results of these analyses indicate that Eurasian large mammals are relatively completely sampled throughout the Middle and Late Miocene, while small mammals are incompletely sampled during two intervals when a strict measure of completeness is implemented. Among the large mammals, there is no significant relationship between either the duration of temporal intervals or the number of localities per interval and CI, while the small mammal CIs are weakly influenced by the number of sampled localities, as well as other factors. Four distinct bioprovinces are identified. First, in contrast to previous research, the degree of endemism in the Spanish mammals until ~9.5Ma distinguishes these faunas from the rest of Western and Southwestern Europe. Similarly, the endemic Italian faunas previously grouped with France and Spain are considered here to belong to their own distinct bioprovince. An expansive Central Europe bioprovince, stretching from France to Romania, as well as an Eastern Europe/Western Asia bioprovince broadly correspond to the previous studies. The patterns of endemism and dispersal in these bioprovinces have important applications as a framework to clarify the biogeography of mammals with less complete fossil records, such as catarrhine primates.

Preparators' Session, Monday 9:45

ADDRESSING A CRITICAL NEED WITHIN THE COLLECTIONS AT HAGERMAN FOSSIL BEDS NATIONAL MONUMENT: REFINED AND IMPROVED TECHNIQUES AND MATERIALS FOR THE PRODUCTION OF MULTI-SIZE, CLAM SHELL SPECIMEN CRADLES

NELSEN, Thomas, Hagerman Fossil Beds National Monument, Hagerman, ID, USA; GRASSO, Jennifer, Hagerman Fossil Beds National Monument, Hagerman, ID, USA; HAULTON, Kenneth, Hagerman Fossil Beds National Monument, Hagerman, ID, USA; GENSLER, Philip, Hagerman Fossil Beds National Monument, Hagerman, ID, USA

Hagerman Fossil Beds National Monument (HAFO) in southern Idaho contains the world's richest known Pliocene-aged fossil deposits yet discovered. Since the monument was established in 1988 the museum collections have grown to well over 50,000 paleontological specimens. Many of the larger specimens represent several hundred skeletal elements belonging to the extinct horse, *Equus simplicidens*. Though the preparation backlog of this material is far from being complete a large number of cranial and post cranial elements are prepared and stored in museum cabinets. A critical need in regards to the storage of collections was identified by the Chief Preparator and the Curator at HAFO. Though the specimens are stored on standard ¼" thick ethafoam drawer liners most require additional support for long term preservation and protection. A considerable number of specimens, primarily cranial and vertebral material, are exhibiting deterioration and breakage due to stress from inadequate support. A very large scale project was designed and put into action to address this critical need. The goal of this project was to not only provide adequate support and protection for the specimen, but also to allow the specimen to be viewed from all sides to facilitate research and exhibition, without removing the specimen from its cradle. This project started with a unique, clam-shell cradle design developed previously by myself and two others. The design was modified and refined to accommodate the needs of the HAFO specimens. By utilizing different materials and procedures, while combining technique changes, we improved the design, reduced materials, and reduced processes while in turn increasing production rates. The end result is a refined design that provides an ultra strong, lightweight housing that protects fossils, allows for easy access, is suitable for transportation and is an aesthetically acceptable option for exhibition. The presentation will focus on the design and production of the specimen cradles with a strong emphasis on specific materials and methodology. This will be a step by step coverage from start to finish utilizing in process photos along with text.

Technical Session X, Tuesday 10:30

A STEM FROGMOUTH (AVES: PODARGIFORMES) FROM THE EARLY EOCENE GREEN RIVER FORMATION AND THE EARLY DIVERSIFICATION OF STRISORES

NESBITT, Sterling, University of Texas at Austin, Austin, TX, USA; KSEPKA, Daniel, North Carolina State University, Raleigh, NC, USA; CLARKE, Julia, University of Texas at Austin, Austin, TX, USA

The early Eocene Green River Formation avifauna preserves the earliest unambiguous members of many extant avian subclades. Here, we present the second specimen of the enigmatic neoavian bird *Fluvioviridavis platyrhamphus,* a large-headed and short-footed taxon from Fossil Lake near Kemmerer, Wyoming. Although the species has been previously considered of uncertain affinities in Neoaves, the new specimen is shown to share the derived presence of a large, rounded mandible, wide, dorsoventrally compressed beak, a completely ossified palate, and dorsally projected nares with extant Podargidae (frogmouths). The systematic position of *F. platyrhamphus,* was evaluated in a parsimony-based combined phylogenetic analysis using morphology (osteology and soft tissue) and molecular sequence data (cytochrome b, c-myc ex3, and RAG-1) and including species of Steatornithidae, Podargidae, Caprimulgidae, Nyctibiidae, Aegothelidae, and Apodiformes, and the fossil forms *Paraprefica kelleri* (Messel Formation), *Prefica nivea* (Green River Formation), and *Masillapodargus longipes* (Messel Formation). We recover *F. platyrhamphus* and *M. longipes* as successive sister taxa to Podargidae (the frogmouth crown clade). Furthermore, the phylogenetic analysis supports a sister taxon relationship between Podargiformes and Steatornithidae (oilbirds) within Strisores (=Steatornithidae + Podargidae + Caprimulgidae + Nyctibiidae + Aegothelidae + Apodiformes). *Fluvioviridavis platyrhamphus* and *M. longipes* reveal that stem frogmouths had a much wider geographic range, here shown to have compassed the Nearctic for the first time, whereas crown members are restricted to Australasia. The mandible and palate of *F. platyrhamphus* and *M. longipes* demonstrate that most of the unique characteristics of the skull that have been linked to the broad gape and diet in living frogmouths arose deep in the evolutionary history of the group, in stem lineage Podargiformes. The Eocene record

of Strisores from the Green River Formation and the Messel Shale indicates that most deep divergences within Strisores had already occurred by the early-middle Eocene.

Poster Session IV, (Wednesday)

EVOLUTIONARY CHANGE IN PORCUPINES IN THE LATE MIOCENE TO PLEISTOCENE OF CENTRAL MYANMAR

NISHIOKA, Yuichiro, Primate Research Institute, Kyoto University, Inuyama, Japan; MAUNG-THEIN, Zin-Maung, Primate Research Institute, Kyoto University, Inuyama, Japan; HTIKE, Thaung, Primate Research Institute, Kyoto University, Inuyama, Japan; EGI, Naoko, Primate Research Institute, Kyoto University, Inuyama, Japan; TAKAI, Masanaru, Primate Research Institute, Kyoto University, Inuyama, Japan

The Neogene Irrawaddy sediments, mainly composed of fluviatile deposits, are widely distributed in central Myanmar. Since the early 20th century it has been known that these sediments yield silicified fossil woods and many vertebrate fossils. Here, we report new discoveries of Old World porcupine (Hystricidae; Rodentia) specimens from the Irrawaddy sediments of Chaingzauk and Gwebin areas, central Myanmar. The biostratigraphic correlations of the mammalian assemblages of these two localities suggest the latest Miocene to early Pliocene for the Chaingzauk fauna and the Pliocene to early Pleistocene for the Gwebin fauna. The Chaingzauk sediments yielded two mandibular fragments of hystricids that are assigned to a new species of *Hystrix*. This species is characterized by huge, semihypsodont, buccolingually wide cheek teeth and robust mandibular corpus. These diagnostic features indicate the species to be phyletically closer to the Mio-Pliocene *H. depereti* from Europe than to any fossil/living *Hystrix* species from Asia. On the other hand, the Gwebin sediments yielded four isolated teeth, probably representing two species: one of them is a comparatively large and semihypsodont species that best resembles *H. zhengi* from the late Pliocene of China and *H. depereti* from Europe, but differs from the Chaingzauk specimen in having the smaller crown base. This species likely fills the geographical and chronological gap between *H. zhengi* and *H. depereti*. The other species is comparatively small and very hypsodont, referring to extant Asian *Hystrix*, *H. brachyura*. It appears that the extant lineage of *Hystrix* occurred in Southeast Asia during the Plio-Pleistocene. Also, the present discoveries indicate that the smaller higher-crowned species replaced the larger lower-crowned species during the Pliocene in central Myanmar. We infer that this succession was caused by an environmental transition from rather wet to dryer conditions in this area, which has been suggested by the changes in the composition of the mammalian fauna and by the stable isotope data.

Poster Session IV, (Wednesday)

IGUANODONTIAN DINOSAURS FROM THE WEALDEN GROUP OF ENGLAND: TAXONOMIC CONUNDRUMS

NORMAN, David, University of Cambridge, Cambridge, United Kingdom

Various disassociated fossil reptile remains collected from the Grinstead Clay Member of the Tunbridge Wells Sand Formation exposed in quarries at Whiteman's Green near the village of Cuckfield in Sussex, England, were described and named in the eighteenth and nineteeth centuries. Some of this material was named *Iguanodon* but neither a specific name nor a holotype for this taxon were provided. Subsequent discoveries of similar dinosaur material from the Cuckfield area as well as from quarries, or eroding sea cliff sections scattered more widely across the Weald of south-eastern England, were added without a great deal of discrimination to anatomical remains attributed to the genus *Iguanodon*; these were often assigned to the species *I. mantelli*. By the mid 1870s new discoveries began to call into question the range and variety of the dinosaurian material attributed to *Iguanodon*. New specific and generic names began to be suggested and discussed on the basis of both new and earlier discoveries; however, their comparative value and statuses were never reviewed thoroughly. As a result, iguanondontian taxonomy has been aptly descibed as chaos. Here, the status of Wealden Group iguanodontians is critically reviewed on the basis of type and referred material; taxonomic assignments are assessed and an overview of taxonomic diversity of these dinosaurs within the Wealden Group is provided.

Poster Session II, (Monday)

EVIDENCE FOR CORRELATED EVOLUTION BETWEEN LONG BONE COMPACTNESS, SWIMMING BEHAVIOR AND BODY MASS IN ARCTOIDEA (MAMMALIA: CARNIVORA)

NORTHOVER, Joanna, Carleton University, Ottawa, ON, Canada; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada; SCHRÖDER-ADAMS, Claudia, Carleton University, Ottawa, ON, Canada

Many aquatic amniotes exhibit an increase in bone density, which can result in the animal having a higher overall density. For a swimming animal this trait counteracts buoyancy and may be adaptive during diving and underwater foraging. An increase in bone density can arise from a thickening of cortical bone and/or reduction of the medullary cavity. The resulting internal bone compactness can be expressed as *K*, the ratio between the medullary cavity and external bone diameter. Previous work has shown a positive relationship between compactness and aquatic specialization in many amniotes including sirenians (dugongs, sea cows), ancestral whales, beavers, sea otters and marine reptiles. Here we evaluate the hypothesis that long bone compactness is correlated with swimming behaviour in Arctoidea. This group of carnivores includes members which are highly swimming specialized, such as Pinnipedia (seals, sea lions, walrus); moderately specialized, such as Lutrinae (otters) and others which are exclusively terrestrial (weasels, badgers etc.). If there is evidence for evolutionary correlation between compactness and swimming behaviour, then *K* could be used to help predict the behaviour of fossil arctoids. The six major limb bones from male individuals representing 43 species of extant arctoids were visualized using computed tomography scanning and digital x-rays.Then *K* was calculated for each bone. In order to characterize swimming behaviour, each species was scored for its morphological specialization, habitat preference, diet and diving ability. These four scores were averaged, resulting in a continuous variable representing their behaviour. To test for correlated evolution between *K*, swimming behaviour and body mass, we used phylogenetically independent contrasts. The results showed a significant positive relationship between swimming behaviour and *K* for the ulna, fibula and humerus. The findings also showed evidence for correlated evolution between behaviour and body mass, as well as body mass and *K* for the humerus, radius, ulna and fibula. Further work will be required to understand if there is a relationship between swimming behaviour and long bone compactness that is independent of body mass.

Poster Session III, (Tuesday)

GEOMETRIC MORPHOMETRIC ANALYSIS OF THEROPOD MANUAL UNGUALS: EVOLUTIONARY AND ECOLOGICAL IMPLICATIONS

NOTO, Christopher, Grand Valley State University, Allendale, MI, USA

The functional morphology of theropod forelimbs and interpretation of their use in behavior remains an active area of research, particularly because the forelimb morphologies of theropods lack extant analogs. Recently published research on the talon morphology of living avian raptors shows that differences in predatory strategy between taxa are correlated with differences in the size and shape of the pedal unguals. While these taxa may sometimes overlap behaviorally, this study suggests that avian raptor claws are adapted to a particular type of prey and predatory strategy.A similar approach to theropod forelimbs may yield insights into their predatory behavior. Theropod manual unguals are similar to the pedal unguals of living birds in that they vary greatly in overall morphology (size, length, curvature), and played a larger role in prey acquisition than locomotion for many species. It is therefore expected that differences in claw shape will follow ecological and/or evolutionary patterns.A series of 14 coplanar landmarks were applied to photographs and published figures representing taxa from the major theropod clades. When possible, claws from all digits were used. Procrustes superimposition and thin-plate splines were used to study shape variation. Multivariate ordination was then used to explore patterns of shape change. Preliminary results show that shape variation is concentrated in the curvature of the nail, projection of the flexor tubercle, and nail size relative to the ungual body. Notably, certain features of shape variation appear related to evolutionary differences at higher taxonomic levels. For example, coelurosaurs differ significantly from non-coelurosaurs in claw shape. This work opens up many potential avenues of future research. First, it allows one to explore ecological differences between theropod species and higher taxa (and the evolution thereof). Second, this approach may help in understanding the evolution of the theropod manus, yielding character data useful for cladistic analyses. Third, these results suggest that covariation among certain shape parameters could aid in assigning taxa to unidentified isolated unguals.

Poster Session II, (Monday)

SQUAMATA FROM THE CONIACIAN THROUGH EARLY CAMPANIAN OF SOUTHERN UTAH

NYDAM, Randall, Midwestern University, Glendale, AZ, USA; NYDAM, Randall, Midwestern University, Glendale, AZ, USA

The Cretaceous-aged portion of the sedimentary rocks in southern Utah form a nearly continuous series of terrestrial and interbedded marine facies that are becoming increasingly well-known for producing a spectacular and highly diverse fauna of fossil vertebrates. With regard to squamates (lizards and snakes) the most intensely studied faunas have been those from the Cenomanian (Dakota Formation), Turonian (Smoky Hollow Member of the Straight Cliffs Formation), and middle Campanian (Kaiparowits Formation). Screen wash and surface collecting of microvertebrate-rich localities in the John Henry Member of the Straight Cliffs Formation (Coniacian) and the Wahweap Formation (Santonian–early Campanian) has resulted in the recovery of numerous morphotypic squamate specimens that partially fill in the gap between the Smoky Hollow Member of the Straight Cliffs Formation and the Kaiparowits Formation. Taxa recovered from the John Henry Member of the Straight Cliffs Formation include a new species of paramacellodid/cordylid-grade lizard, an indeterminate scincomorph, two morphotypes of varanoid lizards, and associated lacertilian skull and osteodermal elements. In addition to the lizards, several vertebrae referable to the enigmatic serpentian *Coniophis* and a partial dentary of an indeterminate snake have been recovered. Squamate specimens from the Wahweap Formation include scincomorphan jaws and osteoderms, anguimorphan osteoderms, and vertebrae referable to *Coniophis*. These specimens provide additional evidence of the apparent persistence of paramacellodid/cordylid-grade lizards into the Late Cretaceous of North America, the iterative presence (but apparetly low diversity) of snakes in the Cretaceous of Utah, and the regional endemism of squamate taxa in the southern regions of the Western Interior of North America.

Poster Session IV, (Wednesday)

A NEW LOOK AT 'OLD' BIRDS FROM THE JEHOL FAUNA

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Starting in the early 1990's, new species, genera, subclades, and lineages of archaic birds were uncovered from the Early Cretaceous Jehol Group in northeastern China. This geologic unit has revealed higher Early Cretaceous avian diversity than any other. While it is the new, exciting, or unusual discoveries that draw our attention, a reappraisal of early discoveries – most of which are fragmentary and poorly preserved – in light of the currently available information, can also provide new informative data, and serves to clarify current hypotheses often based on outdated published information. Several of the earliest-named species from the Jehol are reinterpreted here. The new interpretations of these taxa drastically change their phylogenetic positions. Such compositional changes affect not only the known morphological disparity of a given clade, but also its diversity, range, known ecological specializations, etc. We reinterpret *Liaoningornis* as an enantiornithine based on the morphology of the sternum (comparable to *Eoalulavis*) and pedal morphology, and use the morphology of the elongate corpus of the premaxilla and hypertrophied pygostyle to assign *Boluochia* to Longipterygidae. The phylogenetic placement of other more fragmentary taxa is discussed, and we include a phylogenetic hypothesis through cladistic analysis to support our morphological findings.

Poster Session I, (Sunday)

RECONNAISSANCE PALEONTOLOGY IN THE LATE CRETACEOUS OF DAKHLA AND KHARGA OASES, WESTERN DESERT, EGYPT

O'CONNOR, Patrick, Ohio University, Athens, OH, USA; SERTICH, Joseph, Stony Brook University, Stony Brook, NY, USA; SALLAM, Hesham Mohamed, Mansoura University, Mansoura, Egypt; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA

The majority of our knowledge of post-Cenomanian continental vertebrate diversity in Gondwana is based largely on faunal assemblages from limited locales in South America, Antarctica,India, and Madagascar. By contrast, the African record of continental vertebrates from this temporal interval is vastly undersampled, precluding any meaningful comments regarding supercontinent-level faunal patterns. In an attempt to ameliorate this sampling bias, we have initiated paleontological survey efforts in Upper Cretaceous units exposed near Dakhla and Kharga Oases in the Western Desert of southern Egypt. Although vertebrate remains have long been known from Campanian- to Maastrichtian-aged deposits in southern Egypt, the recovery of continental vertebrates has been relatively limited. Reconnaissance expeditions in 2008 and 2010, working under the auspices of the Mansoura University Vertebrate Paleontology (MUVP) initiative, have been undertaken with the following goals: (A) identify fossil-bearing sequences within the target strata, particularly within the Quseir Formation; (B) establish the local geological context of fossil-bearing localities; and (C) recover voucher specimens from target sequences in order to begin documenting faunal diversity in this critical time interval.Fossil vertebrates recovered thus far include abundant shark, fish, and marine reptile remains from the Duwi Formation and fish, turtle, crocodyliform, pterosaur, and dinosaur remains from the nearshore-marine to fluvial Quseir Formation. Of particular note is the recovery of a partial mosasaur skull, a partial neosuchian crocodyliform, and some of the first saurischian dinosaur remains from the Campanian of Africa. These expeditions highlight the potential for the recovery of continental vertebrate material from one of the most poorly sampled temporal intervals on the African continent. Ongoing field research in southern Egypt by MUVP and collaborating institutions will no doubt yield additional vertebrate remains that will directly impact current models of vertebrate biogeography during the Late Cretaceous Period.

Technical Session XIII, Tuesday 3:15

CRANIODENTAL MEASURES OF DIRE WOLF POPULATION HEALTH IMPLY RAPID EXTINCTION IN THE LOS ANGELES BASIN

O'KEEFE, F. Robin, Marshall University, Huntington, WV, USA; VAN VALKENBURGH, Blaire, University of California Los Angeles, Los Angeles, CA, USA; BINDER, Wendy, Loyola Marymount University, Los Angeles, CA, USA

Previous work on population-size samples of dire wolves from Rancho La Brea suggested that those living at the Last Glacial Maximum (LGM) experienced severe nutrient stress relative to other populations. However, lack of data, and of adequate accuracy and precision in extant data, limited the utility of this system. Here we report a new analysis of dire wolf dental morphology integrating refined age data, complete data for wear and breakage, and hypothesis-driven morphometrics that allows strong inferences concerning overall population health at the end-Pleistocene. Of special interest are Pit 13 and 61-67, as these date to this interval. Dating for these pits was refined by tabulating all known dates and calibrating each using the IntCal04 calibration curve; pit 13 dates to 17.75 kya, the terminal LGM. Pit 61-67 is younger, dating to 13.75 kya, within the Bølling-Allerød (BA) warm period. Breakage and wear data demonstrate that pit 13 has significantly greater measures for both. Analysis of centroid size data extracted from 27 3D landmarks shows that mean body size was significantly smaller in pit 13, and that the associated size distribution is right-skewed. Distance-based morphometrics establish that pit 13 wolves are neotenic, with unusually short snouts; however, analysis of tooth row shape indicates that only pit 61-67 differs markedly from earlier wolves. Evidence for nutrient stress at the LGM is compelling, based on congruent signals from breakage/wear, body size and size distribution, and shape analysis. In contrast, during the BA breakage/wear and size distribution data indicate low nutrient stress, while size and shape data suggest successful adaptation to a warmer climate. Just prior to the end-Pleistocene mass extinction La Brea dire wolves were not food-stressed, suggesting prey was abundant; their extinction therefore may have been rapid locally. This contrasts with recent findings from the *Sporormiella* system indicating that herbivore extinction was gradual through the BA interval in more northern areas. These findings are not mutually exclusive; extinction rapidity or causality need not be homogeneous geographically or temporally.

Poster Session II, (Monday)

A NEW SPECIMEN OF *AGRIOTHERIUM* (MAMMALIA, CARNIVORA) FROM THE LATE MIOCENE-EARLY PLIOCENE IRRAWADDY SEDIMENTS, MYANMAR

OGINO, Shintaro, Kyoto Univ. Primate Research Inst., Inuyama, Japan; EGI, Naoko, Kyoto Univ. Primate Research Inst., Inuyama, Japan; TAKAI, Masanaru, Kyoto Univ. Primate Research Inst., Inuyama, Japan; MAUNG-THEIN, Zin-Maung, Kyoto Univ. Primate Research Inst., Inuyama, Japan; HTIKE, Thaung, Kyoto Univ. Primate Research Inst., Inuyama, Japan

A hemi-mandible of a bear was found in the Lower member of Irrawaddy sediments in the Chaingzauk area, central Myanmar. The Chaingzauk fauna comprises 15 genera of mammals, including three carnivorans (*Agriotherium*, *Ictitherium*, and *Amphicyon*), and at least two genera of reptiles, and a faunal comparison with Siwalik and China indicates its age as the late Miocene to early Pliocene. The specimen was identified as *Agriotherium* based on the characteristics such as a distinct premasseteric fossa and buccolingually wide lower teeth. *Agriotherium* is an extinct, short-faced bear that was commonly present in the Africa, Eurasia, and North America during the late Miocene to Pliocene. This genus is considered to have a close relationship to the middle Miocene *Indarctos*, which had a distribution similar to that of *Agriotherium*. The presence of *Agriotherium* at the Chaingzauk area agrees with the late Miocene to early Pliocene age assignment made for this fauna. The specimen from the Chaingzauk area likely represents a new species of the genus based on the following characteristics: a short mandible, a rectilinearly-shaped inferior border of the mandibular corpus, a reduced m1 talonid, and an m1 metaconid larger than the entoconid-entoconulid ridge. The specimen differs from those of other *Agriotherium* in having an extremely short mandible. The diastema between canine and p4 is short, it lacks p1-p3, and the four existing cheek teeth (p4–m3) are very crowded. The Irrawaddy form is relatively large compared to other species of the genus. All Chinese *Agriotherium* species are smaller than the present specimen. Siwalik *Agriotherium* are similar to the present specimen in size but differ in morphology. Except the extreme shortness, the morphology of the mandible is the most similar to that of an European *Agriotherium, A. insigne*, suggesting that the presence of *Agriotherium* in the Chaingzauk fauna is not associated with the dispersal of the known Siwalik and/or Chinese forms but resulted from another dispersal event from the European lineage.

Romer Prize Session, Monday 10:15

DEVELOPMENTAL FEATURES OF MICROSAURS (LEPOSPONDYLI), AND CONSEQUENCES FOR THE EVOLUTION OF DEVELOPMENT AND PHYLOGENETIC RELATIONSHIPS WITHIN TETRAPODA

OLORI, Jennifer, The University of Texas at Austin, Austin, TX, USA

The complex mosaic of morphological features expressed by lepospondyl microsaurs obscures the placement of microsaur taxa among other early tetrapods. As a step toward resolution, I documented ontogenetic data for the microsaurs *Hyloplesion* and *Microbrachis* and investigated relationships among microsaurs and other extinct and extant tetrapods. Allometric changes in the skeleton of *Hyloplesion* and *Microbrachis* were quantified using both traditional and geometric morphometric analyses. In addition to more traditional length-based methods, Ontogenetic Sequence Analysis (OSA), a size-independent method of ossification sequence reconstruction, was applied to fossils for the first time. I used Parsimov-based Genetic Inference (PGi) of ossification sequence data for 33 tetrapods to quantitatively evaluate the three main hypotheses of living amphibian ancestry (Lepospondyl, Temnospondyl, and Polyphyletic). Skeletal growth in *Hyloplesion* and *Microbrachis* is primarily isometric and ossification is rapid and complete at relatively small size. However, both taxa exhibit lateral lines, and the latter has gills. That pattern is congruent with expectations for stem amniotes, many of which potentially could have possessed amniote-like skeletal development but still retained reproductive ties to aquatic environments. Consistent with the placement of microsaurs as stem amniotes, PGi indicated the Temnospondyl Hypothesis to be the most parsimonious explanation of tetrapod relationships. However, those results contrast with my prior Parsimov Analysis of ossification sequences that favored alternative hypotheses. Overall, no one hypothesis of amphibian evolutionary relationships was supported with significance. The equivalent support for all three hypotheses suggests that despite new sources of data and improved taxonomic sampling, the problem of early tetrapod relationships persists because of significant gaps in the fossil record and millions of years of independent evolution.

Poster Session IV, (Wednesday)

DIETARY BEHAVIOR OF *ASTROHIPPUS STOCKII* FROM THE LATE HEMPHILLIAN OF CENTRAL MEXICO USING THE MESOWEAR METHOD

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A sample of upper cheek teeth belonging to *Astrohippus stockii* was used to investigate the dietary behavior of this horse by means of the extended mesowear method. The sample analyzed here comes from strata belonging to the Rancho Viejo beds at Rancho El Ocote, latest Hemphillian (Hh4) of Guanajuato in Central Mexico. A cluster analysis using a comparative set of 27 recent species with typical diets and the population of *A. stockii* from Guanajuato was performed. The mesowear pattern of this equine species is distinguished by a combination of high and low relief, and round cusps; a comparable mesowear signature is observed in the recent grass-dominated mixed feeders *Alcelaphus buselaphus* (hartebeest) and *Connochaetes taurinus* (blue wildebeest). This suggests that *A. stockii* from Guanajuato included in its diet a greatnumberof abrasive items (grass and/or extrinsic grit), however it would be capableof consuming other succulent resources. The results are in agreement with previous isotopic studies regarding to the dietary behavior of populations referable to *A. stockii* from the late Hemphillian of southern Great Plains, Gulf Coast and Southern Great Basin. Our observations give additional evidence about the dietary behavior of this equine horse, given that is categorized as a variable grazer.

Technical Session IX, Tuesday 9:15

BODY SIZE, CLIMATE AND TIME: A PALEONTOLOGICAL TEST OF BERGMANN'S RULE

ORCUTT, John, University of Oregon, Eugene, OR, USA; HOPKINS, Samantha, University of Oregon, Eugene, OR, USA

One of the earliest ecological variables to be studied, mammal body size remains enigmatic in many ways. In particular, debate still rages among ecologists about the forces that have shaped the geographic body mass trends apparent in most extant mammal taxa. The first explanation to be offered (by Carl Bergmann, whose name has been associated with the hypothesis ever since) is that body size evolution is driven primarily by temperature, with large animals favored in cold climates and small animals favored in warm climates. In the subsequent century and a half, other causal mechanisms, both climatic (e.g. precipitation, seasonality) and biotic (e.g. food availability, competition), have been proposed as well. None of these mechanisms is universally accepted, in part because the variables in question (particularly climatic variables) are often tightly coupled in modern ecosystems. However, given sufficiently well-resolved fossil and paleoclimate records, temperature, precipitation, and seasonality can be decoupled and their influence on body size can be analyzed from a perspective unavailable to neontologists. We have analyzed body size trends in three families (equids, canids, and sciurids) of North American Oligo-Miocene mammals. Body mass was estimated from dental measurements and was tracked within biogeographic regions and along geographic transects (one running from Washington to southern California, the other from Oregon to Nebraska). Body size was regressed against climate variables from previously published reconstructions based on paleopedological, isotopic, and paleobotanical proxies. Body size does not track temperature through time and there is no evidence for latitudinal body mass gradients similar to those observed within many modern taxa. There is no relationship between temperature and body mass at any taxonomic level, counter to the predictions of Bergmann's rule*sensu stricto*, nor does any one climatic variable appear to drive body size evolution. Instead, body mass is likely driven by biotic interactions or a combination of variables, the effects of which may vary widely across taxa.

Poster Session III, (Tuesday)

PRELIMINARY ANALYSIS OF DIPNOI (OSTEICHTHYES: SARCOPTERYGII) FOSSILS FROM DRIEFONTEIN, SOUTH AFRICA

ORTIZ, Daniela, Sam Houston State University, Huntsville, TX, USA; LEWIS, Patrick, Sam Houston State University, Huntsville, TX, USA; KENNEDY, Alicia, Villanova University, Villanova, PA, USA; BHULLAR, Bhart-Anjan, Harvard University, Cambridge, MA, USA; HANCOX, John, University of the Witwatersrand, Johannesburg, South Africa

A recent collection from Driefontein, located in the main Karoo Basin, South Africa, has yielded a rare assemblage of freshwater Triassic microfossils, including a large sample of Dipnoi (lungfish) elements. Sedimentary rocks corresponding to the upper Beaufort Group (Burgersdorp Formation) and biostratigraphic placement of the site in the lower *Cynognathus* Assemblage Zone support an Early Triassic (Olenekian) age of ca. 242 mya. A sample of 239 juvenile dipnoan tooth plates identified to the extinct family Ptychoceratodontidae was surface collected from fluvial deposits. Current research aims to identify dipnoan species at the Driefontein site to better understand the freshwater Early Triassic habitat. Tooth plates were identified by the number and morphology of ridge crests, which radiate from a fused anteromedial point, and the presence of denticles on the occlusal surface. Specimens range from 1 to 13 mm in length, with widths between 3 and 6 mm. Pterygopalatine (upper) tooth plates were identified by the presence of five ridge crests, while prearticular (lower) tooth plates have four. A preliminary analysis has identified tooth plates as upper left (n=23) and right (n=30), and lower left (n=29) and right (n=25), and has tentatively assigned orientations to 41 worn specimens. Also identified were 42 single ridge crest and 49 small unspecified fragments. Based on resemblances to tooth plates previously collected from the northern Karoo Basin, and from localities in similarly aged strata in Poland and Australia, the specimens from Driefontein are referred to the genus *Ptychoceratodus*. The lack of known apomorphies for preserved elements, in addition to wear and fragmentation of the majority of the sample, prevents a confident identification to a lower taxonomic level. The total number of dipnoan species present at Driefontein will be differentiated once apomorphies and the ontogeny of *Ptychoceratodus* are determined. Studying the taxonomic diversity of lungfish from this site will result in an improved understanding of the Early Triassic paleoenvironment that led to the recovery and expansion in faunal diversity in Gondwana following the Permian extinction.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 8:15

JAW MECHANISM, DENTAL OCCLUSION AND EFFECTIVE ORAL FOOD PROCESSING IN HETERODONT CROCODYLIFORMS: AN UNEXPECTED VARIABILITY

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Based on new discoveries of the last few years it is evident that within the Crocodyliformes complex heterodont dentition sometimes including multicuspid crowns appeared in numerous fossil forms through all main lineages of the group. Teeth in these complex dentitions frequently bear extensive wear facets that are the best indicators of occlusion between the upper and lower teeth which refers to oral food processing. Besides dental features, specializations of the jaw apparatus, cranial adductor musculature and jaw movement can also be detected, all reflecting a high variability of jaw mechanism and of intraoral food processing within the group. Comparative study of these features in various taxa revealed at least four different types of jaw mechanism and indicated that some of these mechanisms evolved independently in several lineages of the Crocodyliformes. The most common type is the isognathous orthal jaw closure characteristic for all heterodont forms possessing bulbous, crushing posterior teeth (dominantly among neosuchians). Here, the crushing mechanism is supported by the developed pterygoideus muscles, the highly elevated jaw articulation and the rough wear facets. Anteroposterior mandibular movement during jaw opening and closure appears to have occurred exclusively among the principally Gondwanan notosuchians. Proal (back-to-front) movement detected in the African *Malawisuchus* is supported by features such as the position of sharp carinae, wear facets on the tooth crowns, and developed pterygoideus muscles suggested to be responsible for the protraction of the mandibles during jaw closure. Propalinal (fore-aft) jaw movement can be characterized for a high number of South American genera. The dental morphology, the enamel–dentine interface and the developed external adductors are the main indicators of a retractive power stroke that might have been completed by lateromedial component in these forms. The last type of jaw movement has been detected in the eusuchian *Iharkutosuchus* characterized by lateromedial rotation of the mandibles, as supported by the extensive horizontal wear facets and the unfused mandibular symphysis.

Technical Session XII, Tuesday 3:30

ATMOSPHERIC HYPOXIA INCREASES BONE ROBUSTICITY IN THE AMERICAN ALLIGATOR

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Body mass of extinct vertebrates is often estimated from their limb bone geometry. Scaling relationships of limb bone cross-sectional area and/or length to body mass are based on data derived from extant vertebrates. This method, however, is applicable only to vertebrates raised under modern-day atmospheric conditions. During vertebrate evolution, atmospheric oxygen O_2level may have varied from as high as 30% in the Permian, to as low as 12% in the Late Triassic/Early Jurassic. To date, no studies have considered the effect of ambient O_2on skeletal plasticity*in vivo*. We incubated eggs and subsequently grew hatchlings of the American alligator under chronic hypoxia (12% O_2), normoxia (21% O_2) and hyperoxia (30% O_2). Animals received monthly injections of fluochrome dyes to determine periosteal deposition rates. After three months, animals were sacrificed and their femora either sectioned at mid-diaphysis, or ashed. Despite exhibiting slower growth, hypoxic alligators had significantly greater mass-specific cross-sectional area (+15%), second moment of area (+20%) and polar moment of inertia (+23%) of the femoral midshaft than their normoxic or hyperoxic hatchlings. Mineral content was also significantly higher (+6%) in bones of hypoxic animals. This suggests that exposure to chronic hypoxia, but not hyperoxia, resulted in increased resistance to compressive, bending and torsional stresses on the skeleton. Furthermore, the relationship between femoral periosteal deposition and body mass growth was different between treatments groups, with hypoxic animals accruing more bone per unit body mass. We suggest that prevalent atmospheric O_2level need be considered when reconstructing size and growth curves of extinct vertebrates. Specifically, body masses of crocodyliforms from the Late Triassic/Early Jurassic, when the atmospheric $O_2$was at its nadir, may have been overestimated in the literature and should be revised.

Poster Session I, (Sunday)

HOW A SYNERGY OF SPECIES RECOGNITION AND SOCIAL SIGNALING EXPLAINS CRANIAL ANATOMY AND ONTOGENY IN SEVERAL GROUPS OF DINOSAURS

PADIAN, Kevin, University of California Museum of Paleontology, Berkeley, CA, USA; HORNER, John, Museum of the Rockies, Bozeman, MT, USA; FOWLER, Denver, Museum of the Rockies, Bozeman, MT, USA; SCANNELLA, John, Museum of the Rockies, Bozeman, MT, USA

In previous work we showed why most functional explanations of "bizarre" structures in dinosaurs fail on several grounds, including mechanical, ontogenetic, and phylogenetic (e.g., no functional improvement in a lineage, so no grounds for claiming adaptation by natural selection). We also showed that the hypothesis of sexual selection fails so far because, by Darwin's definition, sexual dimorphism (and not mere sexual difference) has never been convincingly demonstrated in these structures. Social selection has also been proposed. It hypothesizes competition for some social resource, for which both sexes can evolve unusual traits that can evolve rapidly. The problem is that so far these structures have not been tested for social selection. The argument has been made by analogy to animals such as hornbills, but bizarre structures in dinosaurs develop and vary among related species quite differently. Mate recognition has also been hypothesized, but we regard this as a subsidiary function of a more general hypothesis of species recognition.

Here we propose that a combination of species recognition and social signaling explains more of the available data than do other hypotheses. Two forms of variation need to be explained: those that relatively quickly develop and mature more or less allometrically with growth, and those that drastically modify and even reverse growth trajectories especially as skeletal maturity is reached. The first is exemplified by general features of crest shape in lambeosaurines as well as accessory horns and spikes in centrosaurines. The latter is exemplified by the changing shape and direction of brow horns in the ontogeny of *Triceratops* and by the growth and reduction of nuchal spikes and the eventual development of the cranial dome in the ontogeny of *Pachycephalosaurus*. The first kind of variation signals membership in a species, with its general benefits of protection, social interaction, and mating appropriateness. The second signals an individual's status in the group (juvenile, pre-sexual sub-adult, mating adult). This hypothesis, if valid, establishes dinosaurs as highly complex in behavior and social structure.

Poster Session IV, (Wednesday)

DISPARITY IN ABUNDANCE OF THE DWARFED EQUID *ARCHEOHIPPUS* IN MIDDLE MIOCENE DEPOSITS OF SOUTHERN CALIFORNIA

PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, USA; REYNOLDS, Robert, LSA Associates, San Bernardino, CA, USA

Archaeohippus is an early to medial Miocene genus of brachydont, North American equid that exhibits dwarfism with evolutionary development. *Archaeohippus* remains, although generally lower in abundance than those of other contemporary equids, show a cosmopolitan distribution throughout the continent. *Archaeohippus* is an ever-present faunal constituent in Miocene assemblages, particularly those of southern California.

Archaeohippus occurs in the fault separated, Cajon Valley and Crowder formations on the northern flank of the San Bernardino Mountains, and in the Barstow Formation in the Mojave Desert. Both formations contain faunal assemblages of approximately equivalent age, from the late Hemingfordian (He2) through the early and late Barstovian (Ba1-Ba2). However, the Cajon Valley/Crowder Formation contains over two dozen specimens of *Archaeohippus*, including numerous juvenile individuals, from units Tcv-3, Tcv-5 and Tcv-6. In contrast, the Barstow Formation contains only six verified specimens of the same genus restricted to the unnamed middle member. The notable disparity in abundance of *Archaeohippus* between these time-equivalent deposits suggests environmental preferences for this diminutive equid.

The Barstow and Cajon Valley/Crowder formations were deposited at about the same time, but under considerably different conditions. The presence of paleosols in the Cajon Valley and Crowder formations represents stable, vegetated surfaces during depositional gaps that appear to have provided vegetated habitats that favored *Archaeohippus*. Deposition of the fluvio-lacustrine Barstow Formation was apparently at a slow, continuous rate, as indicated by the absence of paleosols. Deposition on the stoss side of the Victorville highlands to the west likely created a nominal rain shadow effect, the resulting aridity proving less hospitable for *Archaeohippus*.

Technical Session IX, Tuesday 10:30

LOSS OF HABITAT AND BIODIVERSITY DURING TERMINAL PLEISTOCENE WARMING: WHAT SMALL MAMMAL FOSSILS TELL US ABOUT THE EFFECTS OF CLIMATE CHANGE

PARDI, Melissa, University of New Mexico Department of Biology, Albuquerque, NM, USA; GRAHAM, Russell, The Pennsylvania State University, Deapartment of Geosciences, University Park, PA, USA

Previous paleoecological research of the late Pleistocene has largely focused on the dynamics between the arrival of modern humans, climate change, and megafauna extinction. While the interactions between large charismatic animals and humans is interesting, recent investigations into how entire ecosystems may have changed during the Pleistocene-Holocene transition tell a story that is equally dramatic. The study of smaller animals provides a more complete picture of how climate change affected late Pleistocene ecosystems. To examine large scale patterns in small mammal community structure, 203 fossil faunas from 183 locations east of the Rocky Mountains in North America were compared using non-metric multidimensional scaling. These faunas ranged in age from the last Full Glacial to the late Holocene. Late Glacial faunas were more diverse than late Holocene faunas. Glacial sites were also more taxonomically similar along an East-West gradient. This finding suggests that this gradient steepened during the transition into the Holocene. Heterogeneous environments during the last glacial could produce such patterns, and are also consistent with the presence of late Pleistocene non-analog faunas and novel habitats. These results indicate that North America not only experienced extinctions of organisms at the end of the last glacial, but that some late Pleistocene habitats were removed from the modern landscape. These findings provide relevant details about how future climate change may affect patterns in terrestrial biodiversity.

Physical Drivers and Marine Tetrapod Evolution, Monday 9:30

PHYSICAL DRIVERS AND THE ORIGINS, EVOLUTION AND DIVERSITY OF MARINE TURTLES

PARHAM, James, Alabama Museum of Natural History, Tuscaloosa, AL, USA; JOYCE, Walter, University of Tübingen, Tübingen, Germany

Marine turtles are iconic marine reptiles, often used as flagship species for conservation efforts. However, the evolutionary history of marine turtles has received relatively little attention from paleontologists. New data on the phylogeny of turtles, from both molecules and morphology, helps shed light on the origin of marine clades. Until recently, most pelagic-adapted marine cryptodires were lumped into one clade (Chelonioidea). In contrast to the traditional 'single origin' hypothesis, independent invasions of the oceans is more congruent with other patterns such as the temporal appearance of lineages and their pelagic specializations, as well as global sea level. The radiation and ecological differentiation of marine lineages show iterative patterns that are plausibly linked to physical drivers (e.g., the development of seagrass communities) and the opening of niches through extinction. This new picture of marine turtle evolution is emerging despite remaining challenges including the need for taxonomic revisions of putatively well-known taxa and the uncertain placement of many Cretaceous forms. As patterns of marine turtle history come into better focus, we can begin to compare them with those from other marine amniotes.

Technical Session II, Sunday 11:00

AN UNUSUAL LARGE NEW MAMMALIAFORM FROM THE LOWER CRETACEOUS CLOVERLY FORMATION OF MONTANA

PARSONS, William, Buffalo Museum of Science, Buffalo, NY, USA; PARSONS, Kristen, Buffalo Museum of Science, Buffalo, NY, USA; SUES, Hans-Dieter, National Museum of Natural History, Washington, DC, USA

Associated skeletal remains representing two individuals of a new mammaliaform taxon were recovered from lower strata of Unit VII of the Lower Cretaceous Cloverly Formation in central Montana. The new taxon was approximately 140% the size of adult *Tachyglossus aculeatus*. The skull is documented by the roof of the braincase, both premaxillae (partial), both maxillae (partial), incomplete right jugal, fragments of the basicranium, and complete left dentary. Five smaller neurovascular foramina are present anterior to the infraorbital foramen: two in the maxilla, one in the region of the suture between the maxilla and premaxilla, and two in the premaxilla. The dentary has a large, mediolaterally narrow but vertically deep condyle. A partial latex endocast shows that the cerebral hemispheres are uniformly expanded laterally and posteriorly. The external division between the olfactory lobes and cerebral hemispheres is clearly defined. There is a distinct fossa for the pineal body. The premaxilla is large. All teeth exhibit polyphyodont replacement. There are no canines, but the third lower incisor is caniniform. The ultrastructure of the enamel is non-prismatic. Columnar structures are clearly visible; the angles of the crystallite axes range between 22° and 37° relative to the vertical axes of the columns. The incisors are vertically oriented and buccolingually compressed. The molariforms, with one exception, are single-rooted. Their distinctive crowns have vertical, thickly enameled walls enclosing a central basin. The walls bear large and small cuspules, which cannot be readily homologized. Postcranial remains include the ilium, isolated centra, neural arches, rib fragments, partial humerus, proximal end of the radius, several manual elements, fragments of the left femur, a complete left tibia, left fibula (partial), articulated left calcaneum and astragalus, and numerous pedal bones. The transverse processes of the sacral vertebrae are not fused to the ilia, but contact them in a "ball-and-socket" articulation. The manual unguals are greatly elongated and dorsoventrally flattened. All manual elements closely resemble those of *Tachyglossus aculeatus*.

Poster Session I, (Sunday)

NEW SKELETAL REMAINS OF *MAMMUTHUS COLUMBI* FROM COASTAL GEORGIA

PATTERSON, David, University of Georgia, Athens, GA, USA; MEAD, Alfred, Georgia College & State University, Milledgeville , GA, USA

Clark Quarry is a recently excavated late Pleistocene (Rancholabrean) locality in Glynn County, Georgia. Radiocarbon dates obtained from mammalian bones and teeth indicate an age between 12,400 and 21,000 radiocarbon years before present. The site has yielded 12

species of mammals, 12 genera of birds, and 18 genera of amphibians and reptiles. The fauna is dominated by fossils of the Columbian mammoth, *Mammuthus columbi*, and the giant bison, *Bison latifrons*. Although North American mammoths have been studied extensively from other localities in the United States, limited *in situ* material has been described from Georgia. However, the type specimen for *Mammuthus* (*Elephas*) *columbi* was described by Falconer in 1857 based upon a partial 3rd upper molar from coastal Georgia. He received the tooth from Charles Lyell who obtained it from Hamilton Couper in 1846. Couper recovered the tooth during excavations of the Brunswick Altamaha Canal in 1838-39. Clark Quarry borders the abandoned Brunswick Altamaha Canal and its location presents the possibility that this new mammoth material is from the same locality as the type specimen. Correlation of Couper's site description, the original canal survey maps, and modern Georgia Department of Transportation maps strongly support this conclusion. Mammoth material identified thus far indicates a minimum of two individuals and includes a juvenile palate and dentary with cheek teeth, adult tooth fragments, complete and partial long-bones, carpals, tarsals, ribs, sternal elements, and cervical, thoracic and caudal vertebrae.

Poster Session III, (Tuesday)

NEW TYRANNOSAUROID REMAINS FROM THE LATE CRETACEOUS 'EL GALLO' FORMATION OF BAJA DE CALIFORNIA, MEXICO

PEECOOK, Brandon, University of Michigan, Ann Arbor, MI, USA; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; WILSON, Gregory, University of Washington, Seattle, WA, USA; HERNÁNDEZ, Rene, Universidad Nacional Autónoma de México, Coyoacán, Mexico; MONTELLANO-BALLESTEROS, Marisol, Universidad Nacional Autónoma de México, Coyoacán, Mexico

North American tyrannosauroids are best known from southern Canada and north-central US, predominantly from paleolowlands along the Western Interior Seaway. The record of tyrannosauroids from southwestern North America has improved with the recent description of *Bistahieversor sealeyi* of New Mexico, and here we add new remains from Baja de California, Mexico. We report a complete, well preserved left fourth metatarsal collected from sediments of the Upper Cretaceous (Campanian) 'El Gallo' Formation exposed near El Rosario, Baja de California, Mexico. The metatarsal was found associated with a nearly complete pedal phalanx and fragments of other phalanges, but no other remains were recovered. The 'El Gallo' metatarsal IV was a part of a strongly arctometatarsalian metatarsus, as evidenced by a deep medial notch proximally and tight articulation for metatarsal III that extends most of the length of the shaft. This condition, along with the overall size and proportions of the bone, supports its identification as a tyrannosauroid. Compared to other tyrannosauroids, the 'El Gallo' metatarsal is relatively short and slender. It is 2/3 the length and 3/4 the robusticity (midshaft circumference/total length) of metatarsal IV of *Tyrannosaurus rex*, but closely resembles the proportions of the gracile *Appalachiosaurus montgomeriensis* and *Albertosaurus sarcophagus*. Due to the fragmentary nature of the 'El Gallo' material, no diagnosis can be made beyond Tyrannosauroidea. Before the discovery of this material, the only non-dental evidence of tyrannosauroids in Mexico was *Labocania anomala*, which consists of a few massive skull bones and fragmentary postcranial remains that include an ischium. An undescribed partial metatarsal, likely metatarsal III, referred to *Labocania* is slightly larger and more robust than the 'El Gallo' metatarsal, but it is too fragmentary and poorly preserved to make more detailed comparisons. Continued sampling in the southwestern US and Baja de California will provide insight into paleobiogeographic provincialism in North America during the Cretaceous.

Poster Session I, (Sunday)

THE EFFECT OF DIAGENESIS ON SR/CA AND BA/CA RATIOS OF TOOTH ENAMEL

PEEK, Stephanie, University of Wyoming, Laramie, WY, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

Elemental concentrations of barium and strontium relative to calcium (Sr/Ca and Ba/Ca) in bioapatite are commonly used to characterize an organism's diet. These ratios decrease with increasing trophic level due to a process known as *biopurification*, where calcium is preferentially incorporated into skeletal material over strontium and barium. Very little research has been conducted to assess how these ratios differ between different types of bioapatite (i.e. bone and enamel). Though Sr/Ca and Ba/Ca of bone have been utilized in a variety of modern studies, the application of these dietary proxies to fossil specimens is limited by the rapid diagenetic alteration of trace element concentrations in bioapatite. To circumvent this, tooth enamel is commonly used when looking at archaeological or fossil material. Enamel, having larger crystals of hydroxyapatite, lower porosity, and fewer organics as compared to bone, is more resistant to diagenetic alteration. Yet, the differences between the Sr/Ca and Ba/Ca ratios of bone and enamel are poorly understood. The goal of this study is to evaluate these differences and to see whether they are retained in archaeological and fossil material. Differences in Sr/Ca and Ba/Ca values in bone and teeth are expected due to differences in timing and period of mineralization as well as additional biopurification steps that occur during formation (i.e. biopurification also occurs across the placenta and mammary glands). Unlike bone, which has its Sr/Ca and Ba/Ca values continuously adjusted as it undergoes biological remodeling, the Sr/Ca and Ba/Ca values of enamel are fixed at the time of mineralization. Thus, physiologically speaking, tooth enamel that is forming in utero or during nursing should have significantly lower Sr/Ca and Ba/Ca ratios than tooth enamel or bone that forms post-weaning. To assess these differences, we will look at bone and tooth enamel from mandibles of four steer (*Bos taurus*) fed a controlled diet and five wild deer (*Odocoileus virginianus*). To address the question of diagenesis, three mandibles each from archaeological and fossil deer remains will be analyzed for bone and enamel Sr/Ca and Ba/Ca.

Technical Session XVII, Wednesday 2:45

ASSESSING MORPHOLOGICAL RATES OF CHANGE: AN EXAMPLE USING COELUROSAURIAN DINOSAURS

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Several recent studies have examined the tempo of the evolution of discrete morphological characters of fossil species. Here we propose a method combining the maximum likelihood phylogenetic reconstruction and dating with relaxed clock models to estimate the divergence time and morphological evolutionary rate of extinct taxa. I used the data matrix of the Theropod Working Group (TWiG) as an example, which contains only morphological characters of more than 80 coelurosaurian dinosaurs (including fossil birds). Phylogeny was reconstructed with GARLI 0.96, implemented with Mkv Model (Markov Model for discrete characters), which is designed for morphological dataset analyses under the maximum likelihood criterion. The advantage of applying maximum likelihood is that: 1) the phylogenetic reconstruction is based on the entire dataset, including missing data , and 2) it yields branch lengths proportional to the time across which characters changed, both of which are important for divergence time estimation. The resulting topology is similar to that from the maximum parsimony reconstruction, with the monophyly and relationships of major coelurosaurian families unchanged, but the ingroup relationships of some clades are modified. I analyzed the phylogeny with the software r8s, to estimate the divergence time and evolutionary rate for each branch. All terminal taxa were temporally calibrated by the age of their first fossil. The dating analyses were implemented with relaxed clock models such as the local clocks model and the rate smoothing model, both allowing variable evolutionary rates for different branches. Results indicate an early radiation of coelurosaurian dinosaurs, with most of the major coelurosaurian clades established before the Jurassic-Cretaceous transition. The early radiation of coelurosaurians happened at about the same time as the increase of oxygen concentration in Middle and Late Jurassic, but whether there is a causal relationship between these events is unclear. Aves show the highest average evolutionary rate compared with other coelurosaurian lineages, which may either reflect the early radiation of birds or reflect the bias of the dataset.

Evolution of the Modern African Fauna, Wednesday 10:15

A REVIEW OF THE FOSSIL RECORD OF CARNIVORA (MAMMALIA) IN AFRICA

PEIGNÉ, Stéphane, Muséum national d'Histoire naturelle, Paris, France; WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden

The order Carnivora has a shorter history in Africa than on any other continent except Australasia and South America. The definite record of the order on the African continent extends back to the late Oligocene. We present a review of the fossil record of the order, based on direct study of the majority of the known fossil carnivoran material by at least one of us. Our review encompasses nearly 120 genera and about twice that many species, to be compared with estimates, made in 1978, of 58 genera and 118 species. Known carnivoran species-locality occurrences have also greatly increased since 1978, to more than 1000, demonstrating that the fossil record of Carnivora in Africa has expanded enormously in the past 30 years, despite biases in its geographical and stratigraphical distribution. Thus, the Neogene fossil record of carnivorans is extremely poor in western, central and west-central Africa, and in some southern countries. In contrast, some regions have yielded extremely rich faunas for certain times and/or have a good and continuous long-term fossil record (typically eastern Africa). With the increasing amount and intensity of field research in Africa, some regions or countries (e.g., Mio-Pliocene of Chad) are showing their scientific potential, indicating that eastern African dominance may not only be due to its unique geographic and tectonic position, which created exceptional conditions for fossilization, but also to the near absence of a fossil record in most other African regions. The arrival of Carnivora in Africa is correlated with a migration event, either from Europe, or Asia, or both. The paleobiogeographical history of the order results from a series of such events, both into and out of Africa. Although the fossil record biases the data, most of these events are distinct and broadly associated with glacioeustatism and, partly, with tectonic events. The earliest events show no size sorting, but gradually middle- to large-sized taxa predominate. During the Pliocene, migrations are mainly out of Africa, correlate with regional climates, and involve middle- to large-sized taxa.

Poster Session II, (Monday)

BEESWAX AS A REMEDIAL TREATMENT FOR PYRITE DISEASE

PELLEGRINI, Rodrigo, New Jersey State Museum, Trenton, NJ, USA; JEHLE, Albert, New Jersey State Museum, Trenton, NJ, USA; GRANDSTAFF, Barbara, University of Pennsylvania, Philadelphia, PA, USA; ALBRIGHT, Shirley, New Jersey State Museum, Trenton, NJ, USA; PARRIS, David, New Jersey State Museum, Trenton, NJ, USA

The minerals pyrite and marcasite are often present in vertebrate, invertebrate, and plant fossils. Oxidation of these iron sulfides (commonly known as "pyrite disease") is arguably the most likely and severe natural cause of deterioration in fossil collections. Because the damage caused by this reaction is considered preventable but irreversible once the reaction has begun, development of remedial treatments has taken a secondary role to localized preven-

tive measures. While preferable, preventive measures are largely inadequate in cases where the reaction is well underway, and in many cases the reaction has already begun before fossil discovery and excavation. The New Jersey State Museum has conducted research and long-term experiments to evaluate the use of Beeswax (and synthetic alternatives) as consolidants in pyrite-diseased fossils for over two decades. Beeswax is readily available and inexpensive. The treatment requires only simple apparatus and a heat source. Fossils and wax are gradually heated to 80-120°C during treatment. Heating has the added benefit of removing bound water, thus dehydrating sulfate minerals produced by sulfide oxidation and decreasing the likelihood of further reactions. Results indicate that despite its limitations, the Beeswax remedial treatment is a cost-effective and efficient means to halt ongoing pyritic decay.

Poster Session II, (Monday)

AN UNUSUAL CERATOPSID QUARRY FROM THE HELL CREEK FORMATION OF MONTANA

PENKALSKI, Paul, Geology Museum, UW-Madison, Madison, WI, USA; SKULAN, Joseph, UW-Madison Geology Museum, Madison, WI, USA

Two partial ceratopsids were recovered from a small quarry in Carter County, southeastern Montana. The material includes skull elements, a lower jaw, a predentary, a poorly preserved syncervical, dorsal vertebrae, ribs, pubes, ischia, two humeri, an ulna, and numerous fragments. Two right postorbitals indicate the presence of at least two animals. Both horncores are unusually straight but otherwise show a similar, subadult morphology. Of the four large frill pieces, one is Torosaurine while another shows *Triceratops* characters including a prominent sagittal scallop. The latter parietal section also exhibits an unusual break that appears to be a pseudosutural division. The elongate, torosaurine squamosal has distinct, poorly fused, sausage-like episquamosals, confirming that this individual was not fully mature when it died. However, it lacks the rolled parietal bar and longitudinal depression characteristic of mature *Torosaurus latus* squamosals. Dorsal vertebrae from the quarry are subtly different than known vertebrae of *Triceratops*. The humerus is adult-sized but intermediate in morphology between *Torosaurus* (MPM VP6841) and *Triceratops* (FMNH 12003). The apparent presence of *Triceratops* and *Torosaurus* together in the same quarry has potential implications for taxonomy and sexual dimorphism. Three interpretations of the quarry material were explored: (1) that it represents a new taxon; (2) that the material represents sexual dimorphs of *Triceratops*; and (3) that one specimen each of *Triceratops* and *Torosaurus* were simply deposited together.

Poster Session I, (Sunday)

TURTLE DIVERSITY FROM THE UPPER JURASSIC AND LOWER CRETACEOUS OF GALVE (TERUEL, SPAIN)

PÉREZ GARCÍA, Adán, Universidad Complutense, Madrid, Spain; XABIER, Murelaga, Universidad del País Vasco, Bilbao, Spain; ORTEGA, Francisco, Facultad de Ciencias UNED, Madrid, Spain

The Upper Jurassic to Lower Cretaceous Galve fossil sites (Teruel, Spain) are located in a sedimentary succession with marginal marine and continental deposits of the Maestrazgo Basin. At present, more than fifty vertebrate taxa have been identified, including fishes, mammals, lissamphibians and many reptiles. Among them, turtles are very abundant but yet poorly known. Herein, four pancryptodiran taxa are recognized. The oldest record comes from the Villar del Arzobispo Formation (Tithonian–Berriasian), and corresponds to an inhabitant of marine environments that can be interpreted as a member of the eucryptodiran group Plesiochelyidae due to several characters, such as the presence of three cervical scutes on the nuchal plate. This group has been previously recognized in the Jurassic of other Iberian locations, but its diversity is not well known. In the Lower Cretaceous beds, turtles come from two formations: Castellar (upper Hauterivian–lower Barremian) and Camarillas (lower Barremian). One of the recognized turtles is ornamented by small pits, and with fine striations perpendicular to the margins of the plates, as that of some members of Pleurosternidae (Paracryptodira). It differs from the European *Pleurosternon* in the morphology and contact between some of its plates, being more similar to some Portuguese Jurassic pleurosternids undescribed yet. The ornamentation of a second taxon is composed of isolated granulations, attributed to Solemydidae (basal Pancryptodira), being similar to those identified in the Cameros Basin (NW of the Iberian Range) or in the Morella sub-basin (Maestrazgo Basin), which have been related to the British taxon *Helochelydra*. In addition, a third taxon is recognized as a new eucryptodiran turtle, also represented in other Spanish localities. The knowledge of the turtles of the Upper Jurassic-Lower Cretaceous transition is very limited in Europe, and particularly in the Iberian Peninsula. In this sense, the chelonian fauna of Galve increases the systematic and paleobiogeographic knowledge on this group, represented there by taxa shared with other European regions as well as exclusive Iberian taxa.

Poster Session III, (Tuesday)

ANATOMY OF A SPEED DEMON: THE CAUDAL MUSCULATURE OF *CARNOTAURUS* AND THE IMPLICATIONS FOR ABELISAURID LOCOMOTION AND EVOLUTIONARY TRAJECTORY

PERSONS, Walter, University of Alberta, Edmonton, AB, Canada

The South American genus *Carnotaurus* is the largest and most derived member of the Abelisauridae, a clade of carnivorous dinosaurs best known for the small horns and other cranial ornamentations common to its members. However, the most bizarre and unique skeletal adaptations of *Carnotaurus* and its close relatives occur not in the skull, but in the tail. The anterior caudal vertebrae of *Carnotaurus* have transverse processes that are posteriorly inclined and dorsally angled to the point of exceeding the neural spines in absolute height. The epiphyses of the transverse processes are flattened and expanded, with rounded posterior tips and projecting half-crescent-shaped anterior tips that interlocked with those directly adjacent in the series. These vertebral structures must have increased the mediolateral rigidity of the tail and, therefore, diminished the capacity to move sinuously and to make tight turns. This study interprets the unique caudal morphology of *Carnotaurus* as a possible adaptation for high-speed sprinting.

The ventral surfaces of the transverse processes of the exceptionally well preserved tail of *Aucasaurus* show a narrow anteroposteriorly directed scar that marks the most dorsal insertion boundary of the *M. ilio-ischiocaudalis*/*M. caudofemoralis* septum. The insertion of the *M. caudofemoralis* onto the lateral surfaces of the transverse processes (unknown in other theropods) and the extreme dorsal tilt of the transverse processes are interpreted as adaptations to permit the dorsal expansion of the *M. caudofemoralis*. In most non-avian dinosaurs, the *M. caudofemoralis* was the primary retractor muscle of the hind limb. Digital muscle models indicate that, relative to its overall body size, *Carnotaurus* had a substantially larger *M. caudofemoralis* than any other theropod yet studied, which suggests the potential for greater cursorial abilities. Consideration of these vertebral adaptations in an evolutionary context reveals a progressive sequence of increasing caudofemoral mass and tail rigidity among the Abelisauridae of South America.

Technical Session XI, Tuesday 2:15

MICRORNAS AND VERTEBRATE PHYLOGENETICS

PETERSON, Kevin, Dartmouth College, Hanover, NH, USA; LYSON, Tyler, Yale University, New Haven , CT, USA; SPERLING, Erik, Yale University, New Haven , CT, USA; ALYSHA, Heimburg, Dartmouth College, Hanover, NH, USA; DONOGHUE, Philip, Bristol University , Bristol, United Kingdom

Understanding the evolution of a clade, either from a morphologic or genomic perspective requires a correct topology, allowing for the polarization of traits and the ability to distinguish homologies from homoplasies. Although great advances have been made in unraveling the vertebrate tree of life, primarily based on the incorporation of molecular data, some areas remain incalcitrant. Two areas in particular are the interrelationships of the jawless fishes (hagfish and lamprey) with respect to the jawed fishes, and the interrelationships among the amniotes. Here, we propose that microRNAs, small non-coding regulatory genes, may be a new dataset that can resolve many relationships as they show three properties that make them excellent phylogenetic markers: 1) new microRNA families are continually being incorporated into metazoan genomes through time; 2) they show very low homoplasy, with only rare instances of secondary loss, and only rare instances of substitutions occurring in the mature gene sequence; and 3) they are almost impossible to evolve convergently. Sequencing small RNA libraries coupled with genomic searches supports the monophyly of the cyclostomes, as hagfish and lamprey share several novel miRNA families not found in gnathostomes or in any other metazoan taxa, and the possession of several novel miRNA families supports a sister group relationship between testudines and lepidosaurs. Because of these three properties, we propose that miRNAs are a novel type of data that can be applied to virtually any area of the metazoan tree, including the vertebrate tree, to test among competing hypotheses or to forge new ones.

Poster Session I, (Sunday)

FIRST PALYNOLOGICAL DATA AND INTERPRETATION OF "LO HUECO" VERTEBRATE SITE (UPPER CRETACEOUS, CUENCA, SPAIN)

PEYROT, Daniel, Universidad Complutense de Madrid, Madrid, Spain; BARROSO-BARCENILLA, Fernando, Universidad de Alcalá de Henares, Alcalá de Henares, Spain; BERRETEAGA, Ana, Universidad de Alcalá de Henares, Alcalá de Henares, Spain; CAMBRA-MOO, Oscar, Universidad Nacional de Educación a Distancia, Madrid, Spain

The "Lo Hueco" fossil site includes an interval in "Garumn" facies (informal term for shallow marine, coastal or continental sediments of south-western Europe deposited during Latest Cretaceous and Early Palaeogene) that contain an exceptional richness and diversity of vertebrate fossils, mainly from titanosaur dinosaurs, but also from fishes, amphibians, turtles, lizards, crocodiles, pterosaurs and other dinosaurs. In order to characterize the palaeoenvironment of this site and compare it with other Spanish outcrops in "Garumn" facies, such as Laño and Chera (that contain fishes, amphibians, turtles, lizards, crocodiles, pterosaurs, dinosaurs and mammals), a preliminary analysis of its spore/pollen content has been achieved. The treated samples have revealed a relatively rich palynoflora, mainly integrated by terrestrial palynomorphs. The presence of the coenobia green alga *Pediastrum* is noteworthy, but the studied samples are characterized by the dominance of angiosperm pollen grains and the poor representation of spores and gymnosperm pollen grains. The angiosperm component accounts for about 80 % of the pollinic sum and is represented by more than 20 taxa, including the common Upper Cretaceous monocolpates *Arecipites*, *Liliacidites* and *Monocolpopollenites*, and the tri-colpate/-porates *Foveotricolpites*, *Triporopollenites*, *Triatriopollenites* and *Subtriporopollenites*. The Normapolles *Vancampopollenites*, *Minorpollis* and *Semioculopollis* have been also observed. The gymnosperms are mainly represented by *Inaperturopollenites*, affiliated to the modern Cupressaceae-Taxodiaceae, and by the monosulcate *Monosulcites*, of uncertain botanical affinities. Cryptogams represent a minor component of the palynoflora, being their main representatives *Leptolepidites*, *Deltoidospora* and

Polypodiaceoisporites. As a whole, the studied samples suggest a tropical palaeovegetation dominated by the angiosperms. The sporadic presence of Normapolles indicates that Fagales constituted a minor component of the palaeoenvironment. The comparison with the assemblages described in other Spanish sites in "Garumn" facies supports a late Campanian-early Maastrichtian age for "Lo Hueco".

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 10:30

REGIONAL VARIATION OF INTERVERTEBRAL JOINT STIFFNESS IN EXTANT AND EXTINCT TETRAPODS AND ITS IMPORTANCE FOR THE WATER-LAND TRANSITION

PIERCE, Stephanie, Museum of Zoology, University of Cambridge, Cambridge, United Kingdom; MOLNAR, Julia, Structure and Motion Lab, Royal Veterinary College, London, United Kingdom; HUTCHINSON, John, Structure and Motion Lab, Royal Veterinary College, London, United Kingdom; CLACK, Jennifer, Museum of Zoology, University of Cambridge, Cambridge, United Kingdom

For decades, the iconic genus *Ichthyostega* has been viewed as an archetypal primitive tetrapod from the Late Devonian. However, recent work has suggested that its locomotor mode was more like that of a seal than a salamander – the intervertebral joints of its trunk flexing in a dorsoventral plane rather than laterally as would be predicted for a basal tetrapod. Its backbone exhibits regionalisation in a manner more like a mammal than a Palaeozoic tetrapod implying the presence of specialised musculature with parts of the column adapted for different functions. Our current study aims to test this idea, by examining a broad selection of phylogenetically disparate aquatic and semi-aquatic animals with very distinct modes of locomotion (e.g., salamanders, crocodiles, otters and seals) in order to tease out morphofunctional differences between the vertebral column. We have chosen these taxa for having aspects of vertebral form and function, especially joints and the structures that guide their motion, which might be partly analogous with those of *Ichthyostega*. Fifteen biomechanical indices of axial joint mobility have been measured on each vertebral unit along the spinal column and morphometric profiles for all representative species have been constructed. Our results identify clear regional variation within the axial skeleton which is intimately linked with locomotor style. These data are then compared to experimental measures of static and dynamic mechanical properties of intervertebral joints in fresh, excised vertebral columns in order to identify how the intervertebral joint stiffness of the axial skeleton varies regionally with morphometric correlates of stiffness. The ultimate goal of this research is to gain a better understanding of the relationship between the morphology and function of the vertebrate axial skeleton and to provide a comparative database for exploring the locomotor behaviour and evolution of *Ichthyostega* and other early tetrapods.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

COMPARISON OF EARLY EOCENE SAN JUAN BASIN, NM *PHENACOLEMUR JEPSENI* WITH *PHENACOLEMUR CITATUS* AND *PHENACOLEMUR PRAECOX* FROM BIGHORN BASIN, WY - STUDY OF THE VARIATION AND VALIDITY OF THESE *PHENACOLEMUR* SPECIES

PILBRO, Clayton, University of New Mexico Anthropology Dept. , Albuquerque, NM, USA

Phenacolemur was a late Paleocene-early Eocene paromomyid plesiadapiform from the western North America and Europe. As many as seven species are recognized in North America, and several are distinguished primarily by differences in size and subtle differences in tooth morphology. However, there are questions regarding the validity of at least one species, *P. jepseni*, a taxon originally named from the early Eocene of the San Juan Basin, New Mexico. Some workers have suggested that *P. jepseni* is a junior subjective synonym of *P. citatus* or *P. praecox* from the early Eocene of the Bighorn Basin Wyoming, where specimens are purported to show a continuum in size and morphology that overlap with smaller samples of *P. jepseni* from New Mexico. Unfortunately there is only the one holotype skull and a limited number of isolated teeth associated with *P. jepseni* collected in New Mexico (15 teeth). The low number of comparable fossils makes a meaningful statistical comparison difficult. However, by looking at the larger *Phenacolemur* collections of *P. citatus* (1,047 teeth) and *P. praecox* (955 teeth) from the Bighorn Basin, I have compared trends, using metric data and statistical tools coupled with physical morphology, between the larger Wyoming sample and the smaller New Mexico sample showing patterns and possible variations between the three closely related species. The result of the statistical analyses show *P. jepseni*, *P. citatus*, and *P. praecox* to be distinct, yet highly variable species with characteristics that show intermediate stages between the three species. Morphologically *P. jepseni* specimens from New Mexico are smaller, lack a paraconid on m2 (present on *P. citatus*, and *P. praecox*), and may have a double-rooted upper canine or P1 not seen in either of the other two species of *Phenacolemur*. With these results, it seems logical to consider the New Mexico *P. jepseni* a valid species of *Phenacolemur*.

Technical Session XIV, Wednesday 8:45

THE EVOLUTION OF TAIL VARIATION IN SAUROPOD DINOSAURS

PITTMAN, Michael, UCL, London, United Kingdom; UPCHURCH, Paul, UCL, London, United Kingdom; HUTCHINSON, John, RVC, London, United Kingdom

Sauropod tails are interesting because of differences in length and articular geometry that underlie their purported 'whip-lash' and tail club specializations. To quantify the form, function, and evolution of sauropod tails, we examined factors associated with dorsoventral and mediolateral vertebral joint flexibility in 17 taxa.We compiled a dataset of approximately 6500 size normalized vertebral measurements, and employed principal components analyses to determine parameters responsible for most data variation. Ancestral states were reconstructed using parsimony-based phylogenetic mapping to determine changes along the nodes of the sauropod tree.Factors associated with stiffness in the dorsoventral plane, particularly transverse process, centrum and chevron height, indicate that dorsoventral stiffness decreased across Sauropoda for the proximal tail. Vertebral width, associated with mediolateral stiffness, decreased across Sauropoda for the proximal and mid-tail. This is in line with our prediction that opisthocoelous and procoelous tails had higher dorsoventral and mediolateral flexibility.We also expected high dorsoventral and mediolateral flexibility in 'whip-lash' tails. However, we observed high proximal neural spine height, low mid-tail neural spine, transverse process and chevron height and relatively narrow vertebral width. This instead suggests that the Diplodocoidea used a stiffer proximal tail to support a long but quite flexible mid- and distal tail. This is consistent however with a variety of behaviour interpretations. The Diplodocoidea condition is thus specialized in comparison to the Neosauropoda condition.We also predicted high stiffness distally in clubbed tails to support the club but lower proximal stiffness to increase range of movement. Higher distal neural spines supported distal tail stiffness. In contrast, we actually found high proximal and mid-tail neural spines, transverse processes and chevrons and wide vertebral width suggesting higher proximal stiffness and a relatively restricted range of club movement. High dorsoventral and mediolateral stiffness appears to be the plesiomorphic condition which clubbed sauropods later exapted.

Physical Drivers and Marine Tetrapod Evolution, Monday 9:00

SENSORY ADAPTATIONS IN MOSASAURS

POLCYN, Michael, Southern Methodist University, Dallas, TX, USA

The shift from a terrestrial to a marine habit in mosasaurs should be reflected inthe sense organs. Well preserved snouts of Turonian fossils reveal a neochoanate palate. The small size of the cupola Jacobsoni, housing the vomeronasal organ, indicates diminished olfactory abilities, consistent with reduction of the olfactory lobe of brain. The facial nerve exits form periodic linear arrays laterally, increasing in density on the anterior portion of the snout. This arrangement is an adaptation for acoustic beamforming with bimodal frequency and spatial sensitivity. The extracollumellar cartilage in mosasaurs is calcified and greatly expanded, suspended within and occupying most of the lateral aperture of the quadrate, forming a stiff, yet functional tympanum. The internal process is robust and passes through the meatus, inserting in the medial wall of the quadrate and medially the contacting the stapes. These modified structures are present in Turonian forms; however, in later forms, the cavity between the extracollumellar cartilage and the quadrate increases in volume and its structure is modified, acting as a tuned cavity backing a tympanic membrane.Optimization of acoustic capabilities is accompanied by increased relative head width in plioplatecarpines, displacing the quadrates laterally and providing enhanced spatial sensitivity. Taken together, the changes in the vomeronasal, facial, and auditory sensory organs, suggest an early shift from chemical to acoustic mode of prey detection and acquisition. Progressive reduction of the vestibular organ, and thus its sensitivity, is positively correlated with derived tail and limb morphology, consistent with increasingly agile swimming. Early modifications of the quadrate, tympanum, and extracollumellar cartilage for submarine hearing is augmented in later forms by modification of the facial nerves for acoustic beamforming, suggesting increased perfection of passive acoustic prey location. Diminished olfactory senses, desensitized vestibular organ and development of novel systems to deal with submarine acoustics are similar to the pattern seen in the evolution of whales.

Technical Session XIII, Tuesday 2:45

COMPARATIVE EVOLUTIONARY ECOLOGICAL MORPHOLOGY OF LOCOMOTION IN TERRESTRIAL VERTEBRATE CARNIVORES

POLLY, P. David, Indiana University, Bloomington, IN, USA; LAWING, A. Michelle, Indiana University, Bloomington, IN, USA; HEAD, Jason, University of Toronto at Mississauga, Toronto, ON, Canada

We studied the evolution in locomotor traits in two North American carnivore guilds, the mammalian Carnivora and the reptilian Serpentes, examining their evolution in functional, phylogenetic, community and environmental contexts to better understand how the coevolution of morphology, environments, and members of the same guild have interacted over long temporal and large spatial scales. We collected locomotor osteological measurements: metatarsal/ femur, anterior/posterior calcaneum, and sustentacular facet/calcaneal length in carnivorans and body/tail length, vertebral length/width, and vertebral shape scores in snakes. For both carnivorans and snakes, we categorized morphology relative to dominant substrate: arboreal, scansorial, natatorial, fossorial, cursorial, and generalized terrestrial (snakes do not have cursorial specialists). The osteological indices were correlated with these categories in both carnivorans (N=132; R^2 = 0.24, 0.11, and 0.35 respectively) and snakes (N=271; R^2=0.52, 0.44, and 0.42 respectively). We used these continuously varying proportions as ecometric indices because they more precisely measure the form-function interaction than do the broad locomotor categories. Using phylogenetic regression, we traced ecomorphological evolution on a tree whose branch-lengths were calibrated against the fossil record. Crown carnivorans originated with a five-toed terrestrial morphology when global temperatures were falling and the dominant tropical forest habitat was fragmenting, rapidly diversifing into arboreal, scansorial, and natatorial morphologies as global habitats opened. Pit vipers originated 47 mya with generalized terrestrial morphology and radiated into

different ecomorphological categories later than carnivorans during the Miocene and Plio-Pleistocene. Community sorting was assessed by sampling all species in each group on a 50 km grid across the continent. Mean locomotor morphology in a community was strongly correlated with ecoregion (R^2=0.70) and macrovegetation (R^2=0.49). In snakes, community-level locomotor ecomorphology was most strongly correlated with mean annual temperature (R^2=0.16).

Poster Session I, (Sunday)

THE UNUSUAL PELVIC CONSTRUCTION OF THE INSULAR SHREW *NESIOTITES HIDALGO* (SORICIDAE, MAMMALIA) FROM MALLORCA (BALEARIC ISLANDS, SPAIN)

PONS-MONJO, Guillem, Institut Català de Paleontologia, Cerdanyola del Valles, Spain; FURIÓ, Marc, Institut Català de Paleontologia, Cerdanyola del Valles, Spain; MOYÀ-SOLÀ, Salvador, ICREA, Institut Català de Paleontologia, Cerdanyola del Valles, Spain

The genus *Nesiotites* includes several species of endemic shrewsfrom some Mediterranean islands. These insular forms resulted from the isolation of different populations of the genus *Asoriculus* after the desiccation of the Mediterranean Seain the Messinian Salinity Crisis (Late Miocene). On all the Mediterranean islands, there was a general trend of these shrews to increase their size. The younger species were always larger than the preceding ones in each portion of land. This is one of the main evolutionary trends under isolation, the so-called 'island rule', which in this case could have served to reduce the energetic cost of these high-metabolic-rate mammals.Mallorca (Balearic Islands, Spain) developed its own evolutionary lineage of *Nesiotites* with a noticeable increase in size from *N. ponsi*, the oldest known species, to *N. hidalgo*, the youngest one. Hitherto, there was no other morphological change noticed than the occasional loss of the tiny tooth immediately anterior to the fourth upper premolar in some specimens of the youngest species. This is quite surprising, considering that other mammalian taxa of the island, for example the bovid *Myotragus*, extremely modified their morphology and life-history during the time they remained isolated.The micromammalian fossil remains of the Plio-Pleistocene and Holocene sites from Mallorca have recently beenreexamined. The inspection of the postcranial elements of *Nesiotites* resulted in the discovery that the sacro-pelvic complex of *N. hidalgo* was completely fused. This is, to our knowledge, the first case of a soricid in which the two halves of the pelvis and the sacrum constitute an undividable skeletal element. The lack of a similar construction in any living shrew makes it difficult to elucidate the mechanical advantage that this fused pelvic girdle could have provided. Extreme modifications like this in the postcranial skeleton of the shrews are rather infrequent, and only the recent species *Scutisorex someneri* (the 'hero shrew') from Congo is comparablein its overdeveloped resistant spine for which there is no satisfactory eco-mechanical explanation.

Poster Session I, (Sunday)

THE DIVERSITY AND NOMENCLATURAL REVISION OF THE HOLOCEPHALIAN FISHES (CHIMAERIFORMES) FROM THE HORNERSTOWN FORMATION (K/T TRANSITION) OF NEW JERSEY, USA

POPOV, Evgeny, Saratov State University, Saratov, Russia

The holocephalian assemblage from the Hornerstown Formation (HF) (latest Maastrichthyan – earliest Paleocene) in New Jersey was the first studied, and most diverse, of the Mesozoic-Cenozoic of the USA. During second half of the XIX century a number of HF chimaeroid taxa (7 genera and 20 nominal species) based mainly on isolated tooth plates and some fine spines were published. Most of them were later revised by L. Hussakof. Prior to the current study, the HF assemblage consisted of 3 genera and 9 species (*Edaphodon mirificus*, *E. laterigerus*, *E. stenobryus*, *E. agassizi* (= *E. smockii*), *E. sedgwicki* (= *E. tripartitus*); *Leptomylus densus*, *L. cooki*, *L. forfex*; *Isotaenia neocasariensis*). In 2009, a number of museum collections with type specimens (in New York, Philadelphia, Trenton and New Haven) were studied, along with additional material and recently collected specimens (totally about 100 specimens). A revision of the numerous HF chimaeroid species confirms the validity of 3 genera and 4 species: *Edaphodon mirificus* (= *E. laterigerus*, = *E. smockii*; = *E. tripartitus*; dominated by number), *E. stenobryus* and *Leptomylus densus* (= *L. cooki*; = *L. forfex*). *Isotaenia neocasariensis* is classified as myriacanthid holocephalian. Additionally the HF assemblage consists of *Ischyodus* cf. *dolloi* and ? *Paredaphodon* sp. The presence of British Cretaceous faunal elements (*E. agassizi* and *E. sedgwicki*) reported earlier could not be confirmed. As a result, the HF chimaeriform diversity consists of two suborders: Myriacanthoidei (1 genus and species; first record after Jurassic) and Chimaeroidei (4 genera and 5 species). The character of the HF assemblage is mainly endemic (2 genera, 4 species) and somewhat heterochronous. It has one species (*Ischyodus* cf. *dolloi*) being typical for European Paleocene, but both *Edaphodon* species show morphological relationships with the Late Cretaceous ones (*E. crassus* and *E. eolucifer*) of Eurasia (Belgium, Russia).

Technical Session XII, Tuesday 4:00

MANDIBULAR MECHANICS OF *ALLIGATOR MISSISSIPPIENSIS:* FROM BEAM MODELS TO FINITE ELEMENT ANALYSIS

PORRO, Laura, University of Chicago, Chicago, IL, USA; REED, David, University of Chicago, Chicago, IL, USA; LEMBERG, Justin, University of Chicago, Chicago, IL, USA; ZAPATA, Uriel, Texas A&M Health Science Center, Baylor College of Dentistry, Dallas, TX, USA; ROSS, Callum, University of Chicago, Chicago, IL, USA

Mandibular function has been investigated using a range of techniques, from simple beam modeling to complex finite element analysis, with numerous studies focusing on extant and extinct archosaurs. However, it is unclear how well results from different modeling methods reflect reality, or how specific performance variables (e.g., reaction forces, model deformation, and stress distribution) vary between these methods. These uncertainties must be considered when comparing results derived from different techniques. Furthermore, it is important to understand how estimated input parameters (e.g., material properties and muscle forces) and the loss of small-scale features such as sutures in fossil taxa affect model results. We modeled the *Alligator* mandible during biting at five different locations using both 2D and 3D beam models, as well as a series of increasingly complex finite element (FE) models accounting for sutures, bone anisotropy, variable constraints, and muscle activity. Our results demonstrate that the FE models exhibited higher peak stresses and greater variability in stress distribution than the beam models; furthermore, reaction force magnitudes and distribution were different in the beam and FE models. These finding suggest that the *Alligator* mandible is not optimized to reduce stress during biting (compared to a simple beam) and that beam modeling does not accurately represent the mechanical behavior of the *Alligator* mandible. Incorporating anisotropic bone material properties and sutures into the FE model reduced sagittal stresses within the mandible, but led to increased transverse and torsional stresses, and reduced bite force magnitude. Our results also suggest that the elongate pterygoid flange of crocodilians mitigates mediolateral and torsional stresses generated during bites on the posterior teeth. These findings demonstrate that model complexity determines which questions regarding mandibular function can be addressed, and highlight the limits imposed by taphonomy when modeling fossil archosaurs.

Poster Session I, (Sunday)

VASCULATURE AND DINOSAUR PHYSIOLOGY: VASCULAR PATTERNS IN EXTANT DIAPSIDS

PORTER, William, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA

Some dinosaurs were among the largest animals known. Great size and low surface-to-volume ratios must have generated high heat loads that required efficient thermoregulatory mechanisms. In extant taxa, vascular systems play a key role in such thermal phenomena as evaporative and convective cooling and basking. Thus, we hypothesize that large-bodied dinosaurs had vascular mechanisms to deal with heat. To elucidate the thermoregulatory abilities of dinosaurs, a comparative study of the vasculature of related extant taxa is necessary to show blood flow patterns, areas of thermal energy exchange, and vascular physiological devices. Blood vessels of birds (pheasant, turkey), crocodilians (alligator), and iguanas were injected with latex/barium solutions of differing concentrations to discriminate arteries and veins in CT scans. Specimens were scanned using the OUμCT scanner at slice thicknesses of 45 or 90 microns and subsequently analyzed with the 3D visualization software Amira/Avizo. Vessels were studied with special attention to their relation to known sites of heat exchange (oral cavity, sinuses, tongue, orbital conjunctiva). The oral vascular plexus was extensive in the birds, alligators, and lizards examined; the anastomoses within the plexus increased rostrally along the maxillary palatal shelf and premaxilla. The airway vasculature was extensive in birds and alligators, although more closely associated with the nasal conchae in birds, whereas in alligators it was distributed along the length of the airway. In lizards, the airway vasculature was found within the nasal vestibule and along the length of the airway. Avian vasculature is known to function in thermoregulation (e.g., selective brain temperature regulation). Anatomically similar arrangements discovered in alligators and iguanas raise the possibility of comparable (but as yet unstudied) thermoregulatory abilities in these nonavian reptiles, and potentially extending to extinct archosaurs, as well. The next phase of this project will characterize these physiological devices in a greater diversity of diapsids and identify the vascular osteological correlates that can be assessed in extinct taxa.

Preparators' Session, Monday 8:00

FROM THE BONEBED TO THE BASEMENT: COLLECTION PROCEDURES AT THE MAMMOTH SITE OF HOT SPRINGS, SOUTH DAKOTA

POTAPOVA, Olga, Mamoth Site of Hot Springs, SD, Inc., Hot Springs, SD, USA; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, USA; WILKINS, William, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, USA

The Mammoth Site (MS) is a 26,000 year-old natural, geologic-hydrologic natural trap with entombed remains of Columbian mammoths and other 83 species of vertebrates, invertebrates and plants. Since the site was discovered in 1974, over 2500 specimens from 58 mammoths, and over 2,000 specimens from invertebrates have been recovered. Due to on-going excavations part of the in situ collection (5-8% of over 1,200 uncovered bones) is removed from the bonebed for treatment and shelf storage, and at the same time about 5-8% of bones are added (newly excavated) annually to the bonebed, mapped and treated. In order to maintain good and reliable records of each bone that is excavated and curated, the collections procedures were developed (following Institute of Museum and Library Services (IMLS) Conservation Assessment Program and IMLS Museum Assessment Program recommendations in 2005), specimens forms redefined, and changes were made in using some of the consolidants. The MS has been carefully mapped for 36 years, predominantly through use of string grids and Cartesian mapping coordinates. With a grant from the IMLS, the MS was able to purchase a Trimble® 5600 robotic transit and completely re-map the bonebed in 2006-2009. This machine, in conjunction with ArcGIS® 9.3.3, is used to produce photo-accurate maps of the specimens, both those in situ and those that have been removed during

excavations. For several years the Mammoth Site has been looking into Light Detection and Ranging (LiDAR) mapping, a laser based technique that yields a 3D point cloud, showing the topology of the bonebed in a way that 2D mapping cannot. Lamentably, LiDAR is an expensive technology beyond the MS's means at this time. By feeding multiple views of a single area of the bonebed into photogrammetric software, a 3D map can be generated. There are several bonebed applications for this new technology. First, by distributing this data to other researchers, they will be able to take measurements of the relationships between bones, and measure their morphology. Second, using archival images, it will be possible to make accurate 3D meshes of the conditions at the site during past excavations.

Poster Session I, (Sunday)

NEW CHONDRICHTHYAN MICROREMAINS FROM NEW YORK, USA: INSIGHTS INTO MIDDLE-LATE DEVONIAN CHONDRICHTHYAN GLOBAL DISPERSION

POTVIN-LEDUC, Daniel, Université du Québec à Rimouski, Rimouski, QB, Canada; CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QB, Canada; LANDING, Ed, New York State Museum, Albany, NY, USA; VANALLER HERNICK, Linda, New York State Museum, Albany, NY, USA; MANNOLINI, Frank, New York State Museum, Albany, NY, USA

Chondrichthyans represent a diverse component of the Devonian fish assemblages from eastern North America. Although most Early and Middle Devonian chondrichthyans are thought to be endemic to Laurussia, some of the shark genera displayed a cosmopolitan distribution by the Late Devonian. Fossil fish remains from New York state, including the Antarctilamnidae *Wellerodus*, suggest an earlier presence of some shark species on both Gondwana and Laurussia. A new Givetian fish assemblage from the Catskill, NY, area composed of ca. 15 species includes two shark genera (*Portalodus*, *Wellerodus*) earlier thought to characterize Gondwanan assemblages. Abundant teeth of a new species of *Portalodus* reveal a monognathic heterodonty and two possible morphotypes, one of them interpreted as juvenile. Rare small teeth are referable to juvenile W*ellerodus wellsi*. In addition, two groups of chondrichthyan scales have been identified: (1) compound scales of ctenacanth type and (2) body and head scales characterized by a single median rhomboid crown and an anteriorly protruding base. Elasmobranch scales similar to both groups have been described from the Givetian of east Gondwana (Antarctica). However, the first group shows even stronger affinity to scales from the Givetian of west Gondwana (Spain). Remains of *Portalodus* and antarctilamnids are known from Australia, Antarctica, South Africa, South America (Bolivia, Brazil, Colombia and Venezuela), Iran and Saudi Arabia, and also from the USA and Europe (Spain, Poland and Russia); this distribution could suggest a dispersal path from north to south, along the west coast of Gondwana. Thus, the New York fossils reinforce the hypothesis of a global dispersal of sharks by the Middle Devonian rather than by the Late Devonian.

Physical Drivers and Marine Tetrapod Evolution, Monday 12:00

WHAT HAPPENED TO GRAY WHALES DURING THE PLEISTOCENE? RECONSTRUCTING THE ECOLOGICAL IMPACT OF SEA-LEVEL CHANGE ON CRITICAL BENTHIC FEEDING HABITATS IN THE NORTH PACIFIC OCEAN

PYENSON, Nicholas, Smithsonian Institution, Washington, DC, USA; LINDBERG, David, University of California, Berkeley, Berkeley, CA, USA

Gray whales (*Eschrichtius robustus*) undertake long migrations, from Baja California to Alaska, to feed on the seasonally productive benthos of the Bering Sea. The invertebrates that form their primary prey are restricted to shallow water environments, but global sea-level changes during the Pleistocene eliminated or reduced this critical habitat multiple times. Because the *Eschrichtius* fossil record is coincident with the onset of Northern Hemisphere glaciation, gray whales survived these massive changes to their feeding habitat, but it is unclear how. We reconstructed the ecological history of gray whales during the past 120,000 years by quantifying gray whale feeding habitat availability using bathymetric data for the North Pacific Ocean, constrained by their maximum diving depth. We used two different estimates of pre-whaling population size (census and molecular estimates) as initial values, and plotted changes in estimated population size based on correlated changes in both eastern and western North Pacific benthic habitats during the last glacial-interglacial cycle. Results using census estimates show that the elimination of key benthic feeding habitat during glacial maxima would have caused multiple genetic bottlenecks, but such genetic patterns are absent in mitochondrial haplotype data. Results using molecular estimates show that gray whales survived glacial maxima in sufficient numbers to maintain genetic diversity, providing independent support for molecular estimates of pre-whaling population size. Given the lack of benthic feeding habitat during glacial maxima, we propose that gray whales survived the Pleistocene by employing generalist filter-feeding modes, similar to those by non-migrating sub-populations off the coast of British Columbia today.

Technical Session XV, Wednesday 8:00

A *URANOLOPHUS*-LIKE LUNGFISH FROM THE PRAGIAN (EARLY DEVONIAN) OF YUNNAN, SOUTH CHINA

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Uranolophus from the Pragian (Early Devonian) of Wyoming, USA, is among the earliest known undisputed lungfish. However, some morphological features of *Uranolophus* such as the shape of the parasphenoid, as well as its phylogenetic relationship, have been debated. Here we report a new *Uranolophus*-like lungfish from the late Pragian of Yunnan, China. The new form exhibits many primitive lungfish features, such as the supraorbital canal not in contact with the infraorbital canal, I bones meeting behind the B bone, the skull broadest posteriorly, the long supratemporal series, and a short prepineal region. It shares with *Uranolophus* aspects of the morphology of the palate: the surface of the palate covered predominantly by small, conical denticles, a continuous strip of teeth along the lateral margin, and a smooth untuberculated area along the posterior margin. The new form differs from *Uranolophus* in the presence of the pineal foramen, the fusion of bones in the anterior part of the skull roof, the relatively long nasal capsule, and a pair of anteriorly positioned vomers. A high-resolution CT scan of the material shows that the new form has a slim triangular parasphenoid which separates the majority of pterygoids. This may suggest that the parasphenoid condition in *Uranolophus* is more likely as suggested in the original description. The anteriorly elongated parasphenoid is also present in *Diabolepis*, *Youngolepis* and porolepiforms, indicating that this might be a plesiomorphy of the Dipnomorpha. Phylogenetic analysis places the new form as the sister taxon to *Uranolophus.* The close relationship between these two forms may indicate some close paleogeographic connections between the South China and Euramerica blocks during the Pragian.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

PHYLOGENETICS OF FOSSIL AND EXTANT DELPHINOIDEA (CETACEA: DELPHINOIDEA) USING BAYESIAN INFERENCE

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Delphinoids (Cetacea: Delphinoidea) are a diverse group of charismatic cetaceans, including Phocoenidae (true porpoises), Delphinidae (oceanic dolphins), and Monodontidae (narwhals and belugas), the phylogenetic relationships of which have recently been examined extensively using molecular data and modern phylogenetic methods. Little emphasis has been placed on the use of morphological characters in this group, let alone scientifically rigorous analyses of the inter- and intrarelationships of fossil grades of putative delphinoids such as the Kentriodontidae. The uncertainty of fossil and extant delphinoid affinities underscores the lack of justification for using certain fossils to calibrate molecular clocks in cetacean phylogeny. Among extant delphinoids, further complications arise as no proposed subspecies or species limits are recognized at the formal taxonomic level, despite compelling evidence for distinct lineages, nor have they been used or recognized in morphological phylogenetic analyses. To reconcile these issues within a cohesive phylogenetic framework, I analyzed morphological and molecular data using Bayesian Inference. I explored methods of partitioning the morphological data based on character type (e.g., binary, multistate) and functional region (e.g., cranium, pectoral region) applying the Mk1 model (currently the only model of evolution available for morphology) to each. I explored the impact of excluding certain taxa, and compared results from molecular-only, morphology-only, and combined data. Monophyly of crown Delphinoidea, as well as Phocoenidae, Monodontidae, and Delphinidae, was strongly supported. No fossils were supported as belonging within the crown taxa. Fossil taxa referable to Phocoenidae were inferred as stem delphinoids. Additionally, results confirm that the Kentriodontidae are a paraphyletic grade with some taxa sister to crown delphinoids and others more closely related to other kentriodontids. These results emphasize the importance of dense taxon sampling for phylogenetic inference, and taxonomic revision of the group is imperative for conservation initiatives and any study of character evolution.

Poster Session III, (Tuesday)

DENTAL MICROWEAR ANALYSIS REVEALS SPATIAL AND TEMPORAL VARIABILITY IN THE DIET OF TWO EOCENE PRIMATES FROM FRANCE

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Diet is important in a primate's life, correlating to parameters as diverse as foraging strategies, body size, ranging, or even social group. It is also highly variable, as potential food sources vary in spatial distribution and availability over time. The fossil record offers few possibilities to assess the dietary range of a given primate over its spatial and temporal distribution. Because of the fragmentary nature of fossils, dietary estimations for extinct primates merely represent either an overall approximation or a snapshot in time. The European primate fossil record of the Eocene has been built up over decades of fieldwork and now offers the possibility of an extensive dietary study in a spatial and temporal framework. Here we focus on two taxa, *Leptadapis magnus* (Adapidae, Adapiformes; 32 specimens sampled) and *Necrolemur antiquus* (Microchoeridae, Omomyiformes, 71 specimens sampled). These two taxa occur in different localities of the late Eocene of France ranging from MP16 (Robiac), MP17a (La Bouffie, Euzet, Fons 6) to MP17b (Perrière). Fossil diet was assessed by dental microwear analysis using a comparative database of 11 species of living strepsirhines. On the whole, leaves were a preferred food for the large bodied *Leptadapis* (4-5kg). However, this taxon varied from a mixed leaf/fruit diet at La Bouffie, a closed tropical rain forest environment, to a strictly folivorous one in the more open environment of Perrière. The small bodied *Necrolemur* (200-300g), on the other hand, basically had a diet mainly based on fruit and would have supplemented its diet with insects. Similarly to that of *Leptadapis*, microwear patterns show variations in *Necrolemur*'s diet between coeval localities, most likely shifting from a soft fruit based diet at La Bouffie to a mixed fruit/insect diet in the tropical wooded savannas of Euzet and Fons, i.e. going from a soft based diet to a more abrasive one.

When comparing localities from similar tropical rainforest environments but of different ages (Robiac *vs* La Bouffie), *Necrolemur* varies from a mixed fruit/insect diet (Robiac) to a mainly fruit based diet (La Bouffie).

Poster Session I, (Sunday)

A PRELIMINARY REPORT ON A BLANCAN MICRO MAMMAL ASSEMBLAGE FROM THE OTAY RANCH VILLAGE 2 NORTH HOUSING DEVELOPMENT PROJECT, SAN DIEGO FORMATION, CHULA VISTA, CALIFORNIA

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Construction activities associated with the development of the Otay Ranch Village 2 North Housing Development Project, Chula Vista, California, exposed approximately 67 feet of marine and non-marine deposits from the lower portion of the Pliocene-age San Diego Formation. Approximately 4000 lbs of micro fossil-rich matrix was collected from informal member 1C, which at this site was a light orange brown, fine-grained sandstone as part of a 10 foot thick paleosol deposit. This unit is below and older than the terrestrially-deposited fluvial member 2C of the San Diego Formation, which previously has produced Blancan micro vertebrate faunas from other areas of southwestern San Diego County. These faunal assemblages from member 2C have been dated to approximately 3.6 million years through biochronological and paleomagnetic techniques. After heavy liquid separation and picking, the 4000 lb sample from Otay Ranch Village 2 North produced a wide array of terrestrial vertebrates which has been cataloged into the paleontology collections of the San Diego Natural History Museum. The small mammal portion of the collection includes the leporid *Hypolagus*, soricids, the sciurids *Spermophilus* and *Tamias*, the heteromyids *Perognathus* and *Dipodomys*, and cricetid rodents *Peromyscus*, *Reithrodontomys*, *Calomys*, and *Neotoma*. A single lower carnassial tooth of the mephitid *Spilogale* was also discovered. This assemblage of micro mammals represents a Blancan-aged fauna older than previously documented terrestrial Pliocene faunas from the San Diego Formation. This older fauna is compared to other Blancan faunas from the Southwestern United States including San Timoteo Badlands and Vallectio-Fish Creek Badlands in Southern California; and the Verde Valley and Stafford and Duncan Basins in Arizona. Initial comparisons reveal the lack of some desert small mammals including arvicoline and geomyid rodents. The recovery of this new fauna is significant owing to the general paucity of Pliocene terrestrial deposits in California.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

LATE MIDDLE TIFFANIAN (LATE PALEOCENE) MAMMALS FROM SOUTHEASTERN SASKATCHEWAN, CANADA

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The late Paleocene Roche Percée mammalian local fauna is based on over 5000 specimens (principally isolated teeth and jaw fragments with teeth) collected in the early 1970s by field parties from the University of Alberta led by D. W. Krause. The fossils come from the Ravenscrag Formation exposed in abandoned pits in the coalfields near Estevan, southeastern Saskatchewan, Canada. Descriptions of the Roche Percée multituberculates and plesiadapiforms were provided in the late 1970s, but the vast majority of the other members of the local fauna had remained unstudied until the present project. My research shows that the Roche Percée local fauna includes over 30 mammalian species, exclusive of multituberculates and plesiadapiforms. Significant discoveries include several new species of viverravid carnivorans, a new species of the phenacodontid condylarth *Ectocion*, a probable new species pertaining to the semi-aquatic pantolestid *Palaeosinopa* (the most abundant taxon in the present study), and rare teeth suggesting only the second known North American occurrence of the European lipotyphlan *Adapisorex*. More conventionally, a late middle Tiffanian Land Mammal Age (Ti4 lineage zone) has been assigned to the Roche Percée local fauna, based mostly on the plesiadapiforms, including the occurrence of *Plesiadapis churchilli*; my correlations from the remainder of the local fauna are in general agreement with this age estimate. My comparisons suggest a close similarity of the Roche Percée assemblage to the near contemporaneous Divide Quarry local fauna in the Bighorn Basin, northern Wyoming, which occurs in geomagnetic polarity chron 26R, at approximately 59 Ma, but also reveal some similarities to slightly older early middle Tiffanian local faunas at localities further west, in the Paskapoo Formation of central Alberta. The specimens from the Roche Percée local fauna represent the largest and most taxonomically diverse assemblage of late middle Tiffanian mammals yet known, offering a unique perspective on mammalian evolution and diversity in North America during this time interval.

Poster Session II, (Monday)

OLDEST BAT (CHIROPTERA, EOCHIROPTERA) FROM AFRICA: EARLY EOCENE FROM EL KOHOL (ALGERIA)

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The Afro-Arabian Paleogene fossil record of Chiroptera is very poor. In North Africa and Arabia, this record is limited, thus far, to a few localities mainly in Tunisia (Chambi, late early Eocene), Egypt (Fayum, late Eocene to early Oligocene), and the Sultanat of Oman (Taqah, early Oligocene). It consists essentially of isolated teeth or mandible fragments. Interestingly, these African fossil bats document two modern groups (Vespertilionoidea and Rhinolophoidea) as early as the late early Eocene, while the bat fossil record of North America, Eurasia and Australia principally includes members of the Eochiroptera during the early Eocene. In Algeria, the region of Brezina, south east of the Atlas Mountains, is famous for the earliest Eocene El Kohol Formation, which yielded one of the earliest mammalian faunas of the continent. A very primitive and endemic fauna including the early proboscidean *Numidotherium koholense* was discovered in a marl level at the base of this rock unit. Recent fieldwork in the same level has led to the discovery of a new vertebrate locality, including isolated teeth of Chiroptera. These fossils represent the first occurrence of Chiroptera in Africa, thus extending back to the earliest Eocene the record of the group on that continent. The material consists of an upper molar and two fragments of lower molars. The upper molar shows a rectangular outline, which is waisted mesio-distally. Its lingual part displays a strong and central protocone that is surrounded lingually by a complete cingulum, which extends distally forming a hypoconal lobe. A metaconule is faintly visible. On the lower molars, the trigonid is higher than the talonid. The large talonid basin bears a small hypoconulid, which is disto-lingual in position, and relatively close but labial to the entoconid. This condition of the hypoconid-hypoconulid-entoconid complex corresponds to a typical submyotodont structure. Such a dental character association occurs primarily in Eochiroptera. This first occurrence of Eochiroptera in Algeria, and by extension in Africa, shows that this basal group of Chiroptera had a worldwide distribution during the early Paleogene.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 8:45

JAW-JOINT FUNCTION AND PLASTICITY IN MAMMALS

RAVOSA, Matthew, University of Missouri School of Medicine, Columbia, MO, USA; NING, Jie, University of Missouri School of Medicine, Columbia, MO, USA; STOCK, Stuart, Northwestern University Feinberg School of Medicine, Chicago, IL, USA; STACK, Mary, University of Missouri School of Medicine, Columbia, MO, USA

Altered loads are known to induce a series of joint tissue responses. This adaptive plasticity appears designed to maintain a sufficient safety factor, and thus the structural integrity of a given element or system, for a predominant loading regime(s). Data regarding the ontogenetic effects of altered stresses on joints can uniquely supplement in vivo experiments as well as benefit our understanding of how behavioral variation during one's lifetime underlies patterns of phenotypic variation. Here, we present an integrative study of the temporomandibular joint (TMJ) and mandibular symphysis in growing rabbits raised from weaning until adulthood on foods of different material properties. Data are derived from metric, microCT, histological, immunohistochemical and gene expression analyses.

Rabbits subjected to joint over-loading develop significantly greater biomineralization, thicker articular and cortical bone, more robust joints, and marked changes in cartilage extracellular matrix components. There are also a number of corresponding changes in TMJ articular disc gene expression patterns. Our study suggests that the short-term duration of earlier analyses of cranial joints offer a limited notion of the complex process of developmental plasticity, especially as it relates to the effects of long-term, naturalistic variation in mechanical loads. Indeed, it is likely that a component of the adaptive increases in jaw-joint proportions and biomineralization represent a compensatory mechanism to cartilage degradation that serves to maintain the functional integrity of a joint system. Thus, while variation in joint anatomy and performance among sister taxa is, in part, an epiphenomenon of interspecific differences in diet-induced masticatory stresses characterizing the individual ontogenies of the members of a species, this behavioral signal may be increasingly mitigated in older organisms by the interplay between adaptive and degradative responses as well as diminished overall levels of plasticity. Such evidence, including the postnatal onset and duration of a given behavior, has critical implications for paleobiological reconstructions of feeding adaptations.

Poster Session IV, (Wednesday)

STASIS IN LATE PLEISTOCENE *BISON* FROM LA BREA TAR PITS OVER THE LAST GLACIAL-INTERGLACIAL CYCLE

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Conventional evolutionary biology often portrays organisms as infinitely responsive to environmental change in size and morphology, but many decades of research on large Pleistocene mammals has shown that they don't change much during the climatic changes of multiple glacial-interglacial cycles. To evaluate this hypothesis, we studied one of the most common late Pleistocene herbivores, *Bison antiquus*, from the Rancho La Brea tar pits in the Page Museum in Los Angeles. We measured large samples (more than 100 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 evaluated these measurements for variation through time using standard ANOVA and t-tests. Even though all the available climatic indicators (isotopes, plants, pollen, land snails) provide evidence of major climatic and vegetational change from the previous interglacial (40 ka-20 ka) to the peak glacial (20 ka-15 ka) to the glacial-interglacial transition (15 ka-10 ka) to the Holocene, none of these bones show any statistically significant differences in size or shape from one level to the next. Such stasis is prevalent among all the common mammals and birds over the late Pleistocene-Holocene, despite dramatic climatic changes. This suggests that birds and mammals are less responsive to environmental variables than conventional evolutionary biology has assumed.

Technical Session XVIII, Wednesday 3:30

DIE AND ROT: EXPERIMENTAL TAPHONOMY OF TADPOLES

REDELSTORFF, Ragna, University College Dublin, Dublin, Ireland; ORR, Patrick, University College Dublin, Dublin, Ireland; MCNAMARA, Maria, Yale University, New Haven, CT, USA

The general term 'soft tissues' disguises the variation in fossilisation potential of the different tissues and organ systems of chordates, even within a single taxon. Modelling this using decay experiments can help resolve the affinities of problematic soft-bodied fossils that may represent chordates. Decay experiments also provide information to help constrain the interpretation of specific anatomical features within fossils. We experimentally decayed tadpoles of the frog *Xenopus laevis* to establish the general pattern of degradation and, in particular the fate of the notochord, nerve cord, gut and lateral line system. These share one general feature in common: they are linear structures running the length of the body. As such, distinguishing between the possible alternatives is potentially problematic in fossil material. Our experiments show that muscle tissue decays rapidly. At the next stage, the internal organs within the coelom as well as the eyeballs disintegrate, while the dermal tissue of the coelom remains coherent until late stages in the decay history. The nerve cord disintegrates relatively early leaving only traces of fibres but no cohesion after loss of the spinal cord membrane. The last internal structure to decay is the membrane of the notochord, while the internal vacuoles decay in the earliest stages in the decay history. Notably, the dermal tissues decayed uniformly over the body surface but is still cohesive at the last stage of our experimentss. A thick bacterial biofilm rapidly developed around the decaying tadpole. This was either: (i) "blanket-like", with its margins fixed to the jar bottom and the tadpole, although 'floating', trapped below it; or (ii) tightly encased the specimen and secured it firmly to the jar bottom. No variable could be identified that correlated with the pattern of biofilm. Such biofilms inhibit both disarticulation of the carcass and its floating after the build-up of internal decay gases.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

LONG-TERM TRENDS IN THE RICHNESS OF LATE CRETACEOUS NONMARINE VERTEBRATE FAUNAS FROM SOUTHERN UTAH

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Robust, quantitative paleocommunity studies using long-duration datasets of whole assemblages are common when investigating shallow marine, invertebrate communities, but such studies are rare for terrestrial vertebrate communities. In order to develop a robust understanding of how terrestrial community structure and trophic organization have changed through time and with respect to environmental perturbations, there is a *critical need* for the quantification of long duration, assemblage level, taxon richness and abundance patterns for vertebrate paleocommunities. This study provides a first approach in quantitatively characterize long-term trends in Late Cretaceous nonmarine vertebrate richness, using faunal occurrence lists from the Kaiparowits Plateau of southern Utah, with the central goal of providing a baseline comparison for major extinction events and other perturbations (sea-level fluctuation, biotic invasions, climate change, etc.) that have affect terrestrial vertebrate diversity throughout Earth's history.

Faunal occurrence data was compiled from microvertebrate localities from the Dakota Formation, Smoky Hollow Member, John Henry Member, Wahweap Formation, and Kaiparowits Formation, and are used to assess changes in taxonomic richness between the late Cenomanian, late Turonian, late Santonian, middle Campanian, and late Campanian, respectively.

The taxonomic richness of nonmarine vertebrates does not change for the majority of the Late Cretaceous, until the Late Campanian where there is a 15-25 % increase. This trend is seen at all taxonomic levels across all major groups and is not an artifact of increased sampling intensity. Origination and extinction rates are also nearly constant throughout this period of the Cretaceous. The Kaiparowits Fm. is the most invariant unit in terms of its sedimentary characteristics, so a larger variety of environments are also not being sampled. While all the localities used in this study were collected from anastomosing rivers the potential effect of different perservational biases between the depositional facies has not been determined and will be addressed in the future.

Poster Session I, (Sunday)

A NEW PLIO-PLEISTOCENE MICROMAMMAL ASSEMBLAGE FROM HADAR A.L. 894, AFAR ETHIOPIA

REED, Denne, University of Texas at Austin, Austin, TX, USA; GERAADS, Denis, CNRS France, Paris, France

A new micromammal fossil fauna recovered from the archeological locality A.L. 894 at Hadar, Ethiopia reveals a ca 2.35 Ma rodent paleocommunity that is substantially different from what was previously known from older deposits at Hadar. This paper reports on the systematics of the new fauna, including at least one new species and one new subspecies of murine rodent, and also discusses the impact the fauna has on our understanding of Plio-Pleistocene paleoenvironments and biogeography. The A.L. 894 fauna provides evidence of a faunal shift occurring between 3.2 and 2.35 Ma, and interval of substantial climate change in East Africa. The timing of this shift is significant as it may coincide with key paleoanthropological events in East Africa such as the emergence of the genus *Homo* at ca 2.5 Ma.

Technical Session II, Sunday 8:00

NEW PERMO-CARBONIFEROUS CASEID SYNAPSIDS FROM NORTH AMERICA AND EUROPE, AND THEIR EVOLUTIONARY SIGNIFICANCE

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Two new basal members of Caseidae provide valuable insights into the early evolution of this clade of Paleozoic synapsids. The preparation and study of a very small, immature synapsid skeleton from the Upper Pennsylvanian Hamilton Quarry in Kansas reveals that it represents the oldest known caseid. The skeleton includes phylogenetically informative parts of the skull, including a very large supratemporal that overhangs the skull table, large triradiate postorbital with a significant contribution to the skull table, reduced squamosal, small temporal fenestra, and a large subtemporal bar. Phylogenetic analysis places this new taxon at the base of Caseidae, more closely related to members of that clade than to its sister taxon, the Eothyrididae. The presence of this basal caseid at the Hamilton Quarry greatly extends the fossil record of this clade of stem synapsids, significantly shortening the ghost lineage of this taxon. Despite its caseid affinity, it lacks any osteological evidence for high fiber herbivory, a characteristic of all other known caseids. Similarly, preparation of caseid specimens collected from the famous Lower Permian Bromacker Quarry near Gotha, Germany has resulted in the discovery of a partial skull. This discovery also has major implications for our understanding of caseid evolution because this is one of the oldest known caseids, being only slightly younger than the small caseid from Kansas. Several articulated postcranial skeletons of this undescribed caseid have been collected previously and prepared, and they reveal the typical features that denote high fiber herbivory, such as a barrel-shaped body. However, the skull lacks the typical leaf-shaped dentition seen in younger caseids. These new caseids not only extend the fossil record of the clade significantly, but they also indicate that the primitive condition for the clade is a combination of relatively small size and a carnivorous or omnivorous diet. Thus, high fiber herbivory and large body size likely evolved within Caseidae, an evolutionary trend that seems to have paralleled the history of another clade of stem synapsids, the Edaphosauridae.

Poster Session IV, (Wednesday)

WHATEVER FITS THE BILL: NOVEL DIGITAL TECHNIQUES FOR RECONSTRUCTING SKULL AND EYEBALL ANATOMY IN THE UNUSUAL EXTINCT HAWAIIAN DUCK, *TALPANAS LIPPA*

RIDGELY, Ryan, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA; JAMES, Helen, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; OLSON, Storrs, National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; IWANIUK, Andrew, University of Lethbridge, Lethbridge, AB, Canada

Talpanas lippa, a bizarre subfossil anseriform from the Holocene of Kauai, Hawaii, is known only from fragmentary skull and postcranial elements. The latter suggest that *Talpanas* was a flightless anatid. Preserved cranial elements include a neurocranium, palate, and parts of the mandible. Although incomplete, these elements are sufficient to allow a testable reconstruction of the complete skull through a combination of comparative anatomical techniques, CT scanning, and 3D modeling. All *Talpanas* skull bones as well as intact heads of closely related extant anatids (*Oxyura*, *Anas*) were scanned at the OUmicroCT scanning facility. Digital endocasts of the brain cavity and inner-ear labyrinths of all specimens were generated using Amira. The eyeball was also segmented and digital skull models were generated for all extant taxa. To reconstruct *Talpanas*, the CT data were imported from Amira into 3D modeling software (Maya). Missing bony elements were either mirrored from existing elements or generated from *Oxyura*, a possible sister taxon to *Talpanas*. The 3D elements from *Oxyura* were then scaled to the size of *Talpanas*, based on neurocranial dimensions. The *Talpanas* elements were positioned in 3D space, and *Oxyura* elements were then "warped" to fit the elements of *Talpanas* using a single lattice deformer. Enough bony landmarks are preserved in *Talpanas* to constrain the deformation of the *Oxyura* elements to limit the possible reconstructions based on the data at hand. The size and placement of the eyeball in *Talpanas* was reconstructed in the skull based on anatomical criteria and then tested against predicted size based on a morphometric analysis of optic foramen and eye size. The resulting reconstruction of skull and eye morphology in *Talpanas* is a testable hypothesis and is well constrained anatomically. Being completely digital, our 3D reconstruction was easily evaluated and refined iteratively despite the distances between team members. Moreover, the skull reconstruction informed the artist, who then applied his expertise to put the animal back in its environment, ultimately completing the research cycle through public outreach.

Poster Session II, (Monday)

A BASAL THYREOPHORAN (DINOSAURIA, ORNITHISCHIA) FROM THE TIOURAREN FORMATION OF NIGER

RIDGWELL, Nicole, University of Chicago, Chicago, IL, USA; SERENO, Paul, University of Chicago, Chicago, IL, USA

Anew small-bodied basal thyreophoran has been discovered in the Tiouraren Formation of Niger in association with the sauropod *Jobaria* and theropod *Afrovenator*. The remains include associated, but disarticulated, bones, teeth, and abundant scutes from many individuals ranging in maturity from subadult to adult. The femoral shaft retains a sigmoid curve but is

considerably stouter in proportion than the North American genus *Scutellosaurus*, suggesting that the new taxon is an obligate quadruped with a body length of approximately two meters. The subtriangular crowns, none of which show wear facets, have symmetrical enamel, a rounded cingulum, and five to six denticles along each edge. The dentition thus appears similar to that in *Scutellosaurus*, the most basal thyreophoran known at present. Portions of both girdles have been recovered showing features more advanced than in comparable bones in *Scutellosaurus*. The scapular blade has a very unusual subtriangular, rather than subrectangular, shape. The ilium has a moderate supraacetabular crest over an acetabulum that is largely open. The preacetabular process twists into a horizontal plane and expands towards its distal end. The pubis has a short prepubic process that is dorsoventrally, rather than transversely, compressed, and a postpubic process that is reduced to a slender rod about one-half the length of the ischium. Dermal armor ranges from small, keeled ossicles to considerably larger hollow-based scutes half as long as the ilium. Although comparisons are limited at present, the new basal thyreophoran appears to be more advanced than *Scutellosaurus* but to lie outside Eurypoda (Stegosauria + Ankylosauria). It represents the first basal thyreophoran from a southern continent.

Physical Drivers and Marine Tetrapod Evolution, Monday 8:30

THE DIVERSIFICATION AND DECLINE OF SAUROPTERYGIA IN THE TRIASSIC WESTERN TETHYS

RIEPPEL, Olivier, The Field Museum, Chicago, IL, USA

During the Triassic, sauropterygian diversification occurred along coastlines, in lagoonal settings, or shallow epicontinental seas. Only the pistosaur lineage ventured into deeper waters, eventually giving rise to the pelagic plesiosaurs at the Triassic-Jurassic boundary. The correlation of sauropterygian diversification with geophysical events is particularly well documented for the Western Tethyan faunal province. A marine transgression beginning in the late Early Triassic, and proceeding from East to West, led to the colonialization of the central European Muschelkalk basin by sauropterygians. The opening of a southern gateway allowed sauropterygians to disperse into intraplatform basins along the northern shore of the Western Tethys, providing for further diversification. Rifting between the African and Eurasian plates opened the Neotethys, which was followed by a divergence of southern (middle Eastern) and northern (European) nothosaurian taxa. The last stem sauropterygians to go extinct in the Late Triassic were the cyamodontoid placodonts, which in virtue of their dermal armor were tolerant of varied environmental conditions that resulted a sea-level drop and an increasingly warmer climate.

Poster Session IV, (Wednesday)

EVIDENCE OF A PREDATION ATTEMPT ON A GIANT BEAVER BY A TERRESTRIAL CARNIVORE

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The skull of an adult Late Pleistocene giant beaver (currently referred to as *Castoroides leiseyorum* from the Cooper River of Charleston Co., South Carolina) shows evidence of a partially-healed bite wound on the left maxilla. A puncture wound in the left infraorbital foramen is consistent with damage caused by a large conical-shaped tooth no less than 45 mm in height. Damage to the ventral maxilla is consistent with crushing caused by the opposing canine of the predator's left mandible. Muscle damage also would have occurred, but the point of injury was anterior to the main mass of the beaver's left masseter muscles. High-resolution cone-beam CT scans and 3D reconstructions of the skull and teeth reveal internal evidence of the traumatic event. The left incisor's pulp canal space was obliterated and the tooth's surface shows gross deformities, indicating that the force of the impact damaged the basal developing region and resulted in it filling with reparative dentin and ceasing to grow. While the incisor ceased to erupt, it continued to be used, resulting in an abnormally shortened and worn left incisor. The right incisor was undamaged and continued to erupt and wear normally. These dental pathologies are consistent with results of studies in which ever-growing incisors of laboratory rats were experimentally traumatized, as well as with observations of trauma to human teeth of determinant growth. The angle in which the predator's tooth entered the infraorbital canal, the position of the crushing injury on the maxilla caused by the predator's mandibular tooth, and the absence of injury to the beaver's zygomatic arch all combine to eliminate the possibility of a crocodilian predator and restrict mammalian predator candidates to only the American lion, *Panthera atrox*. Other carnivores, including the dire wolf and short-faced bear, have incisor arcades too prognathous to have caused the wound as it is preserved.

Poster Session IV, (Wednesday)

NEW EARLY MIOCENE CAMELID FROM THE LAS CASCADAS FORMATION, PANAMA CANAL, CENTRAL AMERICA

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Expansion of the Panama Canal that began in 2008 has resulted in renewed focus on geological and paleontological research. New exposures of outcrops have resulted in recovery of many additional vertebrate fossils from the previously known early Miocene Cucaracha Formation (Centenario Fauna). Here we report the first known mammals from the underlying late Oligocene/early Miocene Las Cascadas Formation, a volcanoclastic and tuffaceous sequence outcropping in the southern part of the Panama Canal. The faunal assemblage includes the oldest records of carnivores, rodents, peccaries, equids, anthracotheres, protoceratids, and camelids from the Panama Canal. The new camelids, represented by two partial dentaries and isolated lower teeth, can be attributed to Floridatragulinae based on the following characteristics: 1) a complete lower dental formula, 2) brachydont lower molars, 3) an unusual elongated jaw with 2 caniniform teeth (C/1-P/1) well separated by a diastema; 4) a long and narrow mandibular symphysis; 5) reduced lower premolars; 6) small intercolumnar pillars present in the molars; and 7) an M/3 hypoconulid divided by lingual and labial selenes. This new Central American floridatraguline lacks the presumably more derived P/2-P/3 diastema present in Hemingfordian-Barstovian North American *Floridatragulus (F. dolinchanthereus, F. hesperus, F. nanus and F. texanus)* suggesting a primitive morphological state similar to the potentially younger floridatraguline *Aguascalentia wilsoni* from the Hemingfordian of Mexico and possibly *Aguascalentia* sp. from the Arikareean of the Texas Big Bend area. Preliminary geochronological and stratigraphical data indicate that the Las Cascadas local fauna may constitute a distinctive Arikareean faunal province characterized by the arrival of early Miocene northern immigrants into a small continental basin clearly connected with North American continental terrains. The inferred appearances of *Aguascalentia* in the Hemingfordian of Mexico and the late Arikareean of Texas and Panama are consistent with the idea that ungulates appearing in the early Miocene of North America may have had their origins in Central America.

Poster Session III, (Tuesday)

NEW MAMMAL RECORDS FROM THE EARLY MIOCENE CASTILLO FORMATION OF VENEZUELA

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We report four mammals: Litopterna, Astrapotheriinae, Pampatheriidae and Orophodontidae from the mainly lutitic series of the Castillo Formation at the Cerro La Cruz locality on the south flank of the Sierra de la Baragua, Lara State, Venezuela. The litoptern, pampathere and orophodont are new records for the fauna and increase the faunal diversity, which includes Iniidae, Platanistoidea, aff. *Prosqualodon australis*, Phyllophaga, Sirenia and two different Astrapotheriinae. The stratigraphic section has high lithological variability vertically reflecting the gradual change from a near shore marine complex to shallow marine sedimentary environments controlled by local marine regression and transgression. Subaereal exposure during maximum regression is indicated by oxidized levees and the presence of mixed lutitic levels, suggesting short intervals of continental environments and deposition. The specimens recovered include an astragalus with the typical spool-like astragalar body characteristic of a Litoptern; a mandible with the external sulcus on m1 lacking, but present in m2, characteristic of members of the Astrapotheriinae (previously documented in the Castillo Formation); a partial imbricating osteoderm that is relatively thin with a small number of well-spaced follicular pits connected by a distinct channel typical of the pampathere, *Scirrotherium,* a genus previously only known from the Miocene of Colombia and the first record of this genus for Venezuela; and a partial mandible with the alveolus of the first molariform, and the second to fourth molariforms, composed of a very thin outer layer of cementun (0.5 mm), a thicker internal layer of osteodentine (6.3 mm) and a core of vasodentine (1.3 mm), diagnostic of the sloth family Orophodontidae also the first record of this family in Venezuela. Ecologically the Orophodontidae, Astrapotheriinae and Litopterna represent forest taxa, while members of the Pampatheriidae are considered grassland inhabitants. The faunal assemblage suggests a mixed habitat of forest with some savanna in the Cerro La Cruz area in the Early Miocene during a time of maximum regression of sea level.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 11:00

ADVANCES IN UNGULATE DENTAL WEAR TECHNIQUES REVEAL NEW PATTERNS OF NICHE BREADTH AND EXPANSION THROUGHOUT THE CENOZOIC

RIVALS, Florent, ICREA and Institut Català de Paleoecologia Humana i Evolució Social, Tarragona, Spain; SEMPREBON, Gina, Bay Path College, Longmeadow, MA, USA; SOLOUNIAS, Nikos, New York College of Osteopathic Medicine, Old Westbury, NY, USA

In the last few decades, dietary ecological reconstructions have been used as powerful tools in gaining insight into local and global environmental trends. Ungulate mesowear and microwear studies in particular serve as useful proxies for demonstrating the existence of geographical and/or temporal variability in diet and vegetation structure. Improvements in these techniques reveal patterns involving Cenozoic vegetation and climatic structure as well as aspects of mammalian niche utilization. Results here indicate a congruity of responses to climate and aridity shifts among different ungulates and a much greater plasticity in dietary behavior among forms with similar tooth crown heights and morphology than previously supposed. Different diets are observed by the same taxon from different localities and brachy-

dont forms are shown to engage in grazing while hypsodont forms are shown to engage in leaf or even fruit browsing. Specific examples from five ungulate families (Antilocapridae, Equidae, Camelidae, Dromomerycidae, and Merycoidodontidae) are used to illustrate these trends. These results are intriguing as increased hypsodonty acquisition through time is generally explained as a mechanism for niche displacement (i.e., browsing forms become grazing forms when displaced from their relatively closed habitats to relatively open ones) such as might have been the case in the evolution of more hypsodont ungulates from brachydont forms. Results here suggest that this classical explanation for increased crown height is too simplistic and not necessarily correct. Increased crown height is considered here as most likely serving the purpose of expanding the dietary breadth of a taxon. That is, crown height augmentation may serve as a mechanism to allow a species to exploit new habitats and to expand its niche but not necessarily to shift exclusively to a new dietary regime.

Poster Session II, (Monday)

FIRST RECORD OF A PACHYCEPHALOSAURID FROM MEXICO

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The Family Pachycephalosauridae has not previously been recorded in Mexico. The specimen presented here is therefore of special interest. The fossil is from a site near La Salada, Coahuila, in strata related to the Aguja Formation (Late Cretaceous: Campanian), and consists of a single tooth crown with the root missing. It possesses characteristics upon which it can be assigned to the Pachycephalosauridae. According to the diagnostic Pachycephalosaurid tooth morphology proposed, the lingual side of the crown is weakly convex vertically, while the buccal side is concave. The crowns have weak ridges that culminate in marginal denticles, with the central denticle being strongest. According to the comparative analysis of the specimen with the morphology given for the family, it is possible to assign the new material of La Salada to the Pachycephalosauridae. This represents the first record of this family in Mexico during the Late Cretaceous and is also the most southern record for this family in North America. The only pachycepahlosaurid known to date from the Aguja Formation is *Texacephale langstoni*, but the current specimen cannot be assigned to that genus until more diagnostic material is found.

Poster Session II, (Monday)

STABLE CARBON ISOTOPE VALUES IN MOSASAUR TOOTH ENAMEL REFLECT NICHE DIFFERENTIATION

ROBBINS, John, Southern Methodist University, Dallas, TX, USA; POLCYN, Michael, Southern Methodist University, Dallas, TX, USA; FERGUSON, Kurt, Southern Methodist University, Dallas, TX, USA; JACOBS, Louis, Southern Methodist University, Dallas, TX, USA

This study presents stable carbon isotope data from tooth enamel for mosasaurine, tylosaurine and plioplatecarpine mosasaurs. Tylosaurine mosasaurs are represented by species and individuals of varying ontogenetic stages and differing geological ages. $\delta^{13}C$ values range from –7.0‰ for a small basal tylosaurine from the Turonian of Texas, between –8.0 and –10.5‰ for the moderately-sized Campanian *T. ivoensis*, and between –10.5 and –13.2‰ for large individuals of a Campanian *T. proriger*. Because carbon isotope values of primary producers decrease with increasing distance from the shore, the values from tylosaurine mosasaurs indicate increasing foraging range correlated with increasing average body size over time. A large-bodied *Mosasaurus* presents a value far lower (–14.4‰) than $\delta^{13}C$ values previously reported for this genus (~–7 to –10‰). Durophagous mosasaurs such as *Globidens* present values of –10.5 to –14.5‰. Tooth enamel $\delta^{13}C$ values should reflect the isotopic values of their prey, in this case indicating the lighter values of shellfish. Additionally, samples from two individuals of *Prognathodon* are among the most depleted isotope values found in mosasaurs (–11.3 to –16.2‰). The depleted values for *Prognathodon* likely represent the respiratory effect of long dive times without expelling CO_2, which has been argued as a cause of lower $\delta^{13}C$ values in the tissues of deep-diving species compared to their shallow- and non-diving counterparts. This study reinforces the conclusion that niche differentiation in mosasaurs is reflected in stable carbon isotope values of tooth enamel.

Poster Session IV, (Wednesday)

THE TAXONOMY AND BIOGEOGRAPHY OF *GIRAFFA* SPP. IN THE PLIO-PLEISTOCENE: EVIDENCE FOR MULTIPLE DISPERSALS OUT OF AFRICA

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The taxonomy and biogeography of the African and Eurasian Giraffoidea is debated, particularly with regard to their importance for understanding the tempo and mode of faunal dispersals from Africa to Eurasia. It has been suggested that the presence of giraffoids in Europe and the Levant in the Plio-Pleistocene is due to early Pliocene dispersals of African fauna and that there were probably no new dispersals of these taxa during the Pleistocene. This study analyzes evidence for the presence of the genus *Giraffa* in Europe and the Levant and tests the hypotheses that: 1) All European giraffoid Pliocene species are Asian rather than African, 2) the presence of *Giraffa* in the Levant indicates an African dispersal starting in the late Pliocene and, 3) its presence in Eurasian Plio-Pleistocene sites represents one or more dispersal events.Results indicate that all giraffoid specimens from Europe can be assigned to Asian taxa and thus they do not indicate an African dispersal. *Giraffa* specimens are only present in three Levantine sites; Bethlehem (ca. 2.5 Ma), 'Ubeidiya (ca. 1.6-1.2 Ma) and Latamne (ca. 1.0 Ma). Taxonomic analyses of *Giraffa* material indicate that the 'Ubeidiya specimens can be assigned to *G. jumae* while those from Latamne can be identified as *G. camelopardalis*. The remains found at Bethlehem are too fragmentary to be assigned to species but are most probably *G. jumae* based on biochronology.Contrary to previous suggestions only three sites in the Levant provide evidence for the presence of *Giraffa*. This confirms an African dispersal beginning in the Late Pliocene and at least two dispersal events. A previously unnoted dispersal event dated to the Epivillafranchian is suggested by the giraffe present at Latamne, which differs from the earlier species in the Levant.The dispersal of *Giraffa* sp., a browser taxon, can be correlated with more humid conditions observed in the Sahara and Negev deserts at these times which would have allowed dispersing populations to cross from East Africa to the Southern Levant. This study provides insight into patterns of dispersal of large mammals during the Plio-Pleistocene and its relationship to climate change.

Technical Session VI, Monday 3:45

ROTATIONAL AND NAVIGATIONAL VESTIBULAR SENSITIVITY DIRECTIONS IN THERIAN MAMMALS

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Neurologic experiments on humans and domestic animal models provide tools for understanding relative vestibular sensory experiences across extant and extinct therian mammals. Researchers have established some relationships between the dimensions of the inner ear, semicircular bony canal arc, radius of curvature and locomotor agility. These previous studies workedfrom classic models of semicircular canal orthogonality and parallelism for the six bony canals contained within the therian skull. Other studies investigating the orientation of semicircular canals in a head-centered reference system found significant deviations of canal orientations and angular relationships from this classic model for humans and common experimental species. These canal variations result in misalignment with the orientations of eye muscles whose eye motor tracking stimulation are influenced by excitatory and inhibitory signals from specific canals. Separate recent neurologic studies have found that semicircular canal dimensions and orientations influence not only balance and eye tracking movements but also navigational abilities processed in higher-order neural connections. Those results came from study of humans and other animals with terrestrial lifestyles. We now report results from a study of 31 extant and recently extinct therian mammal specimens that combined semicircular canal dimensions and orientations to determine the animals' preferred vestibular sensitivity directions in 3D environments. The study utilized HRXCT scans of skulls, 3D imaging, and vector analysis of the inner ear semicircular canal bony labyrinth endocasts. This work extends methods previously utilized for very limited sets of domestic terrestrial species to a wide range of species that exhibit different locomotor specialties, and it provides an understanding of locomotor specialization and sensory sensitivity in extinct mammals.

Poster Session I, (Sunday)

REAPPRAISAL OF BASAL PTEROSAUR RELATIONSHIPS THROUGH THE REDUCED CONSENSUS METHOD

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The last decade saw a boost in our knowledge of pterosaur phylogeny, both by the discovery of new taxa and by the publication and improvement of several works on the topic. The relationship between basal pterosaurs is, however, still a hot debate. Even though it has been well documented that a priori exclusion of taxa can have a major impact on the outcome of an analysis, different researchers tend to use different taxa, leading to quite conflicting results. Here we used the reduced consensus method in a recently published character matrix. Using the software RedCon, there were four possibilities of a posteriori exclusion of wildcard taxa (pruning one, three, eight, or 12 taxa). All reduced consensus trees recovered the Anurognathidae and *Cacibupteryx* as consecutive sister-groups to all other pterosaurs. When not pruned, *Austriadactylus* and *Changchengopterus*, *Harpactognathus* and *Angustinapterus*, and *Raeticodactylus* and *Caviramus* were recovered as sister-groups, respectively. *Sordes*, *Preondactylus* and *Scaphognathus* formed a monophyletic entity. "*Eudimorphodon*" *cromptonellus* was recovered in a sister-group relationship with *Peteinosaurus*, thus making *Eudimorphodon* a paraphyletic group, as already pointed out by recent analyses. Both the Campylognathoididae and the Novialoidea were also recovered as paraphyletic. There is however a monophyletic group, which includes all basal pterosaurs except the *Anurognathidae*, *Cacibupteryx* and *Rhamphorhynchus*. Both species of *Rhamphorhynchus* comprise the sister-group to the Pterodactyloidea, whose topology remained unchanged. It is important to notice that the pruned taxa were not necessarily the most incomplete ones. Also, we would also like to draw attention to the differences obtained between a priori and a posteriori deletion of taxa. When eight taxa were a priori excluded, *Austriadactylus* and *Cacibupteryx* were recovered as the basalmost pterosaurs, while the Anurognathidae was found in a sister-group relationship to the Pterodactyloidea, thus differing much from the results of a posteriori pruning.

Poster Session I, (Sunday)

NEW INSIGHTS INTO THE GEOLOGICAL CONTEXT OF THE LATE CRETACEOUS VERTEBRATE ASSEMBLAGE FROM THE MAEVARANO FORMATION, MAHAJANGA BASIN, MADAGASCAR

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The Maevarano Formation of the Mahajanga Basin, northwestern Madagascar has yielded a spectacular assemblage of Late Cretaceous vertebrates, including ray-finned fishes, anurans, turtles, snakes, non-ophidian squamates ('lizards'), crocodyliforms, non-avian dinosaurs, birds, and mammals. Analyses of this assemblage have revealed significant new insights into its diversity, phylogenetic relationships, biogeography, and paleoecology. Geological studies of the formation and associated units have advanced in pace with the many paleontological discoveries and analyses, and at present there is a very good understanding of the stratigraphy, taphonomy, and paleoenvironment of the Upper Cretaceous section in the Mahajanga Basin.In the Berivotra Study Area (the focal area of field studies for almost two decades), the Maevarano Formation consists of terrestrial facies that represent a dynamic dryland ecosystem laid down in a highly seasonal, semi-arid climate when this region lay within the subtropical desert belt. Various lines of evidence indicate that the formation is Maastrichtian in age. There are no data whatsoever that support previous contentions that the Maevarano Formation is Campanian or older. It is also likely that the beds that yield the vast majority of fossils in the Berivotra area, which are included within the Anembalemba Member, represent an extremely short interval of time. Indeed, sedimentological and taphonomic datasets indicate that most fossils recovered from the member were deposited in recurrent debris flows that collectively represent a few particularly stressful years during the Maastrichtian. Lastly, recent reconnaissance on the western side of the Betsiboka delta along the shores of Lake Kinkony, located ~90 km to the west of the Berivotra Study Area, has led to the identification of a new member in the Maevarano Formation. The distinctive light gray to white calcareous sandstones and marlstones of this new, soon-to-be-formalized unit yield an abundance of aquatic and semi-aquatic vertebrates, and represent a heretofore unsampled paleoenvironment of the Maevarano Formation, which is otherwise comprised of more terrestrial members.

Poster Session II, (Monday)

POSTCRANIA OF SMALL MAMMALS FROM THE LATE PALEOCENE OF WALBECK, GERMANY

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The Walbeck site (late Paleocene of Sachsen-Anhalt, Germany), one of only a few Paleocene mammal localities in Europe and the only one in Germany, has produced a moderately diverse assemblage of mammals including 14 species in at least 5 orders. Although the fossils were collected 70 years ago, significant parts of the collection remain unstudied. The fossils come from Oligocene fissure fills in the Muschelkalk, interpreted to represent a single deposition of reworked Thanetian sediments. Here we summarize for the first time an extraordinary collection of micro-mammal postcrania from the Walbeck fissures. More than 300 individual bones were examined and sorted into morphs for each element. Based on comparative anatomy, size, and relative abundance, we have attempted to associate those elements most likely to represent the same taxon, and to assign them to the most likely dental taxon from Walbeck. The supposed erinaceomorphs *Adapisorex abundans* (n= c.1200) and *Adunator lehmani* (n= c.600) are the most common small taxa in the fauna, accounting for 10-20 times as many specimens as any other small mammal from Walbeck, hence it is likely that the most common elements pertain to these taxa. Comparison with skeletons of *Macrocranion* from Messel (presumably closely related to *Adapisorex* and possibly *Adunator* as well) permits tentative allocation of the most common morphs of long bones and tarsals to these taxa. If these elements are correctly assigned, both species were agile terrestrial hoppers whose forelimbs were much shorter than the hind limbs and were adaptedfor varying degrees of digging. The most common type has a slender, elongate tibia fused with the fibula for half its length. It is closely similar to, but somewhat less specialized than, those of macroscelidids and jerboas. Another humeral morph represents a highly specialized digger evidently unknown from dental remains. As many as seven talar morphs have been identified, including two or three arboreal taxa (relatively rare at Walbeck) that appear to belong to plesiadapiform primates.

Technical Session IX, Tuesday 9:00

BERGMANN'S RULE IN DEEP TIME: DOES THE RELATIONSHIP BETWEEN MAMMALIAN BODY SIZE AND TEMPERATURE APPLY TO PALEOCENE MAMMALS?

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The inverse relationship between body size of endothermic vertebrates and environmental temperature, or Bergmann's rule, is well documented for modern animals, although the advantage of larger body mass in cooler climates is unclear. Despite the prevalence of this pattern, its persistence in deep time is not well known. Although long-term variation in body size within fossil mammal lineages has been documented, the geographic distribution of variation in size has not. Using lower first molar area (m1 L x W) as a proxy, we compiled body size data from the literature for 170 Paleocene (Torrejonian and Tiffanian) mammal species from the western interior of North America. Localities were binned into nine geographic regions based on paleolatitude; the bins span ca. 28° of latitude. The oxygen isotope composition of fossil mammal teeth across these regions suggests that mid-Paleocene latitudinal climate gradients were broadly similar to modern gradients in the region, so we treat latitude as a proxy for temperature. We focused on overall latitudinal variation in mean m1 area across all species and regions and intraspecific variation in eight species that occur in four or more regions. For the entire dataset, lower first molar area exhibits a statistically significant negative relationship with paleolatitude and results are similar at the genus and family levels. Of the eight species studied individually, none demonstrate a statistically significant increase in m1 area with latitude. These patterns are in contrast to those reported for modern mammals. Although a number of physiological, phylogenetic, and environmental factors may influence the relationship between body size and environmental temperature, it appears that at least some Paleocene mammals did not follow Bergmann's rule. The contrasts with modern biogeographic patterns could result from distinct ecology of faunas dominated by archaic mammals, ongoing ecological recovery after the K-P extinction, and/or Bergmann's rule being a geologically recent or episodic phenomenon and not a general characteristic of the geographic distribution of mammalian body size.

Poster Session II, (Monday)

ACTUALISTIC APPROACH TO CERATOPSIAN CRANIAL ONTOGENY AND SCARS: THE FLIP SIDE OF THE JUGAL

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Bone ontogeny is partially related to applied stresses that determine shape. Bone reshaping seems to represent a process of stress (e.g., muscle)-induced plastic deformation. Stresses result only in plastic deformation (to adult state), if rate of osteoblastic activity is greater than osteolysis. If repair rate does not keep pace, stress fractures result. Minor bone structure disruption is part of the normal growth process. Linear patterns of periosteal reaction on external surfaces of jugal, squamosal and parietal bones of *Triceratops* are typical of bone changes previously noted with stress fractures in humans and other animals. The *en face* macroscopic appearance and standard x-ray appearance are indistinguishable from previously reported *Triceratops* phalangeal stress fractures. Occasional presence of a linear surface cleft further substantiates that actualistic analysis. The veterinary term for the associated linear sclerosis is "puppy line," attributed to plastic deformation that resolves as the canine ages. Absence of peri-lesional disorganized bone reaction rules out infectious disease, the only major differential diagnostic consideration. Stress fractures result from repetitive stresses, not single traumatic events. Intraspecific conflict-related horn injuries would be expected to cause bone scoring, not linear periosteal reaction. Actualistic analysis eliminates even that remote possibility. Attributing linear alterations to effects of conspecific horn might have credibility, if damage was a gouge rather than periosteal reaction and if a reasonable behavior were presented that would explain the direction of the linear damage. It is unclear how a horn attack would cause such vertical damage, unless the victim was already lying on its side, a position offering a much more vulnerable target. It is hypothesized that the observed linear reaction in *Triceratops* skull elements may represent part (although exaggerated) of normal growth or at least that the process of repair could not keep up with the stress-induced changes of remodeling. This is parsimonious with the variation in general frill morphology that characterizes ceratopsian ontogeny.

Poster Session IV, (Wednesday)

A NEW SPECIES OF *MOROPUS* IN THE BATESLAND FORMATION AND A REVIEW OF CHALICOTHERE MATERIAL FROM THE RUNNINGWATER FORMATION, GREAT PLAINS MIOCENE OF NORTH AMERICA

ROUNDS, Carolyn, University of Massachusetts, Amherst, MA, USA; COOMBS, Margery, University of Massachusetts, Amherst, MA, USA

The chalicothere *Moropus* was a rare perissodactyl present in the Great Plains region of North America during the Miocene. On the Great Plains, there is a temporal gap in named species of *Moropus* through much of the Hemingfordian North American Land Mammal Age. Within this space in time are specimens currently referred to as *Moropus* sp. from the Batesland Formation in southwest South Dakota and the Runningwater Formation in northwestern Nebraska. A comparison of these fossils with those of previously described species of North American chalicotheres, such as *Moropus elatus*, *Moropus hollandi*, *Tylocephalonyx skinneri*, *Moropus merriami,* and *Moropus matthewi* has shown that there are notable differences between equivalent skeletal elements, especially the teeth and bones of the manus and pes. Further examination of fossils belonging to *Moropus* sp. from the Batesland and Runningwater Formations has revealed that specimens from these two formations possess some substantial differences in morphology. This result is intriguing, as the Batesland and Runningwater Formations share some of the same faunal elements and are considered to be approximate temporal equivalents. Based on these findings, it is proposed that the specimens of *Moropus* sp. from the Batesland Formation belong to a new species of *Moropus*, which may include some Runningwater specimens, and that the other specimens from the Runningwater Formation may belong to *Moropus hollandi*, or a different new species of *Moropus*.

Poster Session III, (Tuesday)

AN EVALUATION OF PRETREATMENT METHODS FOR STABLE ISOTOPE ANALYSIS OF DENTIN CARBONATE

ROUNTREY, Adam, University of Michigan Museum of Paleontology, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan Museum of Paleontology and Dept. of Geological Sciences, Ann Arbor, MI, USA

Various pretreatment methods have been used in efforts to determine the primary carbonate □^{18}O and □^{13}C values of dentin and bone. Pretreatment is usually deemed necessary because these materials may be contaminated with exogenous minerals and ions, and it is possible that the organic matrix interferes with analysis. Furthermore, we have observed that mean □ values for untreated samples of a modern dentin "standard" changed over time. In this study, we investigated the effects of a variety of pretreatment techniques to identify procedures that minimize within-run and long-term variation in □ values.We determined □^{18}O and □^{13}C for samples of finely powdered, well-homogenized modern elephant dentin subjected to the following treatments: 1) no treatment, 2) 3% NaOCl, 3) 30% H_2O_2, 4) 1M acetic acid-calcium acetate buffer (AACA), 5) 3% NaOCl followed by AACA, 6) 30% H_2O_2 followed by AACA. We also documented the effects of sealed versus open treatment vessels, measured changes in pH during treatment, determined carbonate content and mass loss for all samples, and evaluated changes in isotope composition over a ~10-month period.Conducting treatments in closed rather than open vessels had little effect on □ values except in treatment 2 in which leaving the vessel closed had a marked effect on pH. As expected, acidic treatments reduce carbonate yield, but treatment 2 caused an apparent increase over untreated samples, suggesting that carbonate minerals may have precipitated during treatment.Treatment 6 showed the best within-run and long-term repeatability for □^{18}O. Additionally, oxidation of organics occurs under acidic conditions in this treatment, minimizing the possibility that carbonate minerals might precipitate. Untreated samples show the best within-run and long-term repeatability for □^{13}C, but these samples likely contain adsorbed bicarbonate ions that are highly exchangeable. They also show the worst long-term repeatability for □^{18}O. We discuss the performance of other treatments and make a recommendation for studies in which both □^{18}O and □^{13}C are of interest.

Poster Session I, (Sunday)

AGE PROFILE OF COLUMBIAN MAMMOTHS FROM THE TULE SPRINGS FOSSIL BEDS, UPPER LAS VEGAS WASH, NEVADA

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The Tule Springs Fossil Beds in Las Vegas Valley contain a diverse Rancholabrean assemblage of mammals. Columbian mammoths(*Mammuthus columbi*)are especially abundant. Excavations in Unit E1 of the Las Vegas Formation at the Gilcrease spring mound site have produced more than one hundred whole and partial mammoth cheek teeth, but very little bone and tusk material. Teeth of *Bison*, *Camelops*, and*Equus* are also present, but are much less abundant than those of *Mammuthus*.

For the purpose of constructing an age profile, I used thirty whole cheek teeth and determined the age (in African elephant years) of each animal at death. Twenty-seven percent of the teeth represent animals aged 0-12; forty-three percent represent animals aged 13-24; 20 percent represent animals aged 25-36; seven percent represent animals aged 37-48; and three percent represent animals aged 49-60. Radiocarbon dates of six of the teeth range from about 18 thousand radiocarbon years to about 13 thousand radiocarbon years, so this assemblage of teeth appears to represent an attritional assemblage extending over at least five thousand years, beginning near the Last Glacial Maximum.

Compared to healthy herds of African elephants, the juvenile cohort (age 0-12) of the Tule Springs population is depressed. This may be a product of preservation bias; i.e., for some reason the remains of young animals did not end up in the Gilcrease spring-mound deposit in proportion to their abundance in the population. Or it may reflect environmental stress on the population, resulting in a depressed birthrate and/or depressed juvenile survival rate.

Poster Session I, (Sunday)

NEW LOCALITY WITH DINOSAUR TRACKS FROM THE LATE JURASSIC OF THE ATACAMA DESERT, NORTHERN CHILE

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Dinosaur tracks (as isolated footprints and trackways) are known from five localities in Chile, mostly in the northern part of the country. These records extend from the Upper Jurassic (Baños del Flaco and San Salvador formations) to the Early Cretaceous (Chacarilla and Quebrada Monardes formations) in age, and document associations of fauna unknown from their skeletal records. A new site with dinosaur tracks and trackways, known as "Quebrada Arca," is reported here. This new site is composed of a sequence of various sedimentary layers in a ravine, belonging to the Quinchamale Formation (Late Jurassic). Through this ravine the beds are well exposed in almost vertical position, showing tens of layers with dinosaur footprints (belonging to sauropods and theropods), along with sedimentary structures, such as ripple marks. Four sauropod trackways were measured, these show oval marks of pes and manus. The pes impressions (72 x 58 cm on average, n=6) are approximately the double of the maximum length of the manus prints (36 x 17 cm on average, n=5); despite good footprint preservation claw impressions were not detected. The best-preserved trackway contains 11 distinguishable footprints with an average of step angle of 108º. The absence of claws in the manus, the wide-gauge trackway, and a step angle between 100º and 120º, are features found in the ichnogenus *Brontopodus*. Isolated tridactyl footprints, of variable size, were assigned to Theropoda. Interestingly, some beds showed notable bioturbation, caused by hundreds of sauropod footprints, in the same horizon. This is the first dinosaur track site recorded for this Jurassic unit. Nevertheless, this site is placed approximately 100km from the well known Chacarilla Formation. where only ichnites from Cretaceous levels are present. Also, this is the second Jurassic sauropod record in Chile, together with the southern *Parabrontopodus* record from the Baños del Flaco Formation, being the first *Brontopodus*-like record of the Gondwana occidental margin. Future study of this site will broaden our understanding about the faunistical representation of dinosaur assemblages in this part of South America and Gondwana.

Technical Session II, Sunday 10:15

CT SCANNING ANALYSIS OF THE BASICRANIUM AND THE INNER EAR OF *HALDANODON EXSPECTATUS* (DOCODONTA, MAMMALIA)

RUF, Irina, Universität Bonn, Bonn, Germany; LUO, Zhe-Xi, Carnegie Museum of Natural History, Pittsburgh, PA, USA; MARTIN, Thomas, Universität Bonn, Bonn, Germany

The docodont *Haldanodon exspectatus*, a mammaliaform from the Upper Jurassic of Portugal, is a major taxon for studying higher level relationships of mammaliaforms and their morphological evolution. Based on high-resolution computed tomography scanning of four basicranial specimens of *Haldanodon*, we developed a new reconstruction of the petrosal, including the inner ear.Our new study confirms that the main characteristics of *Haldanodon* in the pars cochlearis, the lateral trough and the lateral flange of the petrosal are similar to their homologues in other mammaliaforms, such as *Morganucodon* and *Sinoconodon*. However, *Haldanodon* is unique among Mesozoic mammaliaforms in having a hypertrophied and spongy paroccipital region. The paroccipital process is massive and excavated by a large epitympanic recess and a deep stapedial muscle fossa much larger than in other mammaliaforms. The large size of these external structures is accompanied by extensive development of porous internal structures in the pars mastoideus of the petrosal and the exoccipital. The inferior petrosal sinus in the pars cochlearis is well developed, with multiple external foramina, in correlation with the porous interior of the basioccipital and basisphenoid bones. One specimen has preserved the stapedial footplate and parts of the crurae, which were attached in the center and at the posterior border of the footplate.The vestibular part of the inner ear endocast of *Haldanodon* resembles the condition seen in *Morganucodon* and *Sinoconodon*. The anterior semicircular canal is the largest and the posterior semicircular canal is almost triangular in shape. However, the cochlear canal of *Haldanodon* has a curvature to almost 180°, with an expanded apex, comparable to the apex of the cochlear canal in monotremes, which corresponds to the lagenar macula in the bent membranous duct. The internal acoustic meatus appears to have a separate channel continuing anteriorly with a shallow sulcus on the interior surface of the cochlear canal. We interpreted that these bony characters correspond to the lagenar innervation in *Haldanodon*, which likely had a cochlear lagenar macula as in monotremes.

Poster Session I, (Sunday)

MAXIMUM PARSIMONY AND BAYESIAN INFERENCE ANALYSES OF PALAEOZOIC TEMNOSPONDYLS: SUPPORT FOR A CLADE OF HETEROCHRONIC TAXA AND RAPID CHARACTER EXHAUSTION IN EARLY DIVERGING BRANCHES

RUTA, Marcello, University of Bristol, Bristol, United Kingdom; BOLT, John, Field Museum of Natural History, Chicago, IL, USA

A revised and expanded data matrix of (mostly) Paleozoic temnospondyl amphibians (80 taxa including selected Devonian and Carboniferous outgroups; 270 binary and multistate characters) is used to reconstruct major branching events in this group, and to examine rates of character change and models of character exhaustion. Both parsimony and Bayesian inference retrieve major clades (edopoids; eryopoids-basal archegosauriforms; dvinosaurs; dissorophoids), with a sister group relationship between dvinosaurs and dissorophoids even in the absence of putative heterochronic traits. Statistical support is moderate to good only for a few branches within each clade, and invariably poor for internal branches joining major clades. For increasing number of states, edopoids and dvinosaurs in particular tend to exhaust ('use up') available characters more rapidly than other clades, suggesting release of novel traits in less plesiomorphic branches of the Paleozoic radiation, such as dissorophoids. The interrelationships of the latter remain highly controversial, but a few nodes appear increasingly stable (e.g. olsoniforms). Amphibamids are consistently paraphyletic relative to either branchiosaurids or a branchiosaurid-micromelerpetontid clade.

Technical Session I, Sunday 11:45

PALEOBIOGEOGRAPHIC RANGE OF *CENTROSAURUS APERTUS* (ORNITHISCHIA:CERATOPSIDAE), WITH IMPLICATIONS FOR LATE CRETACEOUS DINOSAUR PROVINCIALITY AND EVOLUTION

RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA; EVANS, David, Royal Ontario Museum, Toronto, ON, Canada; BROWN, Caleb, University of Toronto, Toronto, ON, Canada; SCOTT, Evan, Cleveland Museum of Natural History, Cleveland, OH, USA; CHIBA, Kentaro, Hokkaido University, Hokkaido, Japan

Centrosaurine ceratopsids are well represented in the Late Cretaceous of North America

and are known from localities from Mexico to Alaska. Their fossil record from the Belly River Group (Campanian; ~4 Ma) of Alberta records a succession of at least seven genera displaying high turnover rates (~.25 to .50 Ma). Previous studies have advocated that the group represents an unbroken sequence of anagenesis, or a series of disjointed sequential replacements of taxa tracking preferred habitats along the margin of the fluctuating Western Interior Seaway (WIS). Previous work at the continental scale has noted narrow geographic ranges for large-bodied Late Cretaceous ornithischians west of the WIS, and suggested a high degree of habitat specificity and provinciality in these animals; however, there is little data on the paleobiogeographic distribution of individual large-bodied ornithischian species beyond their relatively restricted occurrences at single localities or within particular host formations. An intense field sampling program in southern Alberta has revealed the first *Centrosaurus apertus* specimens from the Oldman Formation, including an articulated skull, isolated parietals, and a dense bonebed. These localities occur in relatively xeric strata that are time equivalent to the lower part of the putatively more mesic Dinosaur Park Formation 180 km to the north. These new localities, plus a previously undocumented bonebed from Saskatchewan, show that *C. apertus* had a geographic range of at least 250,000 km^2, much larger than previously estimated. This also provides evidence that some centrosaurine species could tolerate a wider range of environmental conditions than previously supposed, and could cross the putative upland-lowland transition in depositional environments adjacent to the WIS, perhaps on an annual basis, possibly following seasonal resources or migrating to and from nesting sites. This has implications for hypotheses of dinosaur provinciality, and must be considered carefully when invoking habitat fragmentation and divergence models in the evolutionary diversification of centrosaurines.

Romer Prize Session, Monday 10:30

SEASONALITY AS A POTENTIAL SOURCE OF VARIATION IN *ALLIGATOR* CRANIAL EVOLUTION

SADLEIR, Rudyard, University of Chicago & Field Museum, Chicago, IL, USA

Unable to internally regulate their body temperature, the global distribution of crocodylians has been principally influenced by climate. During their 80 million year evolution, the coincidence of sharp declines in taxonomic diversity with drops in global temperature during the Eocene-Oligocene and Pliocene suggests that elevated global temperature is a mechanism generating morphological diversity in crocodylian evolution. Natural selection operates upon variation and developmental processes can generate phenotypic variation. Life history and environmentally induced changes during development can be a strong influence on phenotype. The ability of an organism to change its phenotype in response to changes in its environment can be broadly referred to as phenotypic plasticity. *Alligator mississippiensis* ranching provides a unique opportunity to investigate whether the absence of seasonality during ontogeny can induce cranial shape variability, and whether the magnitude and direction of environmentally induced shape plasticity corresponds with fossil *Alligator* evolution. I use 3D geometric morphometrics to analyze extant and fossil *Alligator* cranial shape using coordinate data. This quantitative approach affords the ability to make comparisons of ontogenetic shape change and can statistically test the degree to which two samples share an ontogenetic shape trajectory for insight on evolutionary processes. In addition, geometric morphometrics provides a framework for evaluating patterns of phenotypic evolution and testing for phylogenetic signal in a distribution of shape data. For this analysis I developed a new software application to visualize and explore 3D morphometric data output. My work using 3D geometric morphometric analysis shows the removal of seasonality for continual growth in *A. mississippiensis* significantly alters the cranial shape and ontogenetic shape change from the wild population. Comparison of this phenotypic plasticity in *A. mississippiensis* with the climate record and evolution of fossil *Alligator* cranial shape variation is suggestive of a causal link between climate change, ontogenetic change, and the evolution of *Alligator* cranial shape.

Poster Session II, (Monday)

PHYLOGENETICALLY STRUCTURED VARIANCE IN FELID BITE FORCE: THE ROLE OF PHYLOGENY IN THE EVOLUTION OF BITING PERFORMANCE

SAKAMOTO, Manabu, University of Bristol, Bristol, United Kingdom; LLOYD, Graeme, Natural History Museum, London, United Kingdom; BENTON, Michael, University of Bristol, Bristol, United Kingdom

A key question in evolution is the degree to which morphofunctional complexes are constrained by phylogeny. We investigated the role of phylogeny in the evolution of biting performance, quantified as bite forces, using phylogenetic eigenvector regression. Results indicate that there are strong phylogenetic signals in both absolute and size-adjusted bite forces, although it is weaker in the latter. This indicates that elimination of size influences reduces the level of phylogenetic inertia and that the majority of the phylogenetic constraint is a result of size. Tracing the evolution of bite force through phylogeny by character optimization also supports this notion, in that relative bite force is randomly distributed across phylogeny whereas absolute bite force diverges according to clade. The nonphylogenetically structured variance in bite force could not be sufficiently explained by species-unique morphology or by ecology. This study demonstrates the difficulties in identifying causes of nonphylogenetically structured variance in morphofunctional character complexes.

Technical Session XII, Tuesday 3:15

NEW MATERIAL OF *MEKOSUCHUS INEXPECTATUS* (CROCODYLIA: MEKOSUCHINAE) FROM THE LATE QUATERNARY OF NEW CALEDONIA, AND THE PHYLOGENETIC RELATIONSHIPS OF AUSTRALASIAN CENOZOIC CROCODYLIANS

SALISBURY, Steven, University of Queensland, Brisbane, Australia; HOLT, Timothy, University of Queensland, Brisbane, Australia; WORTHY, Trevor, University of New South Wales, Sydney, Australia; SAND, Christophe, Institute of Archaeology of New Caledonia and the Pacific, Noumea, New Caledonia; ANDERSON, Atholl, Australian National University, Canberra, Australia

New material of the small, pug-snouted eusuchian crocodyliform *Mekosuchus inexpectatus* is described from late Quaternary deposits in the Pindai Caves of New Caledonia, South West Pacific. This material permits the first detailed investigation of the cranial osteology of this previously enigmatic crocodyliform, other species of which are known from the late Oligocene and Miocene of Riversleigh, north-western Queensland, Australia (*M. whitehunterensis* and *M. sanderi*), and the Holocene of Vanuatu (*M. kalpokasi*). The Australian and New Caledonian species of *Mekosuchus* can be differentially diagnosed based on characteristics of the maxillary rostrum and interorbital region. Although poorly known, *M. kalpokasi* is regarded as a valid species. The morphology of *Mekosuchus* spp. indicates that their behaviour and ecology was comparable to that of extant dwarf crocodylians such as *Paleosuchus* spp. and *Osteolaemus tetrapsis*. The absence of any large, permanent freshwater rivers or lakes on New Caledonia during the Quaternary suggests that *M. inexpectatus* was salt tolerant, which may help explain the distribution of *Mekosuchus* spp. in the South West Pacific. Phylogenetic analysis of 110 eusuchian taxa using 185 discrete morpholigical characters places *Mekosuchus* in a clade with *Trilophosuchus*, *Quinkana* and *Volia*, close to the base of Crocodyloidea. Other Australasian Cenozoic crocodylians (*Kambara*, *Baru*, *Australosuchus*, *Pallimnarchus* and *Harpacochampsa*) are most parsimoniously considered non-crocodyline crocodylids, but character support for a clade uniting these taxa is weak. The evolution and paleobiogeographic history of Australasian Cenozoic crocodylians is consequently more complex than previous thought, involving a likely endemic radiation of archaic Gondwanan crocodyloids (Mekosuchinae), and multiple immigrations of more derived crocodylids from South East Asia as Australia moved into increasingly lower latitudes during the Cenozoic.

Technical Session III, Sunday 2:15

POSTCRANIAL MORPHOLOGY OF AN ANOMALUROID RODENT FROM THE LATE EOCENE EGYPT

SALLAM, Hesham Mohamed, University of Oxford, Oxford, United Kingdom; SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; BOUER, Doug, Stony Brook University, Stony Brook, NY, USA; SIMONS, Elwyn, Division of Fossil Primates, Duke Lemur Center, Durham, NC, USA

Anomalurid rodents are today restricted to equatorial Africa, and are represented by three extant genera. *Anomalurus* and *Idiurus* bear a patagium and are known to be gliders; this structure is absent in *Zenkerella*, but all extant genera are arboreal. Anomaluroidea (Anomaluridae + Pedetidae) is likely to be an endemic African group, possibly derived from the early-middle Eocene zegdoumyids. Paleogene anomaluroids are rare, being known from only three sites, all about ~37 Ma, in Algeria, Egypt, and Myanmar. Dental remains of anomaluroids have recently been recovered from the earliest late Eocene Birket Qarun Locality 2 (BQ-2) in the Fayum Depression of northern Egypt. Two species are represented -- one small and highly derived species similar to Miocene *Paranomalurus* from east Africa, and a larger and more primitive stem anomalurid that is similar in size to extant *Anomalurus*. BQ-2 has also yielded the first known postcranial bones of Paleogene anomaluroids, most of which are attributable to the large-bodied species. The forelimb of this large anomaluroid lacks features present in living anomalurids that are related to increased capacity for pronation/supination (such as enlarged and globular capitula) and support for the patagium (such as a greatly expanded olecranon process). The humerus is very short relative to predicted body mass, and unlike the relatively elongate humeri of living species. The femoral head is not large and expanded as in living anomalurids, but meets the femoral shaft at a high angle, suggesting the potential for increased abduction at the hip. Unlike extant anomalurids, the astragalus has a short neck and no articulation for an elongate medial tarsal bone; the distal segment of the calcaneus is relatively short, and the sustentacular shelf is relatively broad, as in sciurids and early fossil rodents such as paramyids. Overall, the postcranial morphology of this primitive fossil anomalurid is highly generalized, and bears many primitive features that were likely present in the ancestral crown rodent. There is no evidence from the forelimb that this primitive species had a patagium or engaged in gliding behavior.

Technical Session XV, Wednesday 10:45

FUNCTIONAL MORPHOLOGY AND MODULAR LAGS IN THE EARLY DIVERSIFICATION OF RAY-FINNED FISHES (ACTINOPTERYGII)

SALLAN, Lauren, University of Chicago, Chicago, IL, USA

Living ray-finned fishes (Actinopterygii) are ecomorphologically disparate, ranging in shape from sunfish and angelfish to eels and seahorses. In contrast, the dozen named Devonian taxa were homogeneous in both form and presumably function. Actinopterygian morphological and functional diversification has been considered a major event within the Mesozoic Marine Revolution, one occurring primarily within the teleost clade and linked to genome duplication. However, a new impetus for examining earlier, non-teleost taxa was recently

provided by recognition of the proximity of the Paleozoic Hangenberg extinction withboth actinopterygian diversity increases and deep phylogenetic branching events. The first study of Paleozoic ray-fin morphospace reveals two surprising phenomena: 1) the diversification of early actinopterygians occurred along functional lines recognizable from extant teleosts; 2) expansion in cranial morphospace occurred in the immediate aftermath of the end-Devonian Hangenberg extinction, while post-cranial diversification lagged by one stage. The functional signal suggests hydrodynamic limits on aquatic vertebrate form were hit early in actinopterygian evolution. The lag between head and body morphospace expansion indicates a changed relationship between functional modules falling under different selective pressures. Actinopterygian diversification was likely first driven by occupation of feeding niches, while locomotory specialization occurred only later, as competition increased. This pattern was suggested to occur among living species (e.g. cichlids) at a microevolutionary scale, but had not been observed at larger temporal or taxonomic levels. Such modular lags – gaps between the diversification of otherwise related functional structures such as heads and bodies - might be a common feature of adaptive radiations.

Poster Session III, (Tuesday)

ECOLOGICAL STRUCTURE AND HABITAT OF TWO MIDDLE MIOCENE SOUTH AMERICAN MAMMAL PALEOCOMMUNITIES

SAMEH, Melissa, CWRU, Cleveland, OH, USA; CROFT, Darin, CWRU, Cleveland, OH, USA

Middle Miocene South American land mammal communities include many species with few or no close living relatives. This can hamper inferences of habitat and community structure or, in some cases, result in erroneous conclusions. One way to deal with such challenges is taxon-free analysis, which focuses on attributes of species rather than their taxonomic affinities. When used with a sufficiently broad comparative data set of modern taxa, taxon-free analysis can provide robust insights into extinct communities.We performed a taxon-free analysis on 120 modern-day mammal communities representing diverse habitats, spread throughout the globe, and two middle Miocene localities: La Venta, Colombia and Quebrada Honda, Bolivia. Our goal was to: (1) test whether the vegetational structure of these localities could be inferred using modern communities; and (2) determine which modern communities were most appropriate models. The fact that the vegetational structure of La Venta has been studied extensively provided a baseline to judge the accuracy of the results. We coded each nonvolant land mammal species for size, locomotor range, and diet. The six size categories were based on an exponential scale. The locomotor categories included arboreal, semi-arboreal, terrestrial, semi-fossorial, fossorial, semi-aquatic, and cursorial. Dietary categories included fruit, grasses, insects, invertebrates, leaves, seeds, bark, and vertebrates. There was also a true omnivore category, for species that had many categories make up their primary diet.These data were used to calculate the percentage of species in each fauna in each category. We then arcsin transformed the data, and used the statistical and graphing program,JMP, to perform a cluster analysis and principal components analysis (PCA). The cluster analysis matched previous findings, in that La Venta clustered with many forested areas. Quebrada Honda grouped with open habitats and temperate broadleaf forests. Additionally, La Venta grouped with South American, North American, and African faunas, while Quebrada Honda grouped with Australian ones.

Technical Session V, Sunday 1:45

IMPACTS OF CENOZOIC CLIMATE AND HABITAT CHANGES ON RODENT COMMUNITIES

SAMUELS, Joshua, John Day Fossil Beds National Monument, Kimberly, OR, USA; JANIS, Christine, Brown University, Providence, RI, USA

A well-documented paleoclimatic record shows a general trend of later Cenozoic global cooling and increased aridity, corresponding with large scale environmental changes from predominantly forest to more open habitats. Previous studies of large mammalian herbivores show ecomorphological and community structure changes corresponding with environmental changes. Here we use the fossil record of rodents from the Cenozoic of North America to improve our understanding of the history of the herbivore component of terrestrial communities. Rodent adaptations for jumping and burrowing should reflect more open environments, and higher crowned teeth should reflect increased aridity and the presence of grasses. Morphological data were gathered for nearly 150 extant rodent genera, including: tooth crown height, incisor shape, relative grinding area, overall limb proportions, and the size of muscular attachments. Discriminant function analysis, analysis of variance, and linear regressions were used to build an ecomorphological framework to infer the dietary and locomotor habits of extinct rodents. 51 extinct species were measured and supplemented by data from literature sources. Broad scale patterns within North American rodent communities were analyzed, as well as finer scale changes within the fossil records of Oregon and Nebraska.Jumping adaptations first appear in rodents around the early Miocene, similar timing to ungulate cursoriality. Burrowing adaptations are seen in multiple lineages as early as the mid Oligocene (30 Ma), and highly fossorial beavers are seen by the late Oligocene (26 Ma). Multiple rodent lineages display parallel increases in herbivorous adaptations over time, such as increased crown height, enlarged grinding area, and broad incisors. The proportion of rodents within communities displaying these adaptations increased dramatically between 30 – 20 Ma. The origin and subsequent radiation of rodents with these ecomorphological adaptations corresponds with environmental changes. This suggests that, in contrast to larger mammals, rodents responded very quickly to mid Tertiary environmental changes, possibly as a result of their shorter generation times.

Poster Session IV, (Wednesday)

MORPHOLOGICAL DIVERSITY OF THE EARLY MIOCENE TRAGULIDAE (CETARTIODACTYLA, RUMINANTIA)

SÁNCHEZ, Israel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; QUIRALTE, Victoria, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; MORALES, Jorge, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; PICKFORD, Martin, Muséum National d'Histoire Naturelle-CNRS, Paris, France

Tragulids comprise small and primitive ruminants that survive as relics in the Old World tropical belt, the genus *Hyemoschus* in Africa and *Tragulus* and *Moschiola* in Asia. The Tragulidae belong to an ancient radiation of basal non-pecoran ruminants that were very common during the Paleogene. The genus *Archaeotragulus*, from the late Eocene of Thailand, is the oldest known tragulid so far. However, with the exception of *Archaeotragulus*, the Tragulidae are unknown from Paleogene deposits. Tragulids suddenly reappear in the basal Miocene, revealing a surprisingly high diversity. These very first Miocene forms are recorded in Africa (ca. 19-20 Ma) represented by *Dorcatherium* and the recently described genus *Afrotragulus*. Shortly after, tragulids are also registered from Asia (*Dorcabune* and *Siamotragulus*) and Europe (*Dorcatherium*). We present here a comparative anatomical analysis of the early Miocene tragulids *Dorcatherium*, *Afrotragulus*, *Dorcabune* and *Siamotragulus*, focusing on published data and new unpublished material from Kenyan and Ugandan localities. We discuss their dental features and their biogeographical distribution. Our results show that, when tragulids are first recorded in the early Miocene of Africa and Asia, two advanced selenodont forms (*Afrotragulus* in Africa and *Siamotragulus* in Asia) existed along with two more primitive bunoselenodont genera (*Dorcabune* in Asia and *Dorcatherium* in Africa). The lower cheek teeth of the selenodont tragulids show a characteristic array of features including flat cusps with expanded cristids, which easily set them apart from the bunoselenodont genera. These features are highly developed in *Afrotragulus*, which also shows elongated molars with very reduced 'M'-structure and an interrupted contact between the anterior and posterior lobes. In fact, *Afrotragulus* will help to clarify the taxonomy and systematics of the group, hitherto obscured by the excessive use of body size as the main criterion used by specialists to diagnose extinct tragulid species. Finally, this early Miocene diversity of tragulids suggests that the family underwent a yet-unknown and important radiation event previous to their first Miocene record.

Poster Session III, (Tuesday)

THE PULMONARY ANATOMY OF *ALLIGATOR MISSISSIPPIENSI*: A UNIDIRECTIONAL AIR FLOW SYSTEM THAT FORESHADOWS THE AVIAN RESPIRATORY SYSTEM

SANDERS, Richard, University of Utah SOM, Salt Lake City, UT, USA; FARMER, Colleen, University of Utah Dept Biology, Salt lake City, UT, USA

Recently we suggested that unidirectional airflow was present in the common ancestor of birds and crocodilians based on our observations of a bird-like pattern of airflow in the lungs of alligators. Furthermore we hypothesize that there are key features of the lung that give rise to this pattern of airflow that are shared by birds and crocodilians. Here we re-examine the anatomy of the alligator lung with the aim of gaining insight into the mechanisms by which this pattern of flow is generated and of elucidating pulmonary features that may be homologous with the avian lung-air sac respiratory system. Like previous workers we find a similar structural plan is present in the crocodilian and avian lung. Using computed tomography and gross dissections, we revisit the anatomy of the crocodilian lung. The topography of the lung of juvenile American alligators is highly similar to the embryologic topography of the avian bronchial network and air sac system. We describe in greater detail the macroscopic anatomy of the alligator lung, homologize avian similarities, and identify the various morphological characters associated with the unidirectional flow-through system including: a Hazelhoff loop-like aerodynamic valve that separates inhaled and exhaled airflow, dorsally located hypervascular gas exchange lung zones, nested spiral inhalational intrapulmonary conductive bronchi, ventral exhalational intrapulmonary bronchi, and hypovascular ventrally located rudimentary intrapulmonary air sacs.

Evolution of the Modern African Fauna, Wednesday 8:45

AFRO-ARABIA AS THE CRUCIBLE OF PROBOSCIDEAN EVOLUTION

SANDERS, William, University of Michigan, Ann Arbor, MI, USA

Since the last major review of African proboscideans three decades ago, new fossil discoveries and chronostratigraphic, systematic, and paleoecological advancements have established Afro-Arabia as the locus of most major proboscidean evolutionary events, extended the record of the order >20 million years older to the late Paleocene, and have more comprehensively documented its phylogeny and temporal, geographic, faunal, and paleobiological contexts. Proboscideans, and constituent taxa including phosphatheres, numidotheres, barytheres, moeritheres, palaeomastodonts, deinotheres, mammutids, gomphotheres, and elephants are now known to have originated in Afro-Arabia, with greatest taxonomic diversity in the Miocene. Comparative study of features such as loph(id) number, accessory conule/crescentoid distribution, half-loph(id) configuration, and tusk shape and construction, indicates that mammutid-gomphothere divergence occurred earlier than previously recognized, possibly within early Oligocene Palaeomastodontidae. It has also helped identify basal members of initial early Miocene gomphothere radiations of gomphotheriines, amebelodontines, and choerolophodontines. As well, this work facilitated development of phylogenetic schema outlining progressive morphometric transformations in these subfamilies and mammutids

that have utility for biochronological correlation of site-horizons. Morphometric analysis also shows that the radiation of early elephants was more complex than previously understood, and isotopic studies indicate that they were among the first Afro-Arabian mammals to specialize in the consumption of C_4 plants. Their activity may have opened local habitats in a manner critical to the connection between grazing and early Pliocene success of other mammalian groups, such as bovids, equids, rhinos, hippos, and suids. Subsequent competition with these groups and climate change appear to have contributed to taxonomic decline among proboscideans, leaving only savanna and forest loxodont elephants on the continent today, and forced an adaptive shift to greater incorporation of C_3 resources in their diets.

Poster Session IV, (Wednesday)

HEAD SHAPE EVOLUTION IN RHINOCEROTIDAE (PERISSODACTYLA): AN OVERVIEW OF ITS ECOLOGICAL IMPLICATIONS

SANISIDRO, Oscar, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; ALBERDI, María Teresa, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; MORALES, Jorge, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain

Rhinoceroses are one of the best examples of possible underestimation of morphologic diversity when considering extant species only. The aim of the study is to assess an introductory analysis concerning head morphology and several paleoecological traits as locomotion (Mc III gracility index) and hypsodonty in Rhinocerotidae. Although cranial morphology in rhinoceroses has been extensively studied in the last decade, the present study represents a wide sampled approach for evaluating the evolution of cranial variability in the family Rhinocerotidae and its ecological implications. A geometric morphometric analysis of the shape of the skull in 93 specimens from 38 rhinoceros genera has been performed. Trends in skull evolution were evaluated by using relative warp analysis. Relationships between morphological variation in head shape and both locomotion and diet were examined through two simple regression analyses. Shape changes along individual evolutionary lineages have been observed. More derived forms in both Rhinocerotini and Elasmotheriini show a certain degree of convergence towards a relatively elongated rostrum and a backwards-slanted skull occiput. They have slender metapodials and more hypsodont dentitions. On the other hand, Aceratheriini and Teleoceratina Rhinocerotini exhibit an enlarged palate, shorter rostrum, shorter metapodials and brachydont dentition.

Poster Session I, (Sunday)

NUMEROUS SHARKS FROM LATEST CRETACEOUS UPPERMOST HELL CREEK FORMATION, NORTH DAKOTA: SEA LEVEL RISE DUE TO THE LATE MAASTRICHTIAN GREENHOUSE EVENT?

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Did climatic fluctuations during the latest Cretaceous effect vertebrate communities leading up to the K/P (Cretaceous/Paleocene) boundary? Microvertebrate sites were wet-screened from the Hell Creek Formation of North Dakota. Two sites include: 1) PTRM (Pioneer Trails Regional Museum) 86002, a channel deposit 29.9 m below the K/P and ~65.9 Ma and 2) PTRM 89003, a crevasse splay 8.4 m below the K/P and ~ 65.6 Ma. Fish were the most numerous specimens. From the remaining 1432 identifiable specimens, there are sharks and rays (79%), amphibians (5%), lizards (2%), snakes (0.2%), crocodilians/champsosaurs (7%), hadrosaurs/ceratopsians (2%), theropods/birds (2%), and mammals (3%). Previous estimates of vertebrate diversity from these sites were based on surface collections and excavations. This yielded vastly different results, with sharks and rays rare or absent and dinosaurs and other larger specimens more numerous. This new study has several implications. First, screening and surface collection, in combination, should be used to produce vertebrate diversity estimates. Second, the discovery of numerous sharks and rays alters the paleoenvironmental picture for the latest Cretaceous in this area, indicating the proximity of a seaway just prior to the K/P. Third, both sites were deposited during or close to the late Maastrichtian greenhouse event (~66.1-65.7 Ma) when a sharp increase in CO2 and temperatures (~2-4° C) occurred. This event may have triggered a rise in sea level. This and other severe fluctuations in climate and sea levels would have stressed and altered terrestrial ecosystems, contributing to the background extinctions leading up to the K/P.

Poster Session III, (Tuesday)

TAPHONOMY OF PIPESTONE SPRINGS MAIN POCKET, A MIDDLE CHADRONIAN MICROVERTEBRATE ASSEMBLAGE FROM SW MONTANA

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Pipestone Springs Main Pocket (Renova Formation, Jefferson County, Montana) is an unusually rich concentration of well preserved small-bodied (<34kg) Chadronian mammals. First discovered in 1899, the fauna includes over 40 mammalian species including numerous holotypes. Renewed fieldwork yielded more than 2000 specimens from the outcrop surface, of which 70% have been identified to element and about 25% to taxon. Dentigerous elements include 493 specimens from over 20 genera. Most common are small artiodactyls (29%), *Ischyromys* (25%), *Paleolagus* (21%), and *Mesohippus* (9%). By element, dentaries and maxillae (35%) are most abundant, followed by vertebrae (23%), phalanges (10%), and metapodials (8%). Ribs and partial skulls are very rare. Coprolites are abundant and contain highly fragmented bone making a scatological origin unlikely as the primary source of float bone. Puncture marks occur in about 20 mandibles. Fossils are widely dispersed throughout a thick volcanoclastic mudstone-siltstone and thus probably were not hydraulically sorted. Over 98% of elements are from small to *Mesohippus* (<34kg) sized mammals. This size selectivity strongly suggests a predatory origin as does the presence of puncture wounds and bone-bearing coprolites. Assuming that post-mortem destructive processes prior to fossilization and during exhumation by erosion did not highly bias the content of the original prey assemblage, two predatory origins are plausible. First, the abundance, completeness, and high preservation quality of small, fragile mammalian dental and postcranial elements suggest an avian origin, although an expected higher proportion of fragile elements, especially ribs, are not seen. Second, occurrence of coprolites and puncture wounds, the rarity of partial skulls, and high percentage of dental elements suggest a mammalian carnivore origin, although elemental damage associated with ingestion is absent. The Pipestone Springs Main Pocket assemblage has a unique taphonomic origin, with the primary source being mammalian carnivores that did not ingest parts of the skeleton of their prey, with secondary input from avian predators.

Poster Session IV, (Wednesday)

NEW REMAINS OF A TITANOSAUR (DINOSAURIA: SAUROPODA) FROM THE EARLY CRETACEOUS OF SPAIN

SANTOS-CUBEDO, Andrés, Grup Guix, Vila-real, Spain; POZA, Bego, Consorci Ruta Minera, Cercs, Spain; SUÑER, Maite, Universitat Valencia, Burjassot, Spain; DE SANTISTEBAN, Carlos, Universitat Valencia, Burjassot, Spain

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 seven hundred fossils have been collected, including vertebrate and invertebrate species. Dinosaur bones (Theropoda and Ornithopoda) are abundant in this assemblage and in the fifth field season bones determined as Sauropoda were found. Taxonomically, the Ana site is dominated by disarticulated remains of ornithopods, which are usually fragmentary and abraded. We identified teeth of Theropoda indet. and Baryonychinae indet., and bones of *Iguanodon* sp. and Iguanodontia indet.

Herein, we report new finds from the Ana site. The specimen 5ANA08125 corresponds to a right and nearly complete femur and it is housed at the Colección Museográfica de Cinctorres, Spain. It is complete except for a part of the fibular condyle and a fragment of the lateral bulge. The preserved dorsoventral length is 114 centimeters (medium-sized femur). It is a well-preserved fossil, showing only some small fractures apparently due to diagenetic processes.

The specimen number 5ANA08125 shares with Titanosauriforms a prominent lateral bulge, the lateromedial flattening of the articular head and the lateromedial flattening of the diaphysis, quantified in terms of eccentricity (Titanosauriformes yield values below 0.50). The specimen also bears several features characteristic of titanosaurians, including an outwardly angled femora with a markedly elliptical cross-section; the presence of a medial deflection of the head of the femur along with a low, laterally oriented flange; the head of the femur situated dorsal to the level of the great trochanter and faced dorsally; the prominent development of a lateral bulge and eccentricity of 0.33. These characteristics allow us to determine 5ANA08125 as belonging to Titanosauria indet.

Poster Session II, (Monday)

INVENTORY AND MONITORING OF VERTEBRATE PALEONTOLOGICAL RESOURCES FROM NATIONAL PARK SERVICE AREAS

SANTUCCI, Vincent, National Park Service, McLean, VA, USA; KENWORTHY, Jason, National Park Service, Denver, CO, USA; TWEET, Justin, National Park Service, Cottage Grove, MN, USA; WOODS, James, National Park Service, Denver, CO, USA

During the past decade baseline paleontological resource inventories were undertaken throughout the National Park Service in order to identify the scope, significance, distribution and condition of fossils.This initial phase of inventories identified at least 224 units of the National Park Service that preserve fossils.Nearly half of the total park areas identified with fossils contain vertebrate paleontological resources, of which 33 parks were identified with vertebrate ichnofossils.The National Park Service supports scientific research and collection of fossil vertebrates through a permit system. The agency manages and monitors thousands of documented paleontological localities.The National Park Service first developed Servicewide policies and technical guidance for the management of paleontological resources during the 1980s. As new laws, policies and scientific methodologies emerge, the National Park Service has demonstrated leadership in paleontological resource management, stewardship and science.In 2009, Glen Canyon National Recreation Area (GLCA) was established as a prototype paleontological resource monitoring park with a focus on the development of long term monitoring strategies for *in situ* fossil vertebrate tracksites.Fluctuating water levels at Lake Powell result in intermittent periods of submergence and exposure impacting many dozens of vertebrate tracksites within GLCA.Long term monitoring of *in situ* vertebrate paleontological resources will provide information to support management decision-making regarding stabilization and recovery of threatened vertebrate fossils.Through the work of professional paleontologists within the National Park Service, along with partnerships with vertebrate paleontologists employed by museums and academic institutions, new vertebrate paleontological discoveries continue to be made within parks and monuments across the

United States.The inventory and monitoring activities accomplished by the National Park Service promote the scientific and educational values of vertebrate fossils as recognized in the Paleontological Resources Preservation Act of 2009.

Technical Session IV, Sunday 2:45

BRAINCASE OF A POLYCOTYLID PLESIOSAUR (REPTILIA: SAUROPTERYGIA) FROM THE UPPER CRETACEOUS OF MANITOBA, CANADA

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Polycotylid plesiosaurs are common components of the Cretaceous marine fauna of the Western Interior Seaway of North America, and represented by a number of skeletons including the skull. Nevertheless, postmortem deformation usually collapses the wide parietal table onto the braincase and displaces the neighboring bones even in well-preserved skull, and their braincase anatomy is hardly obtainable except for the palatal side and occasional isolated elements. A partial skeleton of the polycotylid *Dolichorhynchops osborni* from the Niobrara Formation (Santonian, Upper Cretaceous) in Manitoba, Canada, retains a well-preserved braincase that provides unprecedented details of a polycotylid braincase, such as the dorsal view of the braincase floor and the morphology of individual elements of the otic capsule. A virtual reconstruction of the braincase was created by a three-dimensional scanning technique that produces an accurate reconstruction of missing or damaged braincase elements, and it demonstrates the three-dimensional relationships among the elements in a polycotylid skull for the first time. Revised information on the braincase anatomy of *D. osborni* includes the peculiar morphology of the parasphenoid within the interpterygoid vacuity, long paroccipital process with expanded distal end, notched anterior process of prootic, and the presence and nearly horizontal orientation of the fenestra ovalis. Comparison with other plesiosaurian taxa revealed a considerable variation of the braincase anatomy within the Polycotylidae and Plesiosauria.

Romer Prize Session, Monday 10:45

***TRICERATOPS*: A MODEL ORGANISM FOR DECIPHERING DINOSAUR HETEROCHRONY**

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A combination of small sample sizes and a lack of high-resolution stratigraphy obscures ontogenetic and stratigraphic trends within the majority of non-avian dinosaur taxa. The latest Cretaceous ceratopsid *Triceratops* provides a rare opportunity to track shifts in both of these dimensions of variation within a taxon. *Triceratops* is the most commonly recovered dinosaur in the Hell Creek Formation of Montana and equivalent age strata of adjacent states and provinces. Comparative morphological studies supplemented by histological analyses indicate that this taxon underwent radical changes in cranial morphology throughout ontogeny, providing indicators of relative maturity between specimens. When placed in a new temporal framework for the Hell Creek Formation, specimens of *Triceratops* bridge gaps in stratigraphically resolved ontogenetic sequences. The two species of *Triceratops*, *T. horridus* and *T. prorsus*, are stratigraphically separated and their distinctive features represent a mosaic of heterochronic shifts. The parietal-squamosal frill is paedomorphic such that broad squamosals and an unfenestrated parietal are retained until extremely late in ontogeny relative to ancestral chasmosaurines. Similarly, stratigraphically higher specimens retain a juvenile morphology of the rostrum later in ontogeny. Peramorphic trends include an increase in nasal horn length and closure of the postfrontal fontanelle. Specimens from the uppermost Hell Creek Formation display reduced and laterally compressed postorbital horn cores late in ontogeny. An abundance of specimens combined with resolution of stratigraphic and ontogenetic transformations within *Triceratops* make it a model organism for studying non-avian dinosaur heterochrony. As the end-member of a lineage of chasmosaurines, developmental trends observed in *Triceratops* can be traced back through time, revealing longer term heterochronic trajectories within this group. *Triceratops* demonstrates that a comprehensive understanding of ontogenetic and stratigraphic variation is critical to resolving evolutionary patterns within the Dinosauria.

Romer Prize Session, Monday 11:00

EVOLUTION OF THE DINOSAURIFORM RESPIRATORY SYSTEM: NEW EVIDENCE FROM THE POSTCRANIAL AXIAL SKELETON

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In all extant archosaurs, there is a strong relationship between the postcranial axial skeleton and both pulmonary anatomy and respiratory mechanics. Based on comparisons with extant archosaurs and squamates, the patterns observed in the rib and vertebral morphology of extinct taxa allow for predictions of the gross morphology of their lungs and ventilation mechanics. Lung ventilation in extant crocodilians is achieved by a hepatic-piston pump and costal rotation; this mechanism is associated with a smooth internal thoracic ceiling, facilitating the expansion of the lungs and movement of the internal organs. The rigid lungs and air sacs of the avian respiratory system are coupled with strongly bicapitate ribs that, when articulated, generate a corrugated thoracic ceiling that locks the lungs in place. The dorsal vertebral series and adjacent ribs of 36 well-preserved fossil specimens were examined and compared with phylogenetically relevant extant taxa, permitting the reconstruction of the pulmonary anatomy for Dinosauriformes. When the results are mapped onto a phylogeny for Archosauria, clear trends become apparent indicating that the highly derived avian and crocodilian pulmonary anatomies are a function of very different evolutionary pressures, and that neither likely represents the plesiomorphic pulmonary condition for Archosauria. These data indicate a progression from cranially rigid, heterogeneously partitioned, multi-chambered flow-through lungs in basal dinosauriforms, towards the small rigid avian-style lungs that were likely present in saurischian dinosaurs. There is no skeletal evidence for a crocodilian-style hepatic-piston pump in any of the taxa reviewed, supporting the hypothesis that it was a novel respiratory mechanism acquired by crocodyliforms when they adopted a more aquatic lifestyle.

Poster Session III, (Tuesday)

AN ORNITHOMIMID-LIKE BASAL COELUROSAUR FROM THE EARLY CRETACEOUS (APTIAN) CEDAR MOUNTAIN FORMATION OF UTAH

SCHEETZ, Ashley, Brigham Young University, Provo, UT, USA; BRITT, Brooks, Brigham Young University, Provo, UT, USA; SCHEETZ, Rodney, Brigham Young University, Provo, UT, USA; RAUHUT, Oliver, Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; CHURE, Daniel, Dinosaur National Monument, Jensen, UT, USA

A horizon near the base of the Yellow Cat Member of the Cedar Mountain Formation of eastern Utah is yielding a number of fossils including fish, hybodontid shark coprolites, turtles, sphenodontids, ornithopods, ankylosaurs, and a theropod consisting of partial associated skeleton of a single individual with an estimated length of < 4m. The few recovered cranial bones of the theropod are indicative of a lightly built skull. The frontal suggests a large orbit, the occipital condyle is diminutive (12 mm diameter), and the dentary is delicate with supernumerary, minute alveoli ~2.5 mm long anteroposteriorly. No tooth crowns are preserved in the dentary but a 4 mm tall crown associated with the skull has a bulbous base. Cervicals are highly pneumatic with camellate internal structure, slightly amphicoeleous centra, and anteroposteriorly elongate, low neural spines. The three known cervicals are elongate, with centra up to 2.3 times as long as high, and cervical ?3 is small in diameter, suggesting a long, tapering neck. No dorsals or sacrals are known. Proximal caudals bear thin spines and strongly backswept transverse processes. Distal caudals have prezygapophyses nearly 50% of centrum length, centra wider than tall, and skid-like chevrons. All caudals have a robust ventrolateral prezygapophysial ridge. The scapular blade is broad and the humerus is relatively straight, moderately built, and 33% longer than the lightly built radius.The ilium has a large acetabular shelf, the tibia & fibula are long and gracile, and distally the fibula articulates with the calcanium and a shelf on the astragalus. The astragalar ascending process is moderately high, straight-sided, and narrower than the astragalus body. The metatarsus is not arctometatarsalian but is long (metatarsal III 60% of tibial length). A preliminary cladistic analysis suggests the taxon is a basal coelurosaur and the elongate neck and greatly reduced dentition housed in a light skull are convergent with ornithomimids.

Poster Session IV, (Wednesday)

A LARGE, TALL-SPINED IGUANODONTID DINOSAUR FROM THE EARLY CRETACEOUS (EARLY ALBIAN) BASAL CEDAR MOUNTAIN FORMATION OF UTAH

SCHEETZ, Rodney, Brigham Young University, Provo, UT, USA; BRITT, Brooks, Brigham Young University, Provo, UT, USA; HIGGERSON, Jeff, Brigham Young University, Provo, UT, USA

Among 5000+ bones recovered from Dalton Wells near Moab, Utah nearly 100 bones pertaining to at least four individuals of a large iguanodontid have been recovered. All are preserved in lobes of several stacked debris flows at the base of the Cedar Mountain Formation that rest on, and consist almost entirely of, reworked Morrison Formation that entombed and preserved the bones. Bones from the large adult iguanodont indicate this animal was ~8 meters long, as large as the European *Iguanodon bernissartensis*, with dorsal neural spines 5.5 times as high as the centrum, almost ¾ that of *Ouranosaurus*. Although many skeletal elements are known, most lack phylogenetically useful characters. The lower jaw is represented by an elongate (50 cm long) but incomplete dentary and gradually sloping surangular which is pleisiomorphic for the grade. The thick postorbital and large basioccipital suggests a skull similar to the robust *Iguanodon*. The original iguanodontid teeth from the site, the type of *Iguanodon ottingeri*, are similar to the large European iguanodonts but were later shown to be non-diagnostic at the generic level. The femur possesses a deep, wide anterior intercondylar groove with a robust distal lateral condyle, and a fourth trochanter just above midshaft. The adult femur would have been over one meter long. Although iguanodonts are common worldwide in the Early Cretaceous, phylogenetic resolution is hampered by their incompleteness. Though the Dalton Wells iguanodont is likewise fragmentary, several elements are useful in plugging the taxon into the general scheme of ornithopod phylogeny. The teeth, lower jaws, tall-spined dorsal vertebrae, and femur fits within a transformational series more derived than camptosaurid-grade ornithopods, but less derived than most of the large European iguanodontians.

Poster Session I, (Sunday)

ANALYSIS OF THE BONE CRUSHING BEHAVIOR OF *CANIS DIRUS* USING DENTAL MICROWEAR TEXTURE ANALYSIS

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Dental microwear analysis is an important method for reconstructing the diet of past peoples and extinct animal species. A relatively new dental microwear technique that combines confocal microscopy and scale sensitive fractal analysis (dental microwear texture analysis) has proved to be an objective way of looking at dietary preferences in living and fossil mammals. While the application of this technique has focused mostly on primates and various ungulate species, its application has only recently been applied to carnivorans. It has been hypothesized by other researchers that the extinct Pleistocene dire wolf (*Canis dirus*) ate more bone than the modern gray wolf (*C. lupus*) does today. This behavioral disparity has been proposed due to differences in skull morphology and dentition between these two canids, as well as the high incidence of tooth fracture and breakage in the dire wolf. It is possible that high predator competition during the Pleistocene influenced the dire wolf's diet by increasing carcass utilization through bone consumption. Unlike hyaenids and felids, which lack postcarnassials, canids tend to perform most bone crushing with the posterior molars. This makes inferences of diet differences bases on comparisons of homologous tooth surfaces between canid and other carnivoran families unreliable, and therefore any results of this study will be useful only for comparisons between canids. In the project described here the microwear texture analysis of *Canis dirus* is compared with that of the extant gray wolf, coyote (*C. latrans*), and African wild dog (*Lycaon pictus*) to assess degree of bone consumption in dire wolves.

Technical Session VI, Monday 3:30

INFLUENCE OF BODY MASS ON THE EVOLUTION OF DIEL ACTIVITY PATTERN IN HERBIVOROUS MAMMALS AND IMPLICATIONS FOR PALEOBIOLOGY

SCHMITZ, Lars, UC Davis, Department of Evolution and Ecology, Davis, CA, USA; PRICE, Samantha, UC Davis, Department of Evolution and Ecology, Davis, CA, USA

Extinct synapsid herbivores feature a large range of body sizes. Since body size influences many ecological traits, comparative analyses of the link between body size and ecology in extant species will yield important information for paleobiological inferences. One ecological trait of mammalian herbivores thought to be controlled by body size is diel activity pattern (DAP), i.e., the timing of activity during the 24h cycle. Specifically, it has been suggested that an increase in body mass correlates with the evolution of cathemerality, the activity during both day and night.We tested this hypothesis with a dataset on body mass and DAP of 459 species of extant mammalian herbivores. First, we assigned species to bins of body mass and calculated proportions of DAP for each bin. We recognized that for species of 1kg and above, the proportion of cathemeral DAP increases, whereas the proportions of both diurnal (day-active) DAP and nocturnal (night-active) DAP decrease. Higher proportions of cathemeral species in bins of larger body mass are consistent with the hypothesis, yet may be biased by phylogeny. Thus, we analyzed the dataset in a phylogenetic framework using a time-calibrated tree. First, we tested whether evolutionary shifts in DAP are linked with absolutely large changes of body mass. Indeed, phylogenetically independent contrasts of body mass at nodes with a shift of DAP are larger than contrasts at nodes with no shifts DAP ($p=0.01$). Next, we tested whether shifts from diurnal or nocturnal to cathemeral DAP are more likely than nocturnal/diurnal shifts. This pattern is expected if increases of body mass cause transitions in DAP. Maximum likelihood transition rates based on a symmetric rate model support this prediction.Our results confirm the influence of body mass on the evolution of DAP in herbivorous mammals. Possible mechanisms explaining this phenomenon include foraging and thermoregulatory requirements. Our results further open the possibility that many large-sized extinct synapsid herbivores were active day and night, which is congruent with the recent finding of cathemerality in herbivorous dinosaurs.

Technical Session I, Sunday 10:45

CRANIAL ONTOGENY IN *STEGOCERAS* AND THE EVOLUTION OF CRANIAL DOMING AND ORNAMENTATION IN PACHYCEPHALOSAURIA (DINOSAURIA: ORNITHISCHIA)

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Historically, studies of pachycephalosaurs have recognized plesiomorphic flat-headed taxa and apomorphic domed taxa. More recently, it has been suggested that the expression of the frontoparietal dome in *Stegoceras validum* develops ontogenetically, and that the flat-headed taxon *Ornatotholus browni* may represent a juvenile of this species, but evidence to support these hypotheses was previously limited. Here we test these hypotheses with the first ontogenetic growth series of a pachycephalosaur supported by multiple, independent lines of evidence, including conserved morphology, allometric growth curves, histology, and constrained stratigraphic occurrence. This series demonstrates that cranial growth in *S. validum* proceeded from a flat-headed to a domed state. Dome growth is positively allometric and the frontoparietal grows faster in width than length, resulting in a more triangular dome in adults. While slightly variable between individuals, the morphology of the parietosquamosal bar, and associated ornamentation, is ontogenetically conserved. Flat-headed juveniles display three characters (open interfrontal and frontoparietal sutures, tuberculate dorsal surface texture, and open supratemporal fenestrae) that are reduced or eliminated through ontogeny. Histological examination of this growth series confirms that juveniles have highly vascular skulls and this vascularity is reduced with increasing ontogenetic age. These results have implications for the delineation of species. They suggest that patterns of ornamentation are ontogenetically conserved and thus are of higher taxonomic and phylogenetic value than previously realized, whereas the shape of the dome can change considerably through ontogeny and, therefore, is less reliable. The cranial characters we identify in juvenile *Stegoceras* are also present in flat-headed pachycephalosaurs, which suggests they may also represent juveniles, possibly of domed taxa. However, it remains possible that these characters would be expressed in an ontogenetically mature flat-headed taxon. Multiple lines of evidence, as shown here, will be needed to further resolve the validity of flat-headed taxa.

Poster Session II, (Monday)

δ^{13}C ISOTOPE ANALYSIS OF THE TYPE MAASTRICHTIAN MOSASAURS

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The mosasaur fauna of the type Maastrichtian (SE Netherlands, NE Belgium)consists of five different taxa, with adult specimens ranging in size from 3 to 17 m. Markedly different tooth morphologies clearly suggest each taxon to have occupied a different ecological niche. Here we present a δ^{13}C analysis of tooth enamel structural carbonate of all five mosasaur taxa currently recognized from these c. 66Ma biocalcarenitic limestones.

Tooth enamel δ^{13}C values of 'small' (i.e. 3-5 m body length) species such as *Carinodens belgicus* are in the -10‰ range; larger species such as *Mosasaurus hoffmanni* and *Prognathodon saturator* are distributed around -13‰.

Although one might assume larger species to generally occupy higher trophic levels, and trophic fractionation is known to see δ^{13}C values become about 1‰ less negative in each step up the food chain, we observe the exact opposite here: larger species have a more negative δ^{13}C tooth enamel value.

Earlier work showed a roughly similar negative size/δ^{13}C relationship to exist between mosasaurs from very different geographical and stratigraphical provenance. Our research now eliminates geographical and temporal effects from the equation by sampling multiple specimens of all known taxa in a diverse ecosystem, with all samples coming from a *single* geographical area and from a *limited* (<0,2Ma) stratigraphic interval; our data therefore strongly suggests other factors, such as foraging habitat preference and Bohr effect to be the most important determinants of the different δ^{13}C values observed in different species.

It should be noted that, although in a typical marine ecosystem up to seven trophic levels can be recognized, a tentative reconstruction of the type Maastrichtian marine ecosystem would not necessarily place a large mosasaur such as *P. saturator* at a much higher trophic level than the small *C. belgicus*.

High-resolution serial sampling along the teeth of *M. hoffmanni* and *P. saturator* showed changes in δ^{13}C values during ontogeny to be within the accuracy/measurement error range of the method, and seasonality effects –if any– on the δ^{13}C values can be considered very limited at most.

Technical Session II, Sunday 12:00

3D-ANALYSIS OF FUNCTIONAL SURFACES IN THE PRE-TRIBOSPHENIC DENTITION

SCHULTZ, Julia, Universität Bonn, Bonn, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

Molars of the pre-tribosphenic dryolestid dentition are characterized by embrasure shearing evident from the mesio-distally compressed and linguo-buccally widened "trigon" and trigonid. The reversed triangular pattern of "trigonid" and trigon, shared with the more plesiomorphic symmetrodontans, is crucial for the embrasure shearing process, as the lower molars fit into the embrasures between the upper molars during occlusion. The three main cusps of the trigonid and the sharp leading edges have mainly puncture-crushing function for opening hard exoskeletons of insects. Dryolestids evolved additional shearing surfaces for further processing of softer food items. The lower molars show a unicuspid talonid (hypoconulid) disto-lingual to the trigonid, the upper molars a parastyle mesial to the "trigon". The buccally oriented guiding groove of the unicuspid talonid is homologous to the hypoflexid of the tribosphenic molar. However, in tribosphenic molars the hypoflexid is more steeply inclined and less involved in occlusal contacts. Striation analysis and virtual simulation of the relative movements of the molars using the newly developed "Occlusal Fingerprint Analysis"-software demonstrate a functional difference of the dryolestid and the tribosphenic hypoflexid. In the dryolestid hypoflexid, shearing is the important function during the chewing cycle, when the paracone slides buccally along the guiding groove. The average angle of the striations related to the occlusal plane is steeper than the inclination of the guiding groove in 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 typical tribosphenic grinding phase after centric oc-

clusion does not occur in dryolestids. 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.

Technical Session XV, Wednesday 11:00

THE EARLY APPEARANCE OF ADVANCED EUTELEOSTS AND THE CONTROVERSY BETWEEN MOLECULAR CLOCK AND GEOLOGICAL APPEARANCE OF ACTINOPTERYGIANS

SCHULTZE, Hans-Peter, The University of Kansas, Natural History Museum and Biodiversity Institute, Lawrence, KS, USA; ARRATIA, Gloria, The University of Kansas, Natural History Museum and Biodiversity Institute, Lawrence, KS, USA; GONZÁLEZ RODRÍGUEZ, Katia, Área Académica de Biología, Universidad Autónoma del Estado de Hidalgo, Pachuca, Mexico

The occurrence of an advanced percomorph (Cottiformes, Agonidae) in the Albian/Cenomanian of Mexico places the appearance of higher euteleosts, or neoteleosts, between the Late Jurassic and the end of the Early Cretaceous. This indicates an accelerated diversification of advanced teleosts in the Early Cretaceous. The first "true" teleosts (*Leptolepis*) with cycloid scales, ossified autocentral vertebrae, diural caudal skeleton, etc. occur in the Early Jurassic. Even though there is a dense fossil record, no "true" teleost has been found in deposits earlier than upper Lower Jurassic. The accepted basal teleosts, *Pholidophorus latiusculus* and *Ph. bechei* (occurring in the Late Triassic and Early Jurassic, respectively) have rhombic scales, surangular bone, no ossified vertebrae, etc., and look like other sister groups of "true" teleosts. This contradicts molecular clock data that postulate that teleosts go back to the Paleozoic. In the Middle-early Late Jurassic, teleost taxa (Crossognathiformes, Ichthyodectiformes, and others) restricted only to the Jurassic and/or Cretaceous appear. Only at the end of the Late Jurassic do modern teleosts (Teleocephala) such as elopiforms, ostariophysans and protacanthopterygians appear. Consequently, it has to be expected that osteoglossomorphs and clupeomorphs will be found in Upper Jurassic deposits based on their relationships to elopiforms and ostariophysans. The stepwise occurrence of higher teleostean taxa indicates a discontinued kind of evolution with an acceleration from early teleosts in the Early Jurassic to fossil higher taxa in the Middle Jurassic, to basal Teleocephala in the Late Jurassic and to neoteleosts in the late Early Cretaceous. The two last appearances of high numbers of higher taxa are connected with the two modern highest radiations within teleosts (in cypriniforms and perciforms). In contrast to molecular analyses, the appearance of higher teleostean lineages from the most basal taxa to most advanced modern taxa is condensed to a time span of 100 Million years.

Poster Session II, (Monday)

A 'WOOLLGARI-ZONE MOSASAUR' (SQUAMATA: MOSASAURIDAE) FROM THE CARLILE SHALE (LOWER MIDDLE TURONIAN) OF CENTRAL KANSAS AND STRATIGRAPHIC OVERLAP OF EARLY MOSASAURS AND PLIOSAURID PLESIOSAURS

SCHUMACHER, Bruce, Sternberg Museum of Natural History, Hays, KS, USA; A new specimen of russellosaurine mosasaur (FHSM [Sternberg Museum, Hays, Kansas] VP-17564) from the middle Fairport Chalk Member (*Collignoniceras woollgari* zone, early Middle Turonian), Carlile Shale of central Kansas is among the earliest records of a derived mosasaur known from the North American Western Interior Seaway (WIS). Unequivocally the oldest recorded occurrence of a russellosaurine mosasaur from Kansas, and one of only four Kansas occurrences consisting of more than an isolated element, the specimen includes sevensuccessive caudal vertebrae bearing articulating hemal facets. No demonstrable characters ally the specimen to a more refined taxonomic subgroup. Size of the vertebrae indicates a relatively large animal roughly 3.5 m in total body length. A large pliosaurid plesiosaur skull (FHSM VP-321) is known from similar geographic and stratigraphic positions, and the record of pliosaurs continues (FHSM VP-17469) into the younger Blue Hill Shale (*Prionocyclus hyatti* zone, middle Middle Turonian), demonstrating with certainty that pliosaurs and early mosasaurs shared thisregion of the seaway for minimally one million years. Holding both the earliest evidence of relatively large russellosaurine mosasaurs, and the latest occurrence of old-guard pliosaurs, the Late Cretaceous shallow marine carbonate shelf that was theWIS served as both harbor for evolutionary advancement and a refuge for top predators of a bygone era. Although speculative at the time, the scene of a large pliosaur attacking an early tylosasaurine as first depicted by paleo-life artist Daniel W. Varneris entirely plausible. Upper Turonian rocks record the interval when pliosaurs, long-reigning monarchs of the earth's oceans for some 65 million years, disappear and in their place there is scant but tangible evidence of large tylosaurine mosasaurs appearing. This was a time and environment in which mosasaurs began to diversify and increase in size. Thus, it seems logical to speculate that ever larger and increasingly successful mosasaurs may have played a competitive role in pushing pliosaurs toward extinction.

Poster Session III, (Tuesday)

THE SEDIMENTOLOGY AND STRATIGRAPHY OF BULLOCK CREEK, AUSTRALIA - AN IMPORTANT BIOCHRONOLOGIC MARKER FOR AUSTRALIA'S MID-CENOZOIC

SCHWARTZ, Leah, Monash University, Melbourne, Australia

Bullock Creek, a site in the Northern Territory of Australia, is an important calibration point for Australia's Tertiary fossil record. As a middle Miocene site, it forms a bridge between the diverse late Oligocene-early Miocene sites of South Australia's Etadunna and Namba formations, Queensland's Riversleigh, and more securely dated later Neogene sites. A diverse fauna including dromornithid birds, crocodiles, turtles and fish is found here. Bullock Creek is the type locality for a number of mammal species including the diprotodontid *Neohelos stirtoni*; the macropods *Balbaroo camfieldensis* and *Nambaroo bullockensis*; the thylacoleonid *Wakaleo vanderleueri*; the thylacines *Nimbacinus richi* and *Mutpuracinus archibaldi*; the palorchestid *Propalorchestes novaculacephalus*; and the miralinids *Bargaru kayir* and *Bargaru maru*. This study represents the first detailed geological survey of Bullock Creek. The outcrops of the Camfield beds, a freshwater carbonate deposit, in which the Bullock Creek Local Fauna is found, were mapped in detail. A stratigraphic sequence was demonstrated in which the quarry sites X and Y occur within the same unit, which underlies the unit continaing the Dromornithid Mountain and Far Site quarries. This implies that the assemblage represented at Bullock Creek may in fact be diachronous, but collection records are not as yet sufficient to determine if any time differences are significant. The sedimentological evidence suggests a depositional model wherein the Camfield beds were deposited in a low-energy environment that included oxbow lakes. Diagenesis appears to be the primary factor in determining the preservation of fossils within the Camfield beds, comparable to that of the Ulta Limestone, another local fossil-bearing deposit in which the Kangaroo Well Local Fauna is preserved.

Poster Session IV, (Wednesday)

MICRO-CT ANALYSIS OF THE EAR REGION IN *HETEROXERUS COSTATUS* (RODENTIA, MAMMALIA)

SCHWARZ, Cathrin, Universität Bonn, Bonn, Germany; RUF, Irina, Universität Bonn, Bonn, Germany; MARTIN, Thomas, Universität Bonn, Bonn, Germany

The well preserved skull of *Heteroxerus costatus*, a fossil ground squirrel from the Upper Oligocene of Gaimersheim (MN 28), Southern Germany, was investigated by high-resolution computed tomography (Micro-CT). Based on the CT data, the bony labyrinth housing the inner ear as well as the middle ear ossicles, were reconstructed for testing the proposed phylogenetic position and elucidating the type of locomotion. Further fossil and extant sciuromorph rodents representing different locomotion types (arboreal, gliding, fossorial, generalistic) were included in the study for comparison. *Tupaia* sp. represents the outgroup. The middle ear ossicles of *Heteroxerus* resembles the general morphology observed in our investigated sciuroids, for example *Sciurus vulgaris* and *Spermophilus citellus*. In proportion to the malleus and incus, the stapes of *Heteroxerus* is smaller than in the other sciurids. In all investigated taxa, a secondary crus commune is observed, which exhibits a groundplan character and is regarded as plesiomorphic. The cochlea of *Heteroxerus* has 2.5 turns, and thus differs from the extant fossorial sciurid species, which have almost 3.5 cochlea turns. Adaptations to locomotion and posture can be deduced from the morphometry of the semicircular canals of the bony labyrinth, by studying allometric correlations, e.g. the width, height and length of the canals. For the spatial orientation, the lateral semicircular canal is significantly important. In the first results of this study, regression analyses of the height of this canal show a similarity in *Heteroxerus* and *Spermophilus citellus*, whereas in a fossil specimen of *Spermophilus undulatus* it is considerably larger. Hence, the locomotory behaviour of *Heteroxerus* can be assumed as fossorial, a specialization for living on the ground.

Technical Session XI, Tuesday 3:00

MOLECULAR MECHANISMS FOR THE PRESERVATION OF SOFT TISSUES AND ORIGINAL BIOMOLECULES IN FOSSILS

SCHWEITZER, Mary, North Carolina State University, Raleigh, NC, USA; CLELAND, Timothy, North Carolina State University, Raleigh, NC, USA; ZHENG, Wenxia, North Carolina State University, Raleigh, NC, USA; SAN ANTONIO, James, Orthovita INC, Malvern, PA, USA

No chemical models account for the preservation of original biomaterials in ancient (>1Ma) fossils, so the identification of apparent bone matrix, blood vessels with contents, cells, and peptides derived from original proteins is controversial. However, the persistence of these components after demineralization of skeletal elements has been documented in multiple specimens derived from different ages, taxa, and depositional settings. No obvious biochemical or geochemical commonalities unite these specimens, other than that they are all vertebrates. Except for some fish, vertebrate bone consists of the same components (e.g. collagen, mineral, bone forming cells, vascular components), although these differ in ratio, abundance and protein sequence among taxa. We hypothesize that preservation of these components over geological time must rely on conditions inherent in bone in general, and that mechanisms preservingapparentblood vessels and cells differ from those preserving bone matrix. Experiments provide preliminary evidence that hemoglobin-derived iron may play a role in preservation of vessels and associated osteocytes, and we propose a chemical pathway that may result in preservation. Alternatively, the molecular structure of the collagen fibril, including the physical nature of its triple helical sequences, their modes of intermolecular

interaction, and potentially, the fibril's association with mineral, may contribute to the preservation of fossil collagen in bone. We show molecular interactions that may play a role in early diagenetic processes resulting in long term preservation, despite proposed theoretical limitson thesurvival potentialof original organic components over geological time.

Poster Session III, (Tuesday)

ONE OR TWO SPECIES OF THE GIANT CROCODYLIAN *DEINOSUCHUS*?
SCHWIMMER, David, Columbus State University, Columbus, GA, USA

The largest crocodylomorphs known from North America and Mexicocomprise the Late Campanian eusuchian genus *Deinosuchus*. Originally named from teeth and osteoderms in North Carolina, post-cranial remains in Montana, and skull fragments and a few post-cranial bones from southwest Texas, the huge crocodylian remains were respectively placed in "*Polyptychodon*" (a pre-occupied genus) *rugosus*, *Deinosuchus hatcheri*, and *Phobosuchus riograndensis*. Most recent studies recognize a single genus *Deinosuchus*, but there is no consensus about the number of species. The question of species is due in part to the existence of two distinct continental sub-populations on either side of the Western Interior Seaway (WIS) bisecting the northern American landmass during the later Cretaceous. The eastern *Deinosuchus* morph tends tohave smaller individuals (maximum estimatedoverall lengths under 9.0 m) whereas the western population tends toward much larger individuals (maximum lengths to ~ 12.0 m). Other differential characters include subtleties of the teeth (more rugose external surface in the eastern form) and osteoderms (thick and irregular in the western form). These variations are significant because teeth and osteoderms are among the principle synapomorphies of the genus. It has been debated whether these are size related characters, which, if so, would mean size is the main difference between populations and would imply a single species. New specimens from both sides of the WIS indicate that the eastern-western population differences are not just size-related, and thus justify specific separation. A few very large teeth recently collected in the Southeastern USA indicate ~10 m individuals, yet they are similar to the common, smaller regional specimens with strong surface enamel infolding, and notably different from western teeth. Additionally, osteoderms from smaller western individuals are clearly thicker and less regular than size-equivalent eastern osteoderm specimens. Although the gross skull morphology and known post-cranials are very similar, it is here proposed that the separate species be recognized and formalized as (western) *Deinosuchus riograndensis* and (eastern) *Deinosuchus rugosus*.

Poster Session I, (Sunday)

MORPHOLOGY AND ASPECT RATIO OF THE TAIL OF THE LOWER DEVONIAN OSTEOSTRACAN *SUPERCILIASPIS GABRIELSEI*
SCOTT, Bradley, University of Alberta, Edmonton, AB, Canada; WENDRUFF, Andrew, University of Alberta, Edmonton, AB, Canada; WILSON, Mark, University of Alberta, Edmonton, AB, Canada

Among the jawless vertebrates the Osteostraci are the only group to possess epicercal tails, a synapomorphy they share with the gnathostomes. This makes the tail of osteostracans significant to the evolution of epicercal tails in jawed vertebrates. Unfortunately, few well-preserved caudal fins and trunks are known for osteostracans. Several specimens of *Superciliaspis gabrielsei* have well-preserved tails and allow an accurate reconstruction. These specimens are from the Lower Devonian (Lochkovian) Man On The Hill (MOTH) locality, Northwest Territories, Canada. *Superciliaspis* possesses a trunk that is short and triangular in profile, and narrow at the caudal peduncle, together with a caudal fin that has a low aspect ratio. The dorsal margin of the tail is bordered by thick, plate-like scales that decrease in size posteriorly. The dorsal lobe of the tail extends beyond the posterior end of the main part of the caudal fin and carries a small, oval, scale-covered fin web separated from the main caudal fin by a notch. The posterior margin of the main caudal fin is smooth and nearly straight. The fin web attaches to the ventral horizontal lobe, which extends from the narrowest point in the caudal peduncle, along the ventral margin of the tail. The scales of the caudal fin are square and are aligned in rows perpendicular to the dorsal lobe of the tail. The low aspect ratio of the tail, while greater than seen in extant agnathans, remains consistent with other characters that indicate a benthic lifestyle, including a ventral mouth, flat ventral surface of the cephalic shield, flat ventral surface of the trunk, and absence of an anal fin. A benthic, slow-moving lifestyle is expected to be associated with a low aspect ratio tail adapted for powerful thrusts at low speed, for escape from predators or for opposing resistance from substrate when the animal was feeding or burying itself in the sediment. The morphology of the tail of *Superciliaspis* is thus consistent with the presumed benthic lifestyle of the organism.

Technical Session V, Sunday 3:45

THE TULE SPRINGS LOCAL FAUNA FROM SOUTHERN NEVADA: CONSTRAINING THE RANCHOLABREAN NORTH AMERICAN LAND MAMMAL AGE IN SOUTHWESTERN NORTH AMERICA
SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA; SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, USA; SAGEBIEL, J. Christopher, San Bernardino County Museum, Redlands, CA, USA; MANKER, Craig, San Bernardino County Museum, Redlands, CA, USA

The Rancholabrean North American Land Mammal Age (NALMA), named after the Rancho La Brea asphalt deposits in Los Angeles, California, is defined by the presence of the Eurasian immigrant *Bison* south of 55ºN latitude. Current interpretations place the arrival of this genus in the coterminous United States less than ~240 ka before present, although estimates vary.Land mammal ages are defined in faunal terms, and faunas do not manifest themselves across the entirety of a continent in a geologic instant. Rather, index species employed to define mammal ages can appear in different geographic regions at different times, depending upon dispersal patterns of the species in question. Land mammal ages can thus be considered time-transgressive rather than synchronous. In the case of the Rancholabrean, this diachronous nature may be quantifiable due to the abundance of Pleistocene localities and the accuracy of radiometric dating techniques.Vertebrate fossils assigned to the Tule Springs local fauna, recovered from ground water discharge deposits of the informally designated "Las Vegas Formation" in the Upper Las Vegas Wash, Clark County, Nevada, include the oldest and youngest reliably dated occurrences of *Bison* in the Mojave Desert and the southern Great Basin. Fossils of a long-horned form similar to *Bison latifrons*, as well as a smaller form in the size range of *B. antiquus*, are interpreted to derive from unit B_2 of the formation, which ranges in age between 144 Ka and 89 Ka based upon thermoluminescence dating. Fossils assigned to *B. antiquus* are also known from unit E of the Las Vegas Formation, directly associated with a radiocarbon date of 14,780 +/- 40 ybp. These records effectively delimit the Rancholabrean NALMA in thispivotal region of the American southwest.Many published "Rancholabrean" faunas from southern California and Nevada entirely lack *Bison,* which is the index taxon for this time period; published accounts considered land mammal ages to be temporally rather than faunally delimited. Other southwestern "Rancholabrean" assemblages reported to contain remains of *Bison* actually lack any such fossils. The records of *Bison* from the Tule Springs local fauna are therefore significant in documenting the oldest and youngest occurrences of the genus from the region, as well as providing robust new data on the temporal and geographicdispersal and evolution of these animals through the latest Pleistocene.

Poster Session I, (Sunday)

PLACEMENT OF THE PERMO-CARBONIFEROUS BOUNDARY IN THE HALGAITO FORMATION, CUTLER GROUP, SOUTHEASTERN UTAH
SCOTT, Kim, California State University San Bernardino, San Bernardino, CA, USA; SUMIDA, Stuart, California State University San Bernardino, San Bernardino, CA, USA

Carboniferous-Permian strata of southeastern Utah lack volcanism, significant local reversals in the magnetostratigraphic record, or any large extinction or speciation events, thus barring most avenues of radiometric and relative dating. Marine biostratigraphy has recently redefined the Carboniferous-Permian Global Stratotype Section and Point (GSSP) as the first occurrence of the conodont *Streptognathodus isolatus*, but if a terrestrial deposit lacks a marine influx then it cannot be dated by these means. The Halgaito Formation in the Valley of the Gods area of southeastern Utah has produced fossils at a point when synapsids and lineages leading to modern sauropsid groups diverged. Thus, the Halgaito Formation provides data bearing on both important geological and biological transitions during this time period. Fossils and stratigraphic data collected from 2002 to 2007 allow for biostratigraphic analysis in this region. Taxa present near the Carboniferous-Permian boundary include *Aviculopecten* sp., *Hystriculina wabashensis*, *Orthacanthus texensis*, *Sagenodus* sp., *Lohsania utahensis*, *Diplocaulus*? sp., *Eryops* sp., *Platyhistrix* sp. cf. *P. rugosa*, *Diadectes* sp., Limnoscelidae, *Edaphosaurus* sp., *Ophiacodon* cf. *O. navajoensis*, and *Sphenacodon* sp. with possibly *Varanosaurus* sp. Marine and terrestrial fossils from the Halgaito Formation indicate that the boundary is within 45 meters of the base of the formation, near the McKim Limestone.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 10:45

DENTAL MICROWEAR TEXTURE ANALYSIS, DENTAL MESOWEAR AND DISTAL LIMB ECOMORPHOLOGY OF THE KALFA (MOLDOVA) HIPPARIONINE HORSES: A MULTI-PROXY PALEOECOLOGICAL RECONSTRUCTION
SCOTT, Robert, Rutgers, The State Univ. of New Jersey, New Brunswick, NJ, USA; MERCERON, Gildas, Université Claude Bernard Lyon 1, Campus de la Doua, Villeurbanne, France; TANJU, Kaya, Ege Üniversitesi , Bornova, Turkey; KOSTOPOULOS, Dimitrios, Universityof Thessaloniki, Thessaloniki, Greece; SERDAR, Maya, Ege Üniversitesi , Bornova, Turkey

Following migration from the New World, hipparionine horses are recorded from a wide variety of late Miocene Old World sites. Very early Old World hipparionine horses have been interpreted as either preferring more wooded habitats or somewhat open intermediate habitats. Browsing or mixed feeding have been offered as possible dietary modes.The hominoid-bearing site of Kalfa in Moldova includes a large fossil mammal collection of middle Sarmatian age according to the local biochronological scale (or MN 9 in the Mammal Neogene system). The fauna of Kalfa shows a mix of Eurasian, local (i.e. Paratethyan) and West Asian elements, with a predominance of equids and cervoids. The Kalfa collection of hipparionines is likely the most representative of early Old World hipparions from Eastern Europe.Here we present a multi-proxy analysis of the paleoecology of the Kalfa hipparions. Cover and substrate preference are inferred from habitat scores generated on third metapodials. Probable "last suppers" are inferred using dental microwear texture analysis. Diets over a longer time scale are reconstructed based on dental mesowear.Habitat scores for the Kalfa hipparions based on the elongation and slenderness of third metapodials relative to body size are comparable to those for Höwenegg hipparions previously interpreted as indicative of forested conditions. The Kalfa hipparion third metapodials are neither relatively elongate or slender. Dental microwear textures compare to published values for extant grazing bovids for mean complexity and fall between extant grazing and browsing bovids for mean anisotropy. How-

ever, the sample was extensively coated with preservatives and, despite exhaustive cleaning, it is possible preservative still adhered to wear facets.Kalfa hipparion mesowear was compared with a set of extant species. Among perissodactyls, the Kalfa hipparion sample differed significantly from grazing zebras and the browsing black rhino. It appears more similar to *Equus asinus*, a mixed feeder. The mesowear, microwear, and ecomorphological results taken together suggest a mixed-feeding, forest-dwelling habitus for the Kalfa hipparions.

Technical Session XVI, Wednesday 2:45

DEVELOPMENTAL MECHANISMS UNDERLYING TRENDS IN ARTIODACTYL LIMB REDUCTION: A CASE STUDY IN THE DOMESTICATED PIG, *SUS SCROFA*

SEARS, Karen, University of Illinois, Urbana, IL, USA; BORMET, Allison, University of Illinois, Urbana, IL, USA; ROCKWELL, Alexander, University of Illinois, Urbana, IL, USA; POWERS, Lisa, University of Illinois, Urbana, IL, USA; GROBIS, Matt, University of Illinois, Urbana, IL, USA

Over half of modern mammalian orders experienced digit reduction during their evolutionary history. This includes the artiodactyls, which have likely independently lost some combination of their lateral digits at least 2 times, and likely 4-5 times. Despite the prevalence of this pattern, and over a century of study of digit development, controversy remains as to the primary developmental mechanisms behind mammalian digit loss. To begin to remedy this, we studied the development of the digits of an artiodactyl, the domesticated pig (*Sus scrofa*), from their first appearance through birth. Adult pigs have reduced their 2nd and 5th digits (i.e., the dew-claws), and lost their 1st.

Mammalian digits form in several distinct steps. First, undifferentiated mesenchymal cells condense to form digit anlagen. These anlagen subsequently grow and eventually ossify. Accordingly, two mechanisms have been proposed for how digits are evolutionarily reduced: (1) initial condensations may be reduced, or (2) they may form normally and then be degraded through a slower rate of growth, increased cell death, or fusion to another skeletal element. Impossibly, pig digit reduction has been used as an example for both of these patterns.

To determine how pig digits are reduced, we analyzed their morphology at multiple stages of development (6 stages between embryonic day 25 and birth) using standard morphometric, histological and immunohistochemical methods. We found that pigs initially form all five digits, but that the condensations of the reduced digits (i.e., 1, 2 and 5) are much smaller than those of the unreduced digits (i.e., 3 and 4). Furthermore, we found that all digits have comparable rates of growth and cell proliferation after their initial condensation, and no evidence for increased cell death. Taken together, results suggest that pigs alter their developmental program to reduce their 1st, 2nd and 5th digits by decreasing the size of their initial condensations. Therefore, this study supports the hypothesis that early patterning changes regulate mammalian digit reduction, and does not support the existence of an evolution-constraining phylotypic stage.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 8:15

STABLE ISOTOPE ECOLOGY OF MODERN AMAZONIAN MAMMALS: IMPLICATIONS FOR RECOGNIZING CLOSED CANOPY HABITATS IN THE FOSSIL RECORD

SECORD, Ross, University of Nebraska, Lincoln, NE, USA; KRIGBAUM, John, University of Florida, Gainesville, FL, USA; BLOCH, Jonathan, Florida Museum of Natural History, Gainesville, FL, USA

The ability to recognize closed canopy forests in the geologic record relies on an understanding of modern stable isotope ecology. Vegetation in closed tropical forests exhibits low $\delta^{13}C$ values due to high humidity, low irradiance, and recycled CO_2 below the canopy. Bioapatite values from mammals that occupy closed forests are poorly known, however, with the exception of the Ituri fauna from tropical Africa. This fauna exhibited a wide range of $\delta^{13}C$ values (~11‰), largely driven by very negative values from artiodactyl understory browsers (~-20 to -25‰). Average herbivore $\delta^{13}C$ values were low (~-16‰) compared to more temperate faunas, reflecting low $\delta^{13}C$ values in canopy and forest gap vegetation. This fauna suggests that ancient closed forests might be recognized by a wide range of $\delta^{13}C$ mammal values, by low average values, and by a strongly skewed distribution (skew = -1.7). But will other faunas show the same pattern if the taxonomic composition is different? To address this question we sampled a diverse Neotropical fauna from southern Venezuela, curated at the U.S. National Museum. We sampled apatite from 52 individuals representing 20 species of mammals with predominantly herbivorous diets from wet, closed forest in southern Venezuela. This fauna is dominated by canopy frugivores (mostly monkeys) and large terrestrial rodents (e.g., agoutis, pacas) that eat fallen fruit and other vegetation, filling the niche occupied by artiodactyls in Africa. Like the Ituri fauna, average $\delta^{13}C$ values are markedly low (-17.2‰). Monkeys have low $\delta^{13}C$ values (mean -17.7‰, n=27), with the exception of the folivorous howler monkey (-16.1‰, n=3). The highest mean values occur in peccaries (-14.6‰, n=3) that were presumably feeding in or around open gaps. Lowland pacas yielded intermediate values (-16.6‰, n=6). Understory values were reflected only in the lowland tapir (-19.0, range -17.0 to -20.6‰, n=3). Unlike the Ituri fauna, there is almost no offset between understory browsers and canopy feeders and virtually no skew (skew = 0.25). Thus, recognition of an ancient closed canopy using a fauna such as this must rely upon the overall low $\delta^{13}C$ faunal values, which may require corrections for changes in atmospheric carbon in deep time.

Evolution of the Modern African Fauna, Wednesday 10:45

A CRANIUM OF THE EARLY MIOCENE TENREC *ERYTHROZOOTES* FROM NAPAK, NORTHEASTERN UGANDA

SEIFFERT, Erik, Stony Brook University, Stony Brook, NY, USA; MACLATCHY, Laura, University of Michigan, Ann Arbor, MI, USA; COTE, Susanne, Alberta Biodiversity Monitoring Institute, University of Alberta, Alberta, AB, Canada

Three tenrec genera are known from early Miocene sites in Kenya and Uganda – *Erythrozootes*, *Parageogale*, and *Protenrec*. The phylogenetic affinities of these taxa, and particularly those of *Parageogale*, a form that shares a series of derived morphological features with Malagasy *Geogale*, are currently controversial, and have important implications for tenrec biogeography. It has long been known that collections from the early Miocene (~20 Ma) Napak localities in northeastern Uganda, now housed in the Uganda National Museum, include fragmentary remains of *Erythrozootes* and *Protenrec*, but remarkably a largely complete cranium of *Erythrozootes* was recently identified in the old Napak collections. Only three molar teeth are preserved on the specimen, the rostrum is badly abraded unilaterally, and the specimen is broken through the mesocranium, but otherwise most morphological details are observable either externally or through inspection of micro-CT scans. The specimen exhibits a number of features that are likely primitive within Tenrecoidea. Unlike extant tenrecs aside from *Potamogale*, the relatively unworn M1-2 have distinct metacones and comparatively large protocones, providing additional evidence for the hypothesis that metacone loss and protocone reduction occurred convergently within Afrosoricida. With regard to cranial morphology, the infraorbital canal is relatively small in diameter and more elongate than those of other tenrecs aside from *Geogale*; a suboptic foramen is present; the postglenoid process is tall and not recurved; the piriform fenestra is small and enclosed anteriorly by a broad alisphenoid contribution; there is no patent tubal canal; a well-developed sinus canal courses along the sidewall of the braincase; and the caudal tympanic process of the petrosal was relatively small. Interestingly, the cranial bones of *Erythrozootes* are much thicker than those of extant tenrecs. The Napak specimen exhibits morphology that is very similar to that of a braincase from Koru, Kenya, that was initially attributed to *Erythrozootes* but later considered to belong to the erinaceid *Amphechinus*; the original attribution was evidently correct.

Poster Session III, (Tuesday)

THREE NEW THEROPODS FROM THE CEDAR MOUNTAIN FORMATION (LOWER CRETACEOUS) OF UTAH

SENTER, Phil, Fayetteville State University, Fayetteville, NC, USA; KIRKLAND, James, Utah Geological Survey, 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

Here we report the discovery of three new theropods from the Cedar Mountain Formation (Lower Cretaceous) of Utah. Phylogenetic analysis indicates that one is a troodontid, one is a dromaeosaurid, and one is a basal therizinosauroid. The troodontid specimen consists of a partial left maxilla with nine small, closely spaced alveoli separated by septa. A promaxillary fenestra and a large maxillary fenestra are present. The maxilla is remarkable for its extreme inflation by a large, pneumatic chamber. The dromaeosaurid specimen is a partial skeleton that includes a lacrimal, radius, pubis, ilium, and several vertebrae from the neck, back, and tail. The lacrimal is unusual in that it lacks an anterodorsal process. The pubis is unusual in that it exhibits a pronounced tuber on the cranial edge of the proximal end. The posterior caudal vertebrae have elongated prezygapophyses, as in most other dromaeosaurids. The basal therizinosauroid specimen includes a cervical neural arch, a dorsal centrum, and fragments of several limb and girdle bones. Several manual unguals are almost completely preserved; all are strongly curved and lack a proximal "lip." As in other therizinosauroids, the pedal unguals are strongly curved.

Technical Session XIV, Wednesday 10:15

NOASAURID (THEROPODA: ABELISAUROIDEA) SKELETON FROM AFRICA SHOWS DERIVED SKELETAL PROPORTIONS AND FUNCTION

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An articulated skeleton of a noasaurid theropod from the Elrhaz Formation (Aptian-Albian) of Niger exhibits derived features in the axial and appendicular skeleton indicative of fossorial habits in addition to the unique features of the metatarsus and pelvis that unite later species from other landmasses. The dorsal vertebrae are unusually long (centra length more than twice diameter). The ribcage is reinforced to resist forces generated by the forelimb, including long and robust posterior cervical ribs, five large uncinate processes, ossified sternal ribs and sternal plates, and an enlarged coracoid. As in abelisaurids, the glenoid is directed posteriorly and only slightly laterally. The forelimb is directed posteroventrolaterally, is very short (18% of hind limb length), has intralimb proportions similar to those in abelisaurids, is powerfully constructed (robust deltopectoral crest and olecranon, broad interphalangeal joints), and has straight unguals. The forelimb cannot be flexed anteriorly beyond a coronal plane through the shoulder joints; it can effect a digging stroke that rotates the large-clawed manus toward the midline under the trunk. Digit II, the longest manual digit, preserves a portion of the ungual sheath. The hind limb has cursorial proportions including a tibia longer than the femur, pedal digits II and IV markedly shorter than digit III, and short, flat pedal unguals. The new skeleton, in sum, shows that a greatly shortened, but powerful, forelimb that lacks a semilunate carpal is probably primitive for abelisauroids and may have been used in noasaurids for enlarging burrows in pursuit of prey.

Technical Session XII, Tuesday 2:00

THE EVOLUTION OF TREMATOCHAMPSID CROCODYLIFORMS IN AFRICA: NEW EVIDENCE FROM THE MIDDLE CRETACEOUS GALULA FORMATION, SOUTHWESTERN TANZANIA

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Recent fieldwork in the middle Cretaceous Galula Formation, Rukwa Rift Basin, southwestern Tanzania has recovered a diverse assemblage of continental vertebrates including sauropod and theropod dinosaurs, turtles, fish, and mammals. Crocodyliform material has, until now, been dominated by well-preserved remains of a small mammal-like notosuchian. Remains of a larger taxon extend the morphological diversity of Galula Formation crocodyliforms and represent the first large-bodied middle Cretaceous crocodyliform from sub-equatorial Africa. This new form, represented by a well preserved posterior skull, compares closely with *Hamadasuchus rebouli* from the middle Cretaceous Kem Kem beds of Morocco. Features uniting the two taxa include straight lateral margins of the supratemporal fenestrae, prominent posterior projections of the supraoccipital, and a broad suture for the palatine over the anteroventral surface of the pterygoid flange. The presence of a *Hamadasuchus*-like crocodyliform in Tanzania extends the range of trematochampid crocodyliforms and provides one of the first faunal links between the Galula Formation and potentially penecontemporaneous faunas in North Africa. Reevaluation of other, often problematic, middle Cretaceous African taxa (e.g., *Trematochampsa*, *Stolokrosuchus*) reveal a number of shared derived cranial characters suggesting close phylogenetic relationships with the primarily South American Peirosauridae. A phylogenetic analysis with character sampling targeting trematochampsid and peirosaurid interrelationships was conducted to assess the relationship of the Tanzanian taxon among Mesozoic crocodyliforms. The consensus of most parsimonious trees places the Tanzanian form among a derived clade that includes *Hamadasuchus* and *Trematochampsa* within a larger clade of Gondwanan peirosaurid taxa. These results emphasize the need to clarify and redefine the historically overlapping clades Trematochampsidae and Peirosauridae and indicate a large degree of morphological diversity among these biogeographically important basal mesoeucrocodylians.

Poster Session I, (Sunday)

PAWS FOR THOUGHT: THE LATE PLEISTOCENE FOSSIL VERTEBRATES FROM THE TALARA TAR SEEPS, PERU, AND CORRALITO, ECUADOR

SEYMOUR, Kevin, Royal Ontario Museum, Toronto, ON, Canada

A.G. Edmund collected more than 27,000 fossil bones from the Late Pleistocene tar seep deposit near Talara, Piura, Peru, in January 1958. Of the identified 26,873 specimens, 63.1% represent mammals, 34.7% birds and 2.1% reptiles, with trace amounts of amphibian remains. Of the 16,960 mammal specimens, Carnivora represent over 79% of the specimens. Seven species of Carnivora have been identified (Minimum number of individuals, MNI, in parentheses): the canids *Lycalopex sechurae* (101) and *Canis dirus* (51), the felids *Smilodon fatalis* (20), *Panthera onca* (3), *Puma concolor* (3) and *Leopardus* sp. (2), and the mustelid *Conepatus talarae* (7). The MNI is usually based on podial elements. Although *Panthera atrox* was reported from Talara, this report was in error. This site compares well with the famous Rancho La Brea deposits in California, USA; they are of similar age, carnivorans dominate, a high proportion of juveniles and subadults are present (35% to 47% depending on the species), and a significant number of *Canis dirus* specimens show skeletal pathologies. A habitat with more water than is present today is indicated by this fauna. Edmund collected an additional 4,470 Late Pleistocene vertebrate fossils from the nearby Corralito site and several other minor locations in Guayas province, Ecuador in 1961. Of this total, 95% represent mammals and 5% reptiles, with trace amounts of amphibian and avian remains. Of the 4,225 mammal specimens, Carnivora represent less than 2% of the specimens, with only *Smilodon* (2) and *Lycalopex* (1) recorded. Species of extinct Xenarthra (90% of the specimens) and Artiodactyla (6.6% of the specimens) predominate in these faunas. Although seeped oil was present in these deposits, sedimentological and paleontological evidence suggest that these Ecuadorian sites were fluvially deposited and did not function as carnivore traps as did the Talara tar seeps.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 8:00

TRACE ELEMENT COMPOSITION OF BONE IN RELATION TO THE ECOLOGY OF AFRICAN VERTEBRATES

SHABEL, Alan, U. C. Berkeley, Berkeley, CA, USA

Trace element analysis is an important tool in paleobiology. The success of trace element analysis is limited by diagenetic effects on fossils, as well as by the lack of comparative data on extant organisms. Here I present the results of a survey of trace element composition (Sr, Ba, Ca) in raw bone samples from 79 species of extant African vertebrates (472 individuals) including more than 75% of the native carnivoran mammal species. The primary goal was to study the effect of aquatic resource use on bone tissue chemistry. The ratio of strontium to barium (Sr/Ba) was found to differentiate carnivoran species that foraged in freshwater, ecotonal, terrestrial, and marine ecosystems. This result was supported by data from non-carnivoran vertebrates, including bovids (22 species), tenrecs (*Potamogale velox*), and monitor lizards (*Varanus* spp.). The influence of ocean chemistry on consumer tissue was particularly clear for those species that foraged on both the coastlines and in the interior. This is well illustrated by the strong negative correlation between Sr/Ba and collection distance from the ocean for specimens of *Aonyx capensis* (clawless otter) and *Atilax paludinosus* (marsh mongoose). The Sr/Ba proxy provides a new tool for the ecological reconstruction of fossil organisms and a robust technique for investigations of marine resource consumption in coastal archaeological contexts.

Poster Session III, (Tuesday)

SLOTHS UP A TREE: ELUCIDATING SEMI-ABOREAL LOCOMOTION OF SMALL GROUND SLOTHS (SUPERORDER XENARTHRA, ORDER PILOSA)

SHAW, Barbara, Portland State University, Portland, OR, USA

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 dispersed 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 semiarboreal to penduloportal locomotion. This study reduced the limbs into levers, measuring the length of the lever, load, lift, and fulcrum of both the fore and hind limbs for 37 species of anteaters, ground and tree sloths. The results were analyzed using Principal Component Analyses, and then diagramed in a 2D and 3D scatterplots. The results place the smaller ground sloths from Caribbean islands within the 95% confidence ellipsoid with the semi-arboreal anteaters, supporting the small ground sloths' transition towards trees.

Preparators' Session, Monday 11:30

CREATION OF A LARGE SCALE INTERPRETIVE TRACKWAY DISPLAY

SHAW, Tyler, Peace Region Palaeontology Research Centre, Tumbler Ridge , BC, Canada; NYDEGGER, Lindsey, Peace Region Palaeontology Reseach Centre, Tumbler Ridge, BC, Canada

On May 15, 2010 the Peace Region Palaeontology Research Centre (PRPRC) reopened its doors after seven months of renovations. These renovations were undertaken as a final step to transform the PRPRC from a decommissioned elementary school to fully functioning research museum. Previous renovations have focused on converting the classrooms into offices, preparation labs, and collections space; this round of renovations focused on converting the former gymnasium into a public display area referred to as the Dinosaur Discovery Gallery. The main feature of this gallery is a 30' by 60' interpretive trackway display showcasing four genera of dinosaurs (replica mounts) and five ichnogenera. This scene depicts an Albian flood plain from the Gates Formation, shortly after the water has receded. During the planning stages several ideas were suggested to replicate a suitable track surface including modifying a latex peel of an actual ripple surface to create a plaster cast (replica mold). This idea was deemed unfeasible due to budget, size, and weight constraints. A suggestion from a local contractor resulted in the usage of expanded polystyrene (EPS). Expanded polystyrene has the benefit of being cost effective, light weight, and easily sculpted with heat. Ripple marks were crafted using a hand held propane torch; lightly brushing the surface with the flame. Several ponds and a small drainage channel were added by allowing longer contact between the flame and the EPS. Again several ideas were suggested as to how best craft the dinosaur tracks. Replica casts were produced using a modified lead casting technique. These pieces could then be heated and impressed into the EPS to create replica molds. To finish the surface, cracks between EPS sheets were filled with drywall mud and the surface painted to both match the natural rock and to highlight surface features. Lead stamps were crafted for multiple plant genera. These stamps were painted and pressed into the surface to replicate carbon impressions. Silicone molds were taken of each lead piece to be stored for future projects.

Poster Session I, (Sunday)

NEW DINOSAURS FROM THE LOWER CRETACEOUS KITADANI FORMATION OF THE TETORI GROUP, FUKUI, CENTRAL JAPAN

SHIBATA, Masateru, Fukui Prefectural Dinosaur Museum, Katsuyama, Japan; AZUMA, Yoichi, Fukui Prefectural Dinosaur Museum, Katsuyama, Japan

The Lower Cretaceous Kitadani Formation has been known to yield plentiful dinosaur bones from Japan. Two of the three dinosaur taxa known from Japan were unearthed from this formation. Dinosaur taxa from the Kitadani Fm include the carnosaur *Fukuiraptor kitadaniensis* and the non-hadrosaurid iguanodontian *Fukuisaurus tetoriensis*. For more than 20 years the Fukui Prefectural Dinosaur Museum has conducted an ongoing dinosaur excavation project at the Kitadani Quarry, where the Kitadani Formation crops out in Katsuyama, Fukui Prefecture. Since 2007, the 3rd dinosaur excavation project has made significant new discoveries. Here we report two new dinosaurs from this site.

New titanosauriform sauropod materials have been unearthed from the medium sandstone, approximately 7 meters above the known bonebed where *F. kitadaniensis* and *F. tetoriensis* were discovered. Recovered elements include humerus, ulna, femur, phalanges, cervical and caudal vertebrae. Elements were scattered and disarticulated, with some exhibiting heavy

weathering and deformation. According to characters of preserved bones, this Fukui sauropod is assigned to the basal titanosauriformes. The other new dinosaur comes from the very fine sandstone approximately 1.5 meters above the sauropod bone bed. This second new dinosaur is a dromaeosaurid dinosaur. Most elements of this specimen are disarticulated, but are found in close association, within a 1 square meter area. About 65 % of body parts are preserved, such as maxilla, braincase, cervical, dorsal and caudal vertebrae, and fore and hindlimbs. This is the best-preserved dinosaur from Japan.

These two new discoveries, along with *F. kitadaniensis* and *F. tetoriensis*, imply that there was a diverse dinosaur fauna in the Early Cretaceous of Japan. Although few Japanese dinosaur records exist, dinosaurs from Fukui will help us understand their paleoecology and paleobiogeography in Japan.

Poster Session III, (Tuesday)

A MYSTERIOUS KING-SIZED MESOZOIC LUNGFISH FROM NORTH AMERICA

SHIMADA, Kenshu, DePaul University, Chicago, IL, USA; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT, USA

Lungfishes (dipnoans) are lobe-finned fishes that geologically span from the Devonian to Recent. Here, we describe a previously unreported Mesozoic lungfish species assigned to the genus *Ceratodus* on the basis of an isolated upper tooth plate from Nebraska, U.S.A. The morphology of the tooth clearly suggests that it represents an undescribed taxon. However, this distinct species cannot be given a new taxonomic name because of its mysterious occurrence in the middle of Nebraska where exposures of Mesozoic rocks are not known in the vicinity. The specimen is interpreted to have been transported fluvially from Wyoming where Upper Jurassic- Lower Cretaceous strata representing floodplain-marginal marine depositional environments are common and often yield tooth plates of various *Ceratodus* species; however, it is equally possible that a Native American could have carried the tooth from the west or north to its discovery site. The specimen is noteworthy because, to our knowledge, it is the world's largest dipnoan tooth reported to date, measuring 117 mm in maximum dimension. If one considers the skull and tooth-to-skull ratio of *Ceratodus* to be similar to those of the largest extant lungfish, the Australian lungfish (*Neoceratodus forsteri*) that reaches up to about 2 m in total length, the estimated total length of the undescribed Mesozoic taxon would be about 4 m in life. This discovery adds a remarkable new component to the paleoecology of the Western Interior of North America during the 'Age of Reptiles.'

Poster Session IV, (Wednesday)

HIGH SHELL-CRUSHING PERFORMANCE OF TEETH FACILITATED BY UNIQUE FRACTURE PATTERNS

SHIN, Ji-Yeon, University of California, Davis, Davis, CA, USA; MOTANI, Ryosuke, University of California, Davis, Davis, CA, USA

Vertebrates that feed on shells, or durophages, tend to have rounded tooth crowns. A common interpretation of this phenomenon is that the brittle nature of tooth materials mandates rounded shape to avoid breakage while shell-crushing performance may be sacrificed by this shape. However, the second segment of this statement is an untested hypothesis. We therefore examined if rounded teeth perform differently from pointed tips at crushing shells. We used both rounded tooth-shaped and pointed tips as compressive loading apparatuses and measured the shell strength of the whole shells of two common bivalve species, *Mytilus edulis* and *Ruditapes philippinarum*. A comparison of measured shell strength between the two tip designs revealed a slightly lower average force in tooth-load experiments relative to its point-load counterpart. The reason for this difference can be explained by fracture patterns. We observed in our shell crushing experiments that tooth-load resulted in unique fracture patterns that were absent in point-load experiments. These tooth-specific breakage patterns required less average force than the patterns that are common to both tip designs. Therefore, rounded teeth perform slightly better than pointed teeth in shell crushing by giving rise to unique lower force induced fracture patterns. Multiple regression analyses resulted in equations that showed how shell strength changes according to shell morphology (height, length, thickness and width) regardless of taxonomic differences. Coefficients of regression equations indicated that height and thickness were significant predictors of shell strength. The results justify the common perception that thick and globe-shaped shells provide defense against durophagous predators.

Preparators' Session, Monday 9:15

USE OF RIGID, SEMI-RIGID AND TRANSPARENT CRADLES FOR PREPARATION AND LONG TERM STORAGE OF DELICATE SPECIMENS

SHINYA, Akiko, The Field Museum, Chicago, IL, USA

The preparation of delicate fossils requires a balance of consolidating materials and a series of cradles that transition the specimen from its matrix to its long-term conservation. The use of a cradle made with plaster, ethafoam, or thixotropic rubber, is a widely practiced method of preparing delicate specimens to prevent the specimen from collapsing during preparation. A common approach to stabilize the specimen is to apply consolidants to an unexposed specimen, but this slows the preparation of delicate specimens significantly as the matrix adheres to the specimen, requiring grinding and scraping of the matrix causing potentially damaging vibrations. A non-consolidated specimen must be kept in custom-fitted temporary cradles with appropriate liners and backing materials. A cradle with a tyvek liner and plaster or plaster bandage provides a time effective rigid support. Once the delicate morphology is exposed, a polytetrafluoroethylene (PTFE) sheet liner and woven cotton impregnated with thermal plastic provides a semi-rigid support and cushions against vibration. PTFE conforms to the specimen to provide an adequate liner. The thermal plastic can be remolded if adjustments are required. After the preparation of the specimen, the specimen must be consolidated. Then a transparent, user-friendly cradle, made from an aqueous based polymer commonly used in the dental industry is constructed for long-term conservation to provide appropriate support and reduce the potential for damage during handling. A malleable material, such as cyclododecane (CDD), clay, or PTFE tape is used to build a cushion to protect delicate features and protrusions. This cushion prevents the specimen from contacting the cradle while the cradle is formed. Use of CDD for the cushion is an option due to its sublimation property. A clay block is another option, but is difficult to clean from the specimen. PTFE tape is flexible and has a low coefficient of friction that allows the specimens to not cling to the cushion. Clearly marked registration keys or placement marks can be added to the cradle to guide the proper orientation of the specimen.

Poster Session III, (Tuesday)

ASYMMETRIC SKELETAL ADAPTATION TO A DEBILITATING PATHOLOGY IN THE HINDLIMB OF *POPOSAURUS GRACILIS* (ARCHOSAURIA: POPOSAUROIDEA)

SHIRLEY, Meghan, Temple University, Philadelphia, PA, USA; SCHACHNER, Emma, University of Pennsylvania, Philadelphia, PA, USA; SHAW, Colin, Pennsylvania State University, State College, PA, USA

The analysis of a largely complete and extraordinarily well preserved postcranial skeleton of *Poposaurus gracilis* has provided the opportunity to quantify the uncharacteristic hind limb bilateral asymmetry of this bipedal nondinosaurian archosaur. Percent directional asymmetry was calculated from caliper based morphometric measurements of the pelvis, femur, tibia, fibula, astragalus, and calcaneum, as well as estimates of long bone diaphyseal robusticity (J, *Imax*, *Imin*) measured at the midshaft using cross-sectional moulds. Pronounced directional asymmetry was found in virtually all measures of length, width, circumference and robusticity in all major long bones, as well as the calcaneum and astragalus. The extent of the variation is exemplified by the bilateral differences in the calcaneal tuber. In an obligate biped, the finding of pronounced left hindlimb robusticity indicates a unique gait pattern involving the relative unloading of the right hindlimb. The level of bone remodeling required to produce this asymmetry suggests that this individual was able to maintain itself, in spite of this potentially debilitating variation, for a significant period of its life. This high level of hindlimb bilateral asymmetry is uncharacteristic of a healthy obligate biped, and points to the etiology being pathological or traumatic in nature.

Poster Session II, (Monday)

NEW LOCALITIES FROM THE PALEOCENE-EOCENE THERMAL MAXIMUM TRANSITION DISCOVERED AS THE RESULT OF PROPOSED SURFACE COAL MINE EXPANSIONS IN THE POWDER RIVER BASIN OF NORTHEASTERN 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

Faunal and floral localities representative of the Paleocene-Eocene Thermal Maximum (PETM) from deposits in the Bighorn Basin of Wyoming have been intensively studied. In contrast, contemporaneous deposits in the Powder River Basin (PRB) have received less attention, likely due to the paucity of known localities. In 2009, ARCADIS U.S., Inc. (ARCADIS) discovered nineteen new localities from the PETM transition zone in the PRB resulting from paleontological resource management surveys for five separate coal mine expansion projects. Of these localities, nine contained potentially significant vertebrate specimens, while the remaining localities contained significant plant and invertebrate specimens. The exact stratigraphic position of these localities, as they relate to the PETM, were accurately determined from the extensive coal mine boring logs and coal bed methane well logs from the immediate area. All nine vertebrate localities occurred within a 45 meter interval above the Wyodak Rider coal seam which has been suggested to mark the transition from the Paleocene to the Eocene in the PRB. Specimens identified from these localities were dominated by reptiles, including crocodilians, champsosaurs, and various turtles. Mammal specimens were rare and represented only by partial teeth fragments. Due to the scope of the projects, only specimens on the surface were collected and reposited. Pending further excavation, these localities have the potential to provide significant data regarding vertebrate fauna from the PETM in the PRB, allowing for comparisons in evolutionary trends with PETM vertebrate fauna from other basins. The Thunder Basin National Grassland and the Bureau of Land Management are the primary agencies responsible for the management of these resources under the Paleontological Resources Preservation Act. ARCADIS prepared detailed reports on these localities with recommendations for protective measures to mitigate future impacts from mining operations that would otherwise result in the complete loss of data. By requiring adequate protective measures, the management agencies can ensure that permanently damaging impacts would be avoided while maximizing collections and data recovery from these localities for future research opportunities.

Poster Session III, (Tuesday)

MANEUVERED OUT OF A CORNER: LIGAMENT ENTHESES OF THE ARCTOMETATARSUS ENHANCED TYRANNOSAURID AGILITY

SHYCHOSKI, Lara, University of Alberta, Edmonton, AB, Canada; SNIVELY, Eric, Ohio University, Athens, OH, USA; BURNS, Michael, University of Alberta, Edmonton, AB, Canada

Recent analyses of tyrannosaurid adaptation have focused on their dramatic feeding apparatus, yet their mode of procuring food was contingent on locomotor morphology. Convergently with ornithomimids, tyrannosaurs evolved the arctometatarsus - an elongate, mediolaterally compact, anteroposteriorly strong metapodium that conferred higher linear speed than in other similarly sized theropods. The most unusual aspects of the arctometatarsus also offer hints of agility: constrictions of the central metatarsal (MT III) and rugosity on distal articular surfaces. It is hypothesized that ligaments emanating from these surfaces would have reinforced the foot during complex maneuvering. We apply two tests to this hypothesis: an assessment of comparative agility in tyrannosaurids, and a histological assay for ligament correlates. With origination areas used as a proxy for muscle cross section, a regression of muscle moments against rotational inertia (RI) indicate that tyrannosaurids could turn and brake more rapidly, and were thus more agile than other theropods of equivalent body mass. Using scanning electron micrography, histological preparations and micro-computed tomography on a tyrannosaurid MT III we assessed whether intermetatarsal ligaments were present in a configuration that enhanced tyrannosaur agility. We confirmed that lateral and medial intermetatarsal scars expand distally to approach the collateral ligament pits, unlike other large theropods with lower torque/RI capability. Three oblong tuberosities are consistently oriented indicating enhanced transfer of regional torsion stresses within specific directions to limit splay. Parallel linear assemblages of microscopic fibrocartilagenous ligament-bundle insertion pits (‘entheses’) are inset following the long axis of each tuberosity. Ridges of fibrous attachment areas that extend the length of the scar permit efficient local tensile stress transfer and further augment strength. Relatively high maneuverability and reinforced arctometatarsalian condition suggests high predatory competence and by extrapolation, how Late Cretaceous tyrannosaurids monopolized large predator niches.

Technical Session XVIII, Wednesday 2:30

NEW INFORMATION ON THE PERMIAN AND TRIASSIC VERTEBRATE FAUNAS OF THE LUANGWA BASIN, ZAMBIA

SIDOR, Christian, University of Washington, Seattle, WA, USA; STEYER, J. Sébastien, CNRS-MNHN, Paris, France; ANGIELCZYK, Kenneth, Field Museum, Chicago, IL, USA; SMITH, Roger, Iziko: South African Museum, Cape Town, South Africa; TOLAN, Steve, Chipembele Wildlife Education Trust, Mfuwe, Zambia

The Luangwa Basin of Zambia is one of several rift basins in southeastern Africa preserving nonmarine rocks that record a vertebrate fauna broadly similar to that of the Karoo Basin of South Africa. In July of 2009, our team made collections at 66 localities in the Upper Permian Madumabisa Formation and the Middle Triassic Ntawere Formation. As in the Karoo, the skulls of dicynodont therapsids were the most abundant tetrapod remains in Permian strata, with taxa such as *Diictodon*, *Oudenodon*, and *Pristerodon* well-represented. Among herbivores, pareiasaurs were less common, but sometimes found as semi-articulated skeletons. Gorgonopsians, baurioid therocephalians, and basal cynodonts were also collected in the Madumabisa Formation. Importantly, we found no evidence for distinct faunas preserved in the northern and southern parts of the basin, despite their remarkably different preservational styles. In addition, preliminary results suggest the presence of at least one endemic species, a tusked cistecephalid. Anisian (lower Middle Triassic) outcrops of the upper Ntawere Formation were patchy and mostly representative of a lacustrine depositional environment. Aquatic taxa, such as lungfish and large temnospondyls (including a possible new brachyopoid), were common in the Ntawere, except at one site near the village of Sitwe. This site preserved the first record of a trirachodontid from Zambia: a disarticulated, subadult specimen including parts of the skull as well as much of the appendicular skeleton. The same locality also yielded at least two skulls of a new traversodontid cynodont, as well as postcranial remains of an ornithodiran archosaur. Preliminary study suggests at least two additional archosaurs in the new collection, on the basis of several types of vertebrae and large, serrated teeth. As with tetrapods of the Tanzanian Ruhuhu Basin, the Luangwa tetrapod fauna presents an interesting blend of regionally dispersed taxa as well as species found nowhere else. Future work is planned for both areas, and will aim to unravel the effects of paleoenvironment and depositional system on the geographic differentiation of Permian and Triassic faunas.

Poster Session III, (Tuesday)

ENDOCRANIAL ANATOMY OF *LABIDOLEMUR KAYI* AND ITS RELEVANCE TO THE EVOLUTION OF THE BRAIN IN EUARCHONTOGLIRES

SILCOX, Mary, University of Toronto Scarborough, Toronto, ON, Canada; DALMYN, Claire, York University, Toronto, ON, Canada; HRENCHUK, Andrea, University of Winnipeg, Winnipeg, MB, Canada; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BOYER, Doug, Brooklyn College, New York, NY, USA

Apatemyids are extinct mammals known from the Paleocene and Eocene of Europe, and the Paleocene to Oligocene of North America. Cladistic analysis of 240 craniodental and postcranial traits for a diversity of mammals suggests that apatemyids may be stem euarchontoglirans, relevant for understanding primitive states for that clade. The only endocranial reconstruction previously described for an apatemyid pertains to *Carcinella sigei* from the Late Eocene of France. Here we present a composite virtual endocast of *Labidolemur kayi* derived from high resolution X-ray computed tomography data, based on partial crania from the late Paleocene (Clarkforkian) and Early Eocene (Wasatchian) of the Clarks Fork Basin, Wyoming. In light of *L. kayi*’s phylogenetic position and greater age, this reconstruction may better represent the primitive anatomy of the family. Like *C. sigei*, *L. kayi* had voluminous, transversely expansive olfactory bulbs, accounting for 11-13 percent of the endocranial volume. This is similar to Cretaceous eutherians (e.g., *Asioryctes*), but contrasts with the relatively smaller olfactory bulbs in both the basal gliran *Rhombomylus turpanensis* and in primitive primates (*Ignacius graybullianus, Microsyops annectens*). This suggests some reduction in the relative size of the olfactory bulbs in gliran and euarchontan or primate evolution. Similar to *R. turpanensis*, *I. graybullianus*, and the inferred ancestral condition for *Microsyops*, but unlike *C. sigei*, *L. kayi* exhibited exposed caudal colliculi, supporting the inference that this condition was primitive for Euarchontoglires and Euarchonta, and suggesting some independent expansion of the cerebrum in apatemyid evolution. The cranial capacity of *L. kayi* is estimated at 0.50-0.61 cc. Using a body mass estimate derived from the postcranium of a nearly complete skeleton of *L. kayi*, the estimated Encephalization Quotient (EQ) is 0.23-0.28 or 0.38-0.46 depending on the reconstruction and equation used. These values are much lower than estimates for *C. sigei*, but overlap with the range calculated for *M. annectens* and *Plesiadapis cookei*, suggesting that this may approximate the EQ of the common ancestor of Euarchontoglires.

Technical Session VI, Monday 4:00

INFERRING ECHOLOCATION IN ANCIENT BATS

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Most living bats (Chiroptera) use laryngeal echolocation to form images of their surroundings and to detect and capture flying prey. Echolocation is considered a key innovation largely responsible for the evolutionary success of bats, which number over 1100 extant species and inhabit all continents except Antarctica. Paleontologists have long sought osteological correlates of echolocation that can be used to infer behavior of ancient fossil bats, particularly Eocene taxa representing basal branches of the bat family tree. Four osteological traits have been postulated as indicators of laryngeal echolocation in bats: (1) an enlarged orbicular apophysis on the malleus (one of the middle ear ossicles that transmit sound from the ear drum to the inner ear); (2) an enlarged cochlea (providing increased sensitivity to high frequency sounds in the inner ear); (3) an enlarged paddle-like or bifurcated cranial tip on the stylohyal; and (4) an articulation between the stylohyal and the tympanic (providing a direct chain of transmission between the larynx and the ear). We examine these traits in light of new evidence from bats and other mammals, including high-resolution CT scans of the holotype of the Eocene bat *Onychonycteris*. We conclude that an enlarged orbicular aphophysis cannot be considered an indicator of echolocation. The other traits remain good markers, but stylohyal modifications and an articulation between this element and the tympanic represent two parts of a single complex. Analysis of basicranial morphology indicates that many Eocene bats were echolocators (e.g., *Icaronycteris*, *Archaeonyteris*, *Palaeochiropteryx*, *Hassianycteris*, *Tachypteron*, *Tanzanycteris*). Contrary to recent suggestions that *Onychonycteris* might have been capable of larygeal echolocation, we conclude that available evidence is best interpreted as indicating that it could not echolocate. Because postcranial morphology indicates that *Onychonycteris* could fly and phylogenetic analyses place it on the most basal branch within Chiroptera, the “flight first” hypothesis for the origin of flight and echolocation in bats remains the best-supported hypothesis for the origins of these key features.

Poster Session II, (Monday)

EVIDENCE FOR AN EARLIER PRESENCE OF PLESIOSAURS (REPTILIA, SAUROPTERYGIA) IN ANTARCTICA

SIMÕES, Tiago, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; RIFF, Douglas, Universidade Federal de Uberlândia, Uberlândia, Brazil; GRILLO, Orlando, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; ROMANO, Pedro, Universidade Federal da Bahia, Barreiras, Brazil

Plesiosaurs in Antarctica have been reported from the López de Bertodano and the subjacent Snow Hill Island formations, which crop out along the insular area of the James Ross Island sedimentary basin, Antarctic Peninsula. These strata range from the late Campanian to late Maastrichtian in age. Here, we present a new plesiosaur specimen from the Lachman Crags Member of the Santa Marta Formation, in the North-West of James Ross Island. This represents the first plesiosaur specimen from this stratigraphical unit, and consequently, the oldest one known up to date from Antarctica, pushing the occurrence of the Plesiosauria in this continent back to Santonian times (86.3-83.5Ma). This dating is based on previous and independent direct age estimation works for outcrops in this particular locality. The material is fragmentary, as it is most of the fossil vertebrates from Antarctica, reflecting the harsh weather conditions of that continent. Also, it was found aerially exposed close to dry riverbeds derived from ice melting, which might have contributed to the weathering and disarticulation of the specimen. However, we were able to identify nineteen vertebral centra, including six cervicals which have strongly concave and oval articular faces, as well as a pair of ventral foramina. Parts of the head of a propodial bone and many autopodium elements are also present. The autopodium includes the first proximal and distal mesopodial bones, as

well as some metapodial elements and many phalanges, mostly preserved at their epiphysial ends. Despite the badly conserved conditions, this is the most complete plesiosaur material from James Ross Island. Also, this is the first registered specimen from the stratigraphically older North-Western portion of that island. Thus, we hope this work will enable future findings on James Ross Island to be compared with this new material, contributing to further taxonomic knowledge and temporal distribution of Antarctica´s past vertebrate marine life.

Poster Session II, (Monday)

ANKYLOSAUR FOOT MORPHOLOGY AND FUNCTION

SISSONS, Robin, University of Alberta, Edmonton, AB, Canada

Aspects of biology and functional morphology of fore and hind limbs of ankylosaur dinosaurs are explored and analyzed using comparative morphology and finite element analysis. Reconstruction of the forelimb and posture of *Pinacosaurus grangeri* matches well with trackways attributed to ankylosaurs. The humerus is flexed and the elbow angled away from the body. The radius and ulna articulate perpendicular to one another, with little to no crossover. The metacarpus is upright and forms an arch at the proximal articular surface, resulting in a crescent configuration of the manus, and a semi-supinated posture relative to the main axis of the body. Ankylosaur hind limbs were adapted for bearing large amounts of weight, and finite elements analysis demonstrates that ankle morphology is derived. The ankylosaurid metatarsus has a twisted proximal articular surface, and metatarsals are optimally adapted for bearing weight at increasing angles from medial to lateral. Finite element analysis results, in conjunction with the twisted proximal articular surface, and other morphological features, suggest a rolling motion in the foot while pushing off in the locomotory cycle. This is perhaps an adaptation to cope with the wide hips associated with derived ankylosaurids, bringing the pes closer to the midline of the animal during locomotion to increase maneuverability.

Poster Session I, (Sunday)

REFINING ECOLOGICAL DIVERSITY ANALYSIS IN A PALEOECOLOGICAL RECONSTRUCTION OF OLDUVAI GORGE BED II

SLEPKOV, Rebecca, University of Minnesota, Minneapolis, MN, USA; KOVAROVIC, Kris, Durham University, Durham, United Kingdom; MCNULTY, Kieran, University of Minnesota, Minneapolis, MN, USA

Ecological diversity analysis is a comparative method of paleoecological reconstruction that identifies similarities in the mammal community structure of modern and fossil assemblages. Community structure is quantified by the frequency of niche components such as positional repertoire, dietary adaptation, and body size. Difficulties with this technique center on eliminating taphonomic bias and determining appropriate methods of quantifying the similarities and differences within the comparative sample. We use a number of multivariate statistical tools to refine this type of analysis including multiple methods of ordination for principal components analysis as well as correspondence analysis, discriminant function analysis, and hierarchical cluster analysis. These methods were tested in a reconstruction of the palaeoenvironment represented by assemblages from Lower Bed II (1.79-1.74 ma) and Upper Bed II (1.74-1.2 ma) at Olduvai Gorge, Tanzania. By computing the eigendecomposition using the modern assemblages and applying this ordination to both the modern and the fossil data, taphonomic bias from the latter groups was minimized. The removal of small-bodied taxa from both the fossil and comparative sample limited the influence of preservation and collection biases against micromammals. Results from this research suggest that the Lower Bed II assemblage at Olduvai Gorge was a tropical arid bushland or mixed woodland/grassland. Upper Bed II is best reconstructed as a grassland. These results diverge from previous studies, which suggested a wooded habitat in Lower Bed II comparable to the more closed environment of Bed I. This implies that paleoecological reconstructions relying on single taxonomic groups, as opposed to the entire community structure, may miss significant components of the overall habitat.

Technical Session X, Tuesday 11:00

COMBINED PHYLOGENETIC ANALYSIS OF PAN-ALCIDAE (AVES, CHARADRIIFORMES): THE CONTRIBUTION OF FOSSILS TO THE RESOLUTION OF AVIAN SYSTEMATIC RELATIONSHIPS AND DIVERGENCE ESTIMATION

SMITH, Adam, University of Texas Austin, Austin, TX, USA

Pan-Alcidae have the richest fossil record among Charadriiformes; however, previous phylogenetic analyses of alcid relationships have been overwhelmingly restricted to extant taxa. Evaluation of 25 extinct alcid species along with 52 extant species of alcids and charadriiform outgroup taxa represents the most inclusive taxon sampling of this clade. Systematic relationships were estimated through combined phylogenetic analyses of morphological characters (i.e., osteological, myological, integumentary, behavioral) integrated with mitochondrial and nuclear DNA sequence data (i.e., ND2, ND5, ND6, COI, cyt-b, 12S, 16S, RAG-1), and the results of different methods of phylogeny estimation (i.e., parsimony, Bayesian) were compared. Dense sampling of morphologic characters and extinct taxa resulted in a well-resolved phylogenetic tree that represents the most inclusive hypothesis of alcid relationships to date. The results of this analysis indicate that incongruence between previous analyses of alcid relationships is partly due to the exclusion of extinct taxa. Although many extinct alcid species are known from isolated skeletal elements, inclusion of these species facilitates investigation of the timing and sequence of morphological character changes, and demonstrates the potential of fossils for resolving contentious phylogenetic relationships. Additionally, the timing of cladogenetic events in Pan-Alcidae was estimated with a newly developed set of rigorously evaluated fossil calibration points for Charadriiformes. Calibrated molecular divergence estimates and comparison of minimum cladogram fit to the fossil record allowed for evaluation of previous hypotheses regarding extinction and radiation within Pan-Alcidae. Congruence between the estimated timing of cladogenetic events in Pan-Alcidae and the timing of Cenozoic climatic and geologic events was used a metric to evaluate the likelihood of causal relationships between these events.

Poster Session II, (Monday)

A PLESIOSAUROID SKULL FROM THE TOARCIAN (LOWER JURASSIC) OF ALHADAS, PORTUGAL

SMITH, Adam, National Museum of Ireland - Natural History, Dublin, Ireland; ARAÚJO, Ricardo, Southern Methodist University, Dallas, TX, USA; MATEUS, Octávio, Universidade Nova de Lisboa & Museu da Lourinhã, Lourinhã, Portugal

During the early days of geological exploration in Portugal, a plesiosauroid skull was discovered in the marine beds of the Toarcian age São Gião Formation in the Lusitanian Basin, Alhadas. The specimen (MG33) was studied by H.E. Sauvage who referred it to *Plesiosaurus* sp. This fossil has since been stored in the Geological Museum, Lisbon, where it has been largely forgotten by paleontologists for over a century. It consists of a partial isolated cranium with the premaxillary, suspensorium, and basicranium regions missing. The dorsal surface of the skull is highly abraided so few sutures are visible. The palate on the other hand is well preserved. There are presently four valid plesiosauroid genera known from the Toarcian stage: *Seeleyosaurus, Occitanosaurus, Hydrorion*, and *Microcleidus*. To assess the phylogenetic position of MG33, we coded it as an additional operational taxonomic unit in an existing data matrix and reran the cladistic analysis. In the resulting strict consensus of 15 equally parsimonious trees, MG33 forms an unresolved polytomy with *Hydrorion, Occitanosaurus* and *Microcleidus*. Further comparison of MG33 with these taxa indicates greater similarity to *Hydrorion*. MG33 has a flatparasphenoid between the posterior interpterygoid vacuities, whereas the parasphenoid in *Microcleidus* and *Occitanosaurus* is keeled. MG33 is a rare example of a plesiosaurian from Portugal and represents the westernmost occurence of any European plesiosaurian.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

A MORPHOLOGICAL AND MORPHOMETRIC REDESCRIPTION OF *TANYTRACHELOS AHYNIS*

SMITH, Amy, Virginia Tech, Blacksburg, VA, USA

Tanytrachelos ahynis is a small (approximately 21 cm long) aquatic protorosaur recorded from the Newark Supergroup. Most specimens are known from exposures of the Cow Branch Formation at the Solite Quarry on the Virginia-North Carolina border. Originally described on the basis of roughly 100 specimens, an additional 200 specimens have since been collected. The new material provides added insights into *Tanytrachelos*. Although the vast majority of specimens are impossible to mechanically or chemically prepare from the sediment matrix, Computed Tomography has allowed anatomical details otherwise obscured by sediment to be revealed. The use of quantitative morphometrics has also provided a more quantitative description. The in-depth study resulting from these resources allows for the suite of characters missing for *Tanytrachelos* in previous cladistic analyses of Protorosauria and Archosauromorpha to be added so that future reanalyses may take place. Three hundred and fourteen specimens and two CT scans of *Tanytrachelos* where studied to create a new qualitative description of its morphology. Additionally, 119 length measurements and four angle measurements of individual elements (from which seventeen variables were derived) were taken from these specimens for a quantitative description. The vertebral column of *Tanytrachelos* is comprised of thirteen cervicals, thirteen dorsals, two sacrals, and at least thirty-two caudals. The few preserved skulls show rows of homodont, pleurodont teeth and an orbit that consistently occupies 11%-13% of the lateral area of the skull. The carpus contains an ulnare, radiale, and two distal carpals, and the tarsus contains a calcaneum, astragalus, and distal tarsals 3 and 4. The fifth metatarsal is significantly short, with a hooked shape at its proximal end. Pairs of curved, unfused heterotopic bones are found in some specimens between caudal vertebrae 4 and 5. Traces of soft tissue are seen in a select few specimens, including a remarkable juvenile specimen (measuring approximately 3-4 centimeters in length), which displays a nearly complete body outline.

Technical Session II, Sunday 9:45

THE TAXONOMIC DIVERSITY OF THE STEM MAMMAL *MORGANUCODON* (MORGANUCODONTA: MORGANOCODONTIDAE) FROM LATE TRAISSIC-EARLY JURASSIC FISSURE DEPOSITS OF GLAMORGANSHIRE, WALES, UK

SMITH, Andrew, University of Bristol, Bristol, United Kingdom; GILL, Pamela, University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom; HOOKER, Jerry, Natural History Museum, London, United Kingdom

Triassic-Jurassic fissure fills from Glamorganshire, Wales, UK, offer a unique window into the evolution of Mesozoic mammals. Among the many fissures of this region, diverse assemblages have yielded a wealth of fossil vertebrate material, including a number of isolated

molariforms recently assigned to two new morganucodontan genera. A depauperate fauna is also observed in a number of fissures, and two early mammals, *Morganucodon* and *Kuehneotherium,* have been discovered therein. At present, all *Morganucodon* specimens from these fissures are attributed to a single species, *Morganucodon watsoni.* However, previous studies of the fissure material in this area have identified a taxonomically diverse population of *Kuehneotherium,* and we hypothesize that a similar diversity exists in *Morganucodon*. The abundance of disparate *Morganucodon* material from these depauperate fissures has allowed for rigorous morphometric analysis of dental material to quantifiably assess the presence of taxonomic diversity within these basal mammals. *Morganucodon* dental disparity was assessed via Principle Component Analysis (PCA) and Principle Coordinate Analysis (PCoA) using material from two quarry fissures, to investigate whether a similar taxonomic pattern to *Kuehneotherium* was present. Upper and lower molars cluster in morphospace relative to locality, and this separation is statistically supported by Discriminant Analysis of Euclidian and Manhattan values from PCoA ($P<0.001$). Separation is most distinct in the second molars with a similar morphospace pattern present in the thirds. An increasing buccal salience distance and differing cusp proportions constitute the major morphological characters that define specimen position in morphospace. PCA loading values identified size and inter-cusp distances as significant components of these differences. We conclude from the observed differences in size and morphology that *Morganucodon* possesses a true taxonomic diversity, similar to that of *Kuehneotherium*. This represents further evidence of diversity in the earliest stem mammals, aided by changes in developmental dental patterning, which permitted subsequent ecological diversification.

Technical Session VII, Monday 3:30

THE ENDOCRANIUM, INNER EAR AND PNEUMATIC STRUCTURE OF THE UPPER TRIASSIC PHYTOSAUR *PSEUDOPALATUS PRISTINUS*

SMITH, David, Northland Pioneer College, Holbrook, AZ, USA; SANDERS, Richard, University of Utah, Salt Lake City, UT, USA; PARKER, William, Division of Resource Management, Petrified Forest National Park, AZ, USA; CAVANAUGH, Jones, Summit Regional Medical Center, Show Low, AZ, USA

Endocranial reconstructions of non-ornithodiran archosauriforms are rare, existing for a handful of taxa including some erythrosuchids, phytosaurs, and aetosaurs. The most informative phytosaur endocranial reconstruction is based on serial sectioning of the braincase of *Smilosuchus gregorii*. *Pseudopalatus pristinus* represents a more derived form from the Upper Triassic Chinle Formation, Petrified Forest National Park, Arizona. In an effort to elucidate phytosaur cranial morphology, including the endocranial cavity and associated structures without destructive analysis, three specimens of *Pseudopalatus* were imaged using computed tomography (CT) at the Summit Regional Medical Center in Show Low, Arizona. High quality results were obtained from two of these, PEFO 382, a nearly complete skull with an intact braincase, and PEFO 34042, a partial braincase with both auditory vestibules preserved. *Pseudopalatus pristinus* has a typical non-avian reptilian endocranial serial architecture, comparable to that previously described for *Smilosuchus gregorii*. In both taxa, the pontine and cephalic flexures are shallow, resulting in an elongate cavity, as expected for semi-aquatic quadrupeds. The region accommodating the cerebrum is quite reduced. There is no indication of an enlarged epiphysis in *Pseudopalatus*, and the referred structure in *S. gregorii* probably corresponds to the longitudinal sinus. Most of the cranial nerve channels are preserved in one or the other of the two successfully scanned *Pseudopalatus* specimens and can be related to visible foramina in the braincases. The inner ear structure was recovered in both PEFO 382 and 34042. The cochlea of observed phytosaurs is notably short, presumably reflecting limited high frequency sound discrimination and is easily compared to extant crocodilians; a condition that is highly correlated with aquatic acoustics. The paranasal pneumatic system of *P. pristinus* is quite conservative, consisting of a long paranasal pneumatic tube lacking any subsidiary diverticula that extends to the tips of the premaxillae. Posteriorly, the chamber must have contacted the olfactory bulbs dorsally, though the exact boundary is not reflected in the current data. Ventrally, the chamber came into direct contact with the pterygoideus musculature, indicating active ventilation as is modeled for dinosaurs. The paratympanic pneumatic system in *Pseudopalatus* is poorly reflected in the osseous tissue and may have been limited to the soft tissue. Updated interpretation of some details of the braincase anatomy of phytosaurs supports an aquatic habitat similar to extant crocodilians.

Technical Session IX, Tuesday 8:45

MAMMALIAN BODY MASS EVOLUTION OVER SPACE AND TIME

SMITH, Felisa, University of New Mexico, Albuquerque, NM, USA; RESEARCH COORDINATION NETWORK, IMPPS, University of New Mexico, Albuquerque, NM, USA

The extinction of the dinosaurs at the K/Pg was arguably the seminal event in the history of mammals, opening the door for their subsequent diversification into the wide range of body masses seen today. Yet, with the exception of North America, the tempo and mode of body mass evolution over the Cenozoic has received little attention. Here we compile and analyze data on maximum body mass at the ordinal level for each subepoch for each major continent. Beginning at the K/Pg, maximum body size increased near-exponentially initially, leveled off within approximately 25 million years, and then remained approximately constant until the Recent. There was remarkable congruence in the rate, trajectory and upper limit of size across continents, orders, and trophic guilds, despite differences in geological and climatic history, turnover of lineages, and variation in species composition. Although there are superficial similarities with the variation of key abiotic factors, such as oxygen concentration, temperature and terrestrial land area, there are no significant correlations. The patterns suggest that after the extinction of dinosaurs, mammals diversified to fill unique niches available to the largest terrestrial vertebrates.

Poster Session I, (Sunday)

SEXUAL DIMORPHISM IN TUSKS OF AMERICAN MASTODONS (*MAMMUT AMERICANUM*) AND AFRICAN ELEPHANTS (*LOXODONTA AFRICANA, LOXODONTA CYCLOTIS*): A MULTIVARIATE COMPARISON

SMITH, Kathlyn, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA

Characteristics of social structure, mating strategies, and parental investment can be inferred for mammalian species based on degree of sexual dimorphism, especially when males are substantially larger than females. African elephants (*Loxodonta africana*, *Loxodonta cyclotis*) exhibit marked dimorphism in tusk size and show behaviors typical of strongly dimorphic species. American mastodons (*Mammut americanum*) also exhibit pronounced tusk dimorphism, but mastodons and elephants diverged from a most recent common ancestor over 25 Ma, so whether the two genera exhibit similarities in behavior must be inferred. Similar behavioral traits in mastodons and elephants could be supported if patterns of tusk dimorphism are consistent across the two genera. Separate discriminant function analyses (DFA) of 21 mastodon tusks of inferred sex (assessed in independent analyses) and 45 elephant tusks of known sex, using the same ten tusk variables, illustrate that similar patterns of ontogenetic change in tusk circumference, regardless of genus, effectively discriminate between sexes. Canonical variates analysis (CVA) of tusks from male and female mastodons and male and female elephants, using the same tusks and measurements as in DFA, shows that male tusks are larger than female tusks across all measurements, especially in maximum tusk circumference and pulp cavity depth, for both genera. CVA also emphasizes differences in tusk morphology between genera that imply mastodon tusks are, in general, more robust than elephant tusks, although this difference does not affect the nature of tusk dimorphism. Overall, this study illustrates that there is a characteristic male and a characteristic female tusk form shared by elephants and mastodons. This suggests selection pressures favoring tusk dimorphism remained relatively constant for these lineages since at least the time of their divergence. Thus, mastodons, like modern elephants, likely exhibited behaviors associated with strongly dimorphic species, and aspects of modern elephant behavior may have emerged prior to the divergence of elephants and mastodons.

Preparators' Session, Monday 8:45

CSI KIMBERLY: FOSSIL CRIME SCENE INVESTIGATION PRIOR TO THE ESTABLISHMENT OF THE PALEONTOLOGICAL RESOURCES PROTECTION ACT

SMITH, Matthew, Petrified Forest National Park, Petrified Forest, AZ, USA

On May, 6 2007 a theft of fossil resources was reported by a staff member of the John Day Fossil Beds National Monument. Due to preparators' specialization in the removal of in situ fossil materials from field settings, and knowledge of the marks that fossil collection and preparation leave on specimens, the preparation staff was asked to perform forensic analysis of material gathered at the crime scene. This study included gathering of evidence from the crime scene, analysis of tool marks using photo-microscopy, analysis of associated fossil material, and analysis of negative impressions of the stolen fossil in the surrounding matrix. Preparation staff also helped to serve a warrant at the suspect's house. During the warrant police seized digital photographs and videos that appear to match the crime scene and found additional fossil material and matrix that appears to be associated with matrix from the crime scene. Using all the material available we attempted to identify the genus of the stolen specimen and determine its "value". Value was determined using the Archaeological Resources Protection Act protocols as a working model. Extensive photo documentation of the locality and physical evidence proved to be crucial to analyzing material collected at the suspect's house. Also, our use of reversible glues in the museum sciences was found to lend itself to the legal process with little conflict. The evidence points to the conclusion that the suspect not only was at the scene of the crime on the day in question but that he had associated materials from the stolen fossil in his household when warrants were served later that year. Unfortunately, the case has yet to go to trial at this time. Regardless of the outcome the generalities of the crime scene analysis may prove to be an instructive example for law enforcement officials and museum staff gathering evidence at future fossil crime scenes on federal land.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

REGIONAL DISJUNCTION IN PLEISTOCENE FAUNAS FROM INDIANA AND THE MIDWEST

SMITH, Michael, Indiana University, Bloomington, IN, USA

The mammal fauna from Harrodsburg Crevice, a Late Pleistocene site from southern Indiana, USA, has several anomalous occurrences, including a northerly occurrence of *Panthera onca augusta* (Pleistocene jaguar) and a late occurrence of *Platygonus vetus* (Pleistocene American peccary). Two published radiocarbon dates (25,050 ybp and 34,460 ybp) suggested that the Harrodsburg fauna belonged to an interstadial of the Wisconsinan (during Marine Isotope Stage 3), which if true would make the occurrence of *P. onca* the northernmost of the

Rancholabrean and the occurrence of *P. vetus* the only one in the Rancholabrean. To consider the fauna in a broader ecological and temporal context, a species presence/absence matrix was created comparing the Harrodsburg with other Pleistocene sites. Cluster analysis using two similarity indexes, Simpson and Raup-Crick, failed to link the Harrodsburg fauna with nearby Late Pleistocene to Recent sites: Peccary Cave (Arkansas); Brynjulfson, (Missouri); Ten Mile Rock, Hollidaysburg (Pennsylvania); and New Trout Cave, (Virginia). The Harrodsburg fauna was closely linked to more distant sites in south-central Texas (Cave Without a Name, Hall's Cave, Levi Shelter, Zesch Cave). This regional disjunction is interpreted to mean that the Harrodsburg fauna is older than suggested by the radiocarbon dates, instead representing an earlier, much warmer, perhaps Middle Pleistocene, interglacial period, which is biostratigraphically more consistent with the presence of *P. vetus* and *P. onca augusta*.

Technical Session X, Tuesday 10:45

PHYLOGENETIC ANALYSIS OF PELECANIFORMES (AVES) BASED ON OSTEOLOGICAL DATA: IMPLICATIONS FOR WATERBIRD PHYLOGENY AND FOSSIL CALIBRATION STUDIES

SMITH, Nathan, Field Museum of Natural History, Chicago, IL, USA

Debate regarding the monophyly and relationships of the avian order Pelecaniformes represents a classic example of discord between morphological and molecular estimates of phylogeny. This lack of consensus hampers interpretation of the pelecaniform fossil record, which has major implications for understanding patterns of character evolution, and for dating deep splits in higher-level avian phylogeny. The monophyly and phylogenetic relationships of the Pelecaniformes were assessed through parsimony analysis of an osteological dataset encompassing 59 taxa and 464 characters. Pelecaniform monophyly is rejected, with Phaethontidae recovered as distantly related to all other members of the order, which are supported as a monophyletic Steganopodes. Incongruence length difference tests suggest that some anatomical partitions of the dataset may possess different phylogenetic signals, and partitioned analyses reveal that these discrepancies are localized outside of Steganopodes, and are primarily due to a few problematic taxa or poorly supported nodes. The Plotopteridae, an extinct family of wing-propelled divers, are recovered as the sister group to Phalacrocoracoidea, suggesting extensive convergence in the pectoral limbs of plotopterids and penguins. Relationships of several fossil pelecaniforms representing key calibration points for studies of higher-level avian diversification are well resolved. These include *Limnofregata* (sister group to Fregatidae), *Prophaethon* and *Lithoptila* (successive sister groups to Phaethontidae), and ?*Borvocarbo stoeffelensis* (sister group to Phalacrocoracidae). The sister group relationships of these fossil taxa are well supported, and invariant when 'backbone' constraints based on recent morphological or molecular phylogenies are imposed. However, the successive outgroup relationships of several of these "stem fossil + crown family" clades remain variable and poorly supported across recent studies of avian phylogeny. Thus, the impact these fossil calibrations have on patterns of temporal diversification depends heavily on the resolution of deep nodes in avian phylogeny.

Technical Session VI, Monday 1:45

FIRST MODERN MAMMALS FROM THE LATEST PALEOCENE OF EUROPE

SMITH, Thierry, Royal Belgian Insitute of Natural Sciences, Brussels, Belgium; DE PLOËG, Gaël, Centre Permanent d´Initiatives pour l´Environnement des Pays de l´Oise, Verberie, France; MÉTAIS, Grégoire, Muséum National d´Histoire naturelle, Paris, France; ERIC, De Bast, Royal Belgian Insitute of Natural Sciences, Brussels, Belgium; SOLÉ, Floréa, Muséum National d´Histoire naturelle, Paris, France

The eastern part of the Paris Basin in North France is one of the most representative areas for the late Paleocene mammals of Europe whereas the Tienen Formation in the nearby Belgium Basin has yielded the earliest Eocene mammals of Europe. The Dormaal deposits of the Tienen Formation, that are correlated with the Paleocene Eocene Thermal Maximum, include the earliest modern mammals of Europe such as the primate *Teilhardina belgica*, the artiodactyl *Diacodexis gigasei* and several species of ischyromyid rodents, miacid carnivores and hyaenodontid creodonts. Recently, the locality of Rivecourt (Oise) in the central part of the Paris Basin has yielded a small intriguing mammal fauna. First results indicated a late Paleocene age based on the occurrence of typical groups such as pleuraspidotheriids and lousinine condylarths, and plesiadapiforms including the well-known marker *Plesiadapis tricuspidens*. New material from Rivecourt and detailed comparisons indicate also the presence of several mammal species that compare better with the earliest Eocene of Dormaal. Among these, the particular louisinine *Microhyus musculus* which is also recorded from the latest Paleocene of the Spanish Pyrenees suggests a younger age. But the interest of the Rivecourt fauna is focused on dental remains of rodents and miacid carnivorans attesting for the first time the presence of at least two modern mammal orders already in the latest Paleocene of Europe. Interestingly, these two groups are also the only modern groups recorded from the latest Paleocene of North America making Rivecourt a direct equivalent to the Clarkforkian North American Mammal Age

Poster Session III, (Tuesday)

IMPACT AND SCYTHE-LIKE JAW FUNCTION IN LARGE CRETACEOUS THEROPODS: *MAJUNGASAURUS*, *TYRANNOSAURUS* AND *GIGANOTOSAURUS* COMPARED

SNIVELY, Eric, Ohio University, Athens, OH, USA; WITMER, Lawrence, Ohio University, Athens, OH, USA; RIDGELY, Ryan, Ohio University, Athens, OH, USA; WROE, Stephen, University of New South Wales, Sydney, Australia; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH, USA

Large theropod dinosaurs evolved divergently in the LateCretaceous, with carcharodontosaurids giving way to abelisaurid-predominant faunas in Gondwana, and tyrannosaurids assuming hegemony in the north. These theropods have very different skull structures that have yet to be analyzed in a comparative functional context, and biomechanical modeling provides an opportunity to test hypotheses regarding paths to niche dominance. For anatomical accuracy, endocranial and pneumatic spaces were segmented in Amira and subtracted from CT-based models of *Majungasaurus crenatissimus*, *Giganotosaurus carolinii,* and *Tyrannosaurus rex*. Dynamics and finite element modeling (FEM; conducted in Mimics, Avizo, and Strand7) indicate distinct feeding motions and correlates of feeding mode. As an extant control for these interpretations, we check correlations of structure versus function in a merlin (*Falco columbarius*) and bald eagle (*Halaieetus leucocephalus*). Contrary to expectations, tyrannosaurids could deploy a rapid initial bite, with high kinetic energy and impact force to bone upon initial food contact. Results for *Giganotosaurus carolinii* suggest effective sagittal strikes and retraction, and a pincer and scythe-like action of the slender mandible and teeth. In contrast, the cranium of *Majungasaurus* was resistant to torsion during lateroflexion and that of *T. rex* to forces in both yaw and roll. These results suggest alternating, lateral head retraction in *Majungasaurus* for slicing into prey. Control FEM of raptors signals caution for this inference: merlins, despite also having lateroflexion-resistant skulls, do not cut into prey by alternating retraction. However, finite element results confirm the validity of simpler structural comparisons. With the most geometrically authentic models yet of extinct reptiles and strict extant control, we can now better assess parameters influencing absolute performance and more confidently interpret the morphology of theropod feeding.

Technical Session XIII, Tuesday 2:00

EARLIEST EUROPEAN CARNIVOROUS MAMMALS ("CREODONTA", CARNIVORA): SYSTEMATICS, PHYLOGENY, EVOLUTION AND PALEOBIOGEOGRAPHY; FAUNAS FROM THE EARLY EOCENE OF THE PARIS BASIN

SOLÉ, Floréal, Muséum National d'Histoire Naturelle, Paris, France

The carnassial placental mammals (Hyaenodontida, Oxyaenodonta and Carnivora) from the Early Eocene (MP7-MP10) of Europe have been recently studied. Most of them are known from the Paris Basin. The "Creodonta" are considered as a diphyletic group and are separated in Hyaenodontida and Oxyaenodonta. The Hyaenodontida are knownfrom twenty-five species, the Oxyaenodonta by three species and the carnivorans by seven species. For the first time, carnivorans are described from Late Paleocene localities (Jibou, Romania; Petit Patis, France). The localities from Jibou and Petit Patis could represent an equivalent of the North-American Clarkforkian. The phylogenetic analysis of the earliest hyaenodontans results in the recognition of five major clades: Limnocyoninae, Koholiinae, *Prototomus*-like "Proviverrinae", *Arfia*-like "Proviverrinae" and *Proviverra*-like "Proviverrinae". The Paleocene genus *Tinerhodon* from Africa is not referred to one of these clades. The phylogenetic analysis of the earliest carnivorans causes us to question the validity of the Carnivoramorpha. Indeed, the specialized carnassial shear on P^4 and M_1 in the Viverravidae and Carnivora appears probably convergent. The concept of the "Miacidae" must be abandoned. The study of the carnivorous mammals helps to understand the faunal dispersals that occurred near the Paleocene-Eocene boundary. The Carnivora appeared probably in Asia during the Late Paleocene and dispersed 1) during the Late Paleocene (from Asia to Europe and from Asia to North America) 2) at the P/E boundary from Asia to North America through Europe. The Hyaenodontida appeared in Africa during Late Paleocene and dispersed 1) from Africa to Asia during the Late Paleocene (Limnocyoninae) and 2) at the P/E boundary from Africa to Europe (*Proviverra*-like "Proviverrinae") and to North America through Europe (*Prototomus*-like "Proviverrinae" and *Arfia*-like "Proviverrinae"). The Oxyaenodonta appeared in North America during Paleocene and dispersed to Europe at the P/E boundary.

Romer Prize Session, Monday 11:15

PHYLOGENY OF THE CARNIVORAMORPHA, WITH IMPLICATIONS FOR LOCOMOTOR RECONSTRUCTION

SPAULDING, Michelle, Columbia University /American Museum of Natural History, New York, NY, USA

The first undisputed representative of the crown group Carnivora appeared about 43 million years ago, whereas the first definitive carnivoramorphan (crown Carnivora plus its stem taxa) is over 63 million years old. This roughly 20 million years of fossil-sampled 'stem group' evolution is rare among mammalian clades, critical to understanding the phylogenetic placement of Carnivora within Eutheria, and important for reconstructing ancestral conditions at the base of Carnivora. Previous contributions focused on craniodental evidence, typically to the exclusion of the postcranium. Here, over 100 postcranial characters and more than 20 new dental characters have been used to greatly expand an existing craniodental data set. The resulting phylogeny samples more than 60 taxa, of which > 25 are basal carnivoramor-

phans, including representatives of every available genus known from significant cranial or postcranial material. This species-level phylogeny is the most comprehensive attempt yet to investigate basal carnivoramorphan evolution. This analysis tests, for the first time, monophyly of genera and the relationships between described genera. The genus *Miacis* resolves as polyphyletic in the most parsimonious phylogeny, with many species of *Miacis* having only distant relationship to the type species.

This first comprehensive inclusion of postcranial characters permits an unprecedented examination of the evolution of locomotion within basal carnivoramorphans. Features previously hypothesized to be functional indicators can be determined to be apomorphies with potential functional significance or retained plesiomorphies. For example, the nimravids have been reconstructed as arboreal in several shaped-based analyses. However, this study demonstrates that the postcranial features indicating an arboreal mode of life are retentions, and that nimravids have newly acquired features more likely related to a terrestrial habit. The inclusion of a robust postcranial partition also permits testing of hypotheses of carnivoramorphan affinities for incomplete taxa and better elucidates their placement relative to other taxa.

Poster Session II, (Monday)

THE PHYLOGENETIC LABILITY OF PROBLEMATIC BASAL ORNITHISCHIANS

SPENCER, Marc, Department of Geoscience, University of Iowa, Iowa City, IA, USA

Monophyly of derived ornithischian clades such as Thyreophora, Ceratopsia, Iguanodontia, and Pachycephalosauria has been corroborated in numerous analyses. The relationships of these clades within Ornithischia, however, are less certain. Moreover, the placement of taxa such as *Lesothosaurus diagnosticus*, Heterodontosauridae, and traditional basal ornithopods (basal cerapodans and neornithischians) are unresolved. *Lesothosaurus* was generally considered one of the basalmost ornithischians; however, until recently, it was never included in a quantitative species-level phylogenetic analysis of all representative ornithischians. Heterodontosaurids have been recovered as basal ornithopods, basal cerapodans, basal ornithischians, and as the sister group to Marginocephalia. Ornithopoda—traditionally considered a well-supported clade containing 'hypsilophodontids' and Iguanodontia—collapsed into a polytomy at the base of Cerapoda in several recent analyses and the relationships of these taxa to Marginocephalia are unresolved. A phylogenetic analysis was performed on 42 ornithischians representing both basal and derived taxa and a matrix of 220 discrete characters. *Lesothosaurus* was recovered as the sister taxon to Thyreophora; a result noted in few analyses. Heterodontosauridae collapsed into a polytomy at the base of Ornithischia with *Pisanosaurus mertii* and *Eocursor parvus*. A monophyletic Ornithopoda was recovered; however, if traditional clade membership is considered (Ornithopoda *sensu lato*), then the taxon is polyphyletic (e.g. heterodontosaurids as basal ornithischians). The resultant phylogeny is poorly resolved with little support for most nodes and with little improvement in resolution using reduced consensus methods. The results presented here lend support to several hypotheses, both traditional and recent, of the placement of *Lesothosaurus*, heterodontosaurids, ornithopods, basal cerapodans, and basal neornithischians. Additionally, these results underscore the need for a larger taxonomic sampling to illuminate ornithischian relationships.

Poster Session I, (Sunday)

THE SPECIES-LEVEL TAXONOMY OF *SPHENACODON FEROX* MARSH (EUPELYCOSAURIA: SPHENACODONTIDAE) FROM THE LATE PENNSYLVANIAN-EARLY PERMIAN OF NEW MEXICO

SPIELMANN, Justin, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; RINEHART, Larry , New Mexico Musem of Natural History and Science, Albuquerque, NM, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Sphenacodon is a pelycosaurian-grade synapsid, best known from the Lower Permian of Rio Arriba County, northern New Mexico. Of the two species (*S. ferox* and *S. ferocior)*, *S. ferox* is known from comparatively little skull material, and the skulls historically assigned to the taxon are heavily reconstructed and composed of few actual cranial elements. In contrast, *S. ferocior* is known from numerous nearly complete skulls that have been extensively illustrated and described in the literature. Here, we report on a new, nearly complete skull of *S. ferox* collected from the eastern wall of the Cañon del Cobre, New Mexico,in a *Sphenacodon*-dominated bonebed (NMMNH locality 5379). Lithologically, the quarry is in a finely laminated, dark reddish brown, immature arkosic sandstone with pale, greenish-yellow banding at ~10 cm intervals and is within the upper vertebrate assemblage zone of the Cañon del Cobre (Seymouran land vertebrate faunachron). This new skull demonstrates numerous cranial differences between *S. ferox* and *S. ferocior* including: overall skull size; number of premaxillary teeth; number of precanine maxillary teeth; shape of the ventral maxillary margin; shape of the maxillary step; development of the dorsal lamina of the maxilla; thickness of the orbital process of the frontal; shape of the anteroventral corner of the temporal fenestra; shape of the squamosal-jugal suture; shape of the parietals; and extent of the dental field on the palatal ramus of the pterygoid. *Sphenacodon ferox* has a temporal range from the Late Pennsylvanian (late Virigilian: Coyotean lvf) through the Early Permian (late Wolfcampian: Seymouran lvf), whereas *S. ferocior* is restricted to the Coyotean lvf, but it does span the Pennsylvanian-Permian boundary.

Poster Session II, (Monday)

ASSOCIATED CRANIODENTAL AND POSTCRANIAL HYENA FOSSILS FROM THE TYPE LOCALITY OF *PACHYCROCUTA BELLAX*, KROMDRAAI, STERKFONTEIN VALLEY, SOUTH AFRICA

SPIGELMYER, Lauren, Penn State Altoona, Altoona, PA, USA; BOVARD, Brittany, Penn State Altoona, Altoona, PA, USA; HARTSTONE-ROSE, Adam, Penn State Altoona, Altoona, PA, USA

Hyena fossils recovered from newly prepared breccia discovered in the hominin-bearing, Sterkfontein valley (Gauteng, South Africa) site of Kromdraai are the first associated craniodental and postcranial remains of *Pachycrocuta* from South Africa. While this site is significant as the type locality of the hominin taxon *Paranthropus robustus*, it is also significant as a source of carnivore fossils and is the type locality for *Pachycrocuta bellax*. The validity of the lattertaxon is debated – it may be synonymous with *P. brevirostris* – due in part to the scarcity of material that may be attributed to it. This study aims to describe these new fossils and contextualize them. To do this, they have been qualitatively and quantitatively compared to all of the fossil hyena material held at the Transvaal Museum (Pretoria, South Africa) and the University of the Witwatersrand (Johannesburg, South Africa) as well as a wide sample of modern hyena specimens from all three species of durophagous Hyaenidae. These data have been supplemented with data from other African and European hyena fossils. While the paucity of hyena fossils from South Africa, especially those representing *Pachycrocuta,* makes it difficult to test the validity of the taxon *P. bellax*, this new set of associated specimens which compares very favorably to the type specimen is only the second specimen altogether and the first set of fossils containing postcranial material that may be readily ascribed to the taxon. Thus these important fossils may serve as a key specimen in identifying other postcranial remains (which would yield information about functional locomotion adaptations) and as another craniodental specimen on which to base assertions on the validity of the taxon especially in relation to the well known *P. brevirostris*.

Poster Session I, (Sunday)

TAPHONOMIC ANALYSIS OF THE SKELETAL AGGREGATION OF *PANTELOSAURUS* (SPHENACODONTIA, EUPELYCOSAURIA)

SPINDLER, Frederik, Institut für Geologie, TU Bergakademie, Freiberg, Germany; SCHNEIDER, Jörg, Institut für Geologie, TU Bergakademie, Freiberg, Germany; VOIGT, Sebastian, Institut für Geologie, TU Bergakademie, Freiberg, Germany

The only fossil material of *Pantelosaurus* is a skeletal aggregation of six adult individuals from coal-bearing palustrine deposits of the Early Permian Döhlen Formation, Germany. The skeletons are articulated and complete, making them a unique discovery. However, neither the death of the animals nor the taphonomy of their carcasses has been studied in detail. During the re-evaluation of the taxon a taphonomic analysis was carried out that included parts of the specimens for which there is no previously published research, as well as lithologic samples of the host rock. Historically, the light greenish bone-bearing claystone has been interpreted as a lacustrine deposit in which the carcasses were successively accumulated over a significant period of time before a mudflow instantly buried the assemblage. According to our analysis, the bone-bearing rock of the *Pantelosaurus* slab is tripartite. A dense pyroclastic claystone at the base is overlain by reworked ash fall deposits containing aligned plant remains and the *Pantelosaurus* skeletons which show evidence of transport such as limb dragging, torsion, slight and incomplete disarticulation, and non-hierarchical stacking with reciprocal overlap. A dark brown claystone covers the aggregation. Based on our results we suggest the following scenario: (1) The animals were killed simultaneously by catastrophic carbon dioxide exhalation in an active volcanic area. (2) For a short time, initial decay affected the subaerially exposed carcasses. (3) During re-deposition of volcanic ash beds the carcasses were concentrated and stacked. (4) Finally, a mudflow buried the bone assemblage. There is no reason to doubt that *Pantelosaurus* was, at least occasionally, a common element of the terrestrial tetrapod fauna in the Döhlen Basin, but results of our taphonomic study indicate that the holotype specimen cannot easily be used to prove eupelycosaur social behavior.

Poster Session IV, (Wednesday)

PALEONTOLOGIC SITE STEWARDSHIP ON FEDERAL LAND IN NEVADA; A MODEL FOR PROMOTING CITIZEN SCIENCE

SPRINGER, Kathleen, San Bernardino County Museum, Redlands, CA, USA; SCOTT, Eric, San Bernardino County Museum, Redlands, CA, USA; MANKER, Craig, San Bernardino County Museum, Redlands, CA, USA; LAKE, Quintin, San Bernardino County Museum, Redlands, CA, USA

In 2008, the San Bernardino County Museum (SBCM) was awarded a Federal Assistance Agreement from the Bureau of Land Management (BLM) entitled "Upper Las Vegas Wash Conservation Transfer Area (CTA) -Treatment, Protection, and Interpretation of Heritage Paleontologic Resources through Public Involvement". The CTA comprises ~5,000 acres and protects ~500 fossil sites. The grant directs the collection and curation of Rancholabrean age taxa from the "Las Vegas Formation", geologic mapping, and research that integrates the general public, providing opportunities for education, interpretation, and site stewardship. As indicators of past ground water discharge, the sediments closely track hydrologic change through the last two glacial maxima and entomb one of the most significant late Pleistocene vertebrate assemblages from the American southwest. Public advocacy has endorsed this area as a future "fossil beds" type national monument.

The objectives of the agreement were creation of a "site stewardship" program to engage the local community in the management of fossil resources within the CTA, allowing for hands-on involvement whereby the site stewards are actively participating in "citizen science" from discovery to the stabilization and/or collection of fossils localities. Site stewards, as keepers of public lands, assist paleontologists by actively engaging in the collection of new data. Training included a three-day classroom/field workshop to orient future stewards on the geology and paleontology of the region, an introduction to GPS and maps, and an extensive primer on Federal laws regarding the protection of fossil resources, including the 2009 Paleontologic Resources Preservation Act. Stewards conducted an initial walk-through of assigned parcels and actively worked under supervision in an existing, previously disturbed quarry, doubly illustrating the need to protect the resource. Stewards are expected to cyclically prospect their parcel quarterly. The SBCM has also created additional educational opportunities by producing exhibit content and fossils for exhibition in kiosks that will be public interpretation loci for the citizens of southern Nevada.

Poster Session II, (Monday)

NEW JUVENILE AND ADULT MATERIAL OF KOPIDODON MACROGNATHUS (MAMMALIA: PAROXYCLAENIDAE) FROM MESSEL, GERMANY

STEFEN, Clara, Senckenberg Naturhistorische Sammlungen Dresden, Museum für Tierkunde, Dresden, Germany; LEHMANN, Thomas, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt, Germany

Since its first description in 1933 a limited number of specimens of Kopidodon macrognathus have been recovered from the Middle Eocene fossil locality of Messel, NE of Darmstadt, Germany. So far, twelve specimens ranging from a mandible fragment to more or less complete skeletons are housed in the Hessische Landesmuseum Darmstadt, the Senckenberg Museum Frankfurt and in private collections. Four of these have never been described. Two new specimens, recovered from the Messel Pit in 2004 and 2007 and housed at the Senckenberg Museum Frankfurt, are presented here and help us to implement the description of this rare paroxyclaenid. One is the nearly complete skeleton of an adult individual; the left side is visible. The second is the skeleton of a smaller, younger individual also visible from the left, but with a separate severed cranium and lacking some cervical vertebrae and parts of the arms. Both specimens show a body outline with a broad tapering tail. These two specimens yield some new information on the ossification rate and tooth replacement and enable some new morphological observations. For instance, the adult specimen has a complete vertebral column with 20 thoraco-lumbar vertebrae, three sacral ones fused by their centra but not their processes, and 31 caudal vertebrae, which most likely represent the complete tail. The first five caudal vertebrae show a posteriorly elongated transverse process decreasing in size caudally, which have not been described in other specimens. The 6th caudal shows a similar transverse process in the caudal part but bears an additional shorter anterior process merging with the posterior one at the level of the centrum. From the 7th caudal vertebra onwards, there are two clearly separated transverse processes but decreasing in size up to the 13th one. The atlas is not well visible but the axis is preserved in clear lateral view showing a very prominent spinous process. The scapula is particularly well preserved. It shows a very prominent and strong scapular spine as well as a second crest along the axillary border marked in the distal half and tapering off to the proximal rim. Unnoticed so far is the extension of the proximal third of the axillary border of the scapula towards the thorax. This area is the origin of the Musculus teres major. On the femur, the femoral head is set on a short neck and is at the same level as the great trochanter suggesting a somewhat limited mobility. Conversely on the humerus, the head is more elevated than the tuberosities allowing a great mobility. Thus it seems that Kopidodon was a rather arboreal animal with a highly specialised forelimb and a fairly generalised hind limb.

Poster Session IV, (Wednesday)

USING THE PAST TO PREDICT THE FUTURE: BLUE GROUSE AS A MODEL FOR CLIMATE CHANGE

STEGNER, Allison, Stanford University, Stanford, CA, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA

Understanding how and why species change through time as a result of shifting environments is a valuable tool for understanding how species will respond in the future, and thus how they should be managed today. We conducted a study of temporal change in the blue grouse, a habitat specialist and environmental indicator of western North America, by investigating how body size of this species differs across its range, and how it has changed since the Pleistocene. We measured modern and fossil bone lengths as a proxy for body size and then tested for a relationship between body size and climate variables using linear regression, and compared fossil body size to modern with Wilcoxon signed-rank tests. Unlike most migratory species, which move to warmer regions during the winter, blue grouse show an unusual preference for tracking colder environments. However, they do not conform to Bergmann's Rule where larger body-sized populations are found in cooler climates. Populations that track temperature show larger body sizes with higher minimum temperatures and more pronounced seasonality in precipitation.

Evolution of the Modern African Fauna, Wednesday 8:30

EVOLUTION OF THE AFRICAN FAUNA: PALEOGENE TO NEOGENE FAUNAL TRANSITIONS RECORDED IN THE LATE OLIGOCENE NSUNGWE FORMATION OF TANZANIA

STEVENS, Nancy, Ohio University, Athens, OH, USA

In recent years, new fossil mammal-bearing sites have been discovered in the Paleogene of sub-Saharan Africa, refining the record of migration into Afro-Arabia of several groups of mammals of Eurasian origin. Work over the past decade has revealed the first terrestrial vertebrate localities from the Oligocene of Africa below the equator, in the Songwe Member of the Nsungwe Formation in the Rukwa Rift Basin of southwestern Tanzania. Dated at 24.9 MY using multiple radiometric approaches, several localities in this region provide a critical window into the paleoenvironment and taxonomic composition of the African interior. Fluvial and lacustrine depositional events in the Rukwa Rift preserve a diverse vertebrate and invertebrate fauna with several new taxa of micromammals including two new macroscelideans, along with several phiomorph rodent taxa that bridge older faunas from Saharan Africa and the Arabian Peninsula with those from the Miocene of eastern and southern Africa. Other small-bodied mammals include an anthropoid primate resembling older parapithecoids from northern Africa, a lorisiform strepsirhine smaller than but similar in aspect to those from the early Miocene of Kenya, and a novel diminutive hyracoid. Lacustrine localities also provide dental and postcranial evidence of larger-bodied mammals. Non-mammalian discoveries include anurans, crocodylians, lizards, snakes and avians, in addition to several clades of freshwater fishes and invertebrates. Documentation of novel afrotheres at the close of the Paleogene, along with members of so many other vertebrate groups, lends insights into the geographic and temporal continuity of the evolution of the modern African fauna.

Technical Session X, Tuesday 11:30

FOSSIL LOVEBIRDS (PSITTACIFORMES: *AGAPORNIS*) FROM SOUTH AFRICA: CONSTRAINING THE ORIGIN AND INITIAL RADIATION OF THE CLADE

STIDHAM, Thomas, Texas A&M University, College Station, TX, USA

Lovebirds are a clade of 9 extant species occurring in subsaharan Africa and Madagascar. Their closest extant relatives are not among the extant parrot lineages in Africa, but include taxa from Asia and Australasia (e.g., *Micropsitta* and *Loriculus*) indicating the dispersal of the lovebird ancestor from those regions to Africa. Molecular clock estimation places the crown lovebird diversification between 4.4 and 10.6 Ma. A new parrot taxon (represented by most of the appendicular skeleton from multiple individuals) from the Pliocene Langebaanweg site in South Africa appears to be the sister group to crown lovebirds, constraining the presence of the lovebird lineage in Africa by at least 5 Ma. That new taxon exhibits a mixture of characters of both crown clade lovebirds and Australasian taxa. Hundreds of bones from the Plio-Pleistocene cave sites in the Bloubank Valley of South Africa represent at least 2 additional diminutive new species of lovebirds. One of those species has a squared end of the basiorbital fossa on the quadrate, and that character is only present within the crown clade (more derived than the basal grey-headed lovebird, but more basal than the white eye ring clade). The other undescribed species also is within the crown clade, but among the basal lineages. The oldest record of that species is at least 2.1 Ma, constraining the basal split within the crown lovebird clade by that time. Phylogenetic constraint indicates that these extinct South African taxa likely were forest/woodland taxa that did not make domed nests. The Bloubank lovebirds only occur (and are common) at localities that have produced *Australopithecus robustus*, but are absent at localities in the same valley that contain fossils attributed to *Homo*. Those data are suggestive of shared habitat preferences between the lovebirds and australopithecines. The last records of lovebirds in the valley (at ~1Ma) are penecontemporaneous with the youngest records of australopithecines in the area. The regional extinction of lovebirds over most of South Africa might be related to the climate-related shifts in habitats to that dominated by grasslands.

Poster Session III, (Tuesday)

CLARIFICATION OF THE SKELETAL ANATOMY OF PHYTOSAURS BASED ON COMPARATIVE ANATOMY AND THE MOST COMPLETE SPECIMEN OF *ANGISTORHINUS*

STOCKER, Michelle, The University of Texas at Austin, Austin, TX, USA

Despite recent phylogenetic analyses revising phytosaur ingroup relationships and taxonomy, many details of the anatomy, phylogeny, and diversity of basal phytosaurs remain unknown. Complete skeletons are exceedingly rare among phytosaurs, and only two basal taxa are known from more than cranial material. Little attention was paid to phytosaur postcranial anatomy, and most descriptions focused on the skull. Because of this lack of data, there is no comprehensive understanding of the skeletal anatomy of any phytosaur. I address this problem by elucidating the skeletal anatomy and relationships of *Angistorhinus*. Specimens of *Angistorhinus* are common from the Otis Chalk Quarries (Dockum Group, Texas). Current diversity estimates within *Angistorhinus* range from one to possibly eight taxa, though no phylogenetic analysis tested the specimen-level systematics or taxonomy. However, a newly prepared specimen of *Angistorhinus* is the most complete North American phytosaur specimen known. It is the only specimen of *Angistorhinus* that consists of more than cranial material. Preserved material includes the skull, partial mandibles, full vertebral column articulated for much of its length, a partial hindlimb, ribs, gastralia, osteoderms, and both forelimbs with digits. A comparative morphological examination of this new specimen elucidated additional characters for future phylogenetic analysis. In comparison to *Smilosu-*

chus gregorii, the most common phytosaur taxon used in higher-level archosaur phylogenies, the osteoderms are mostly smaller and more rectangular with less ornamentation, the anterior notch of the coracoid is rounder and more extensive, and the olecranon process of the ulna is less expanded. In addition to clarifying *Angistorhinus* anatomy, all observable neurocentral sutures are open, indicating a probable juvenile stage despite a length of over three meters. This specimen represents a rare opportunity to clarify phytosaur postcranial anatomy, develop morphological characters from the entire skeleton for phylogenetic analysis, and explore phytosaur ontogeny in a single, complete individual.

Poster Session I, (Sunday)

MORPHOLOGY AND SYSTEMATICS OF DINOSAUR EGGSHELLS AND THE IDENTIFICATION OF PROBLEMATIC OOSPECIES

STOUT, Jeremy, East Tennessee State University, Johnson City, TN, USA; BOARDMAN, Grant, University of Nebraska-Lincoln, Lincoln, NE, USA

The identification of dinosaur species based on eggs and eggshell fragments has historically been tentative at best due to the usual absence of skeletal remains either associated with, or embryonic within, the fossilized egg. We made thin-sectional slides of eggshell fragments from several dinosaur oospecies, along with eggshell specimens of a modern emydid turtle, alligator, two species of ratite birds, and an anseriform bird. Under low microscopy, the specimens were analyzed using polarized light. A new data matrix was established based on shell morphology, and systematic analyses performed on the ootaxa. Some of the fossil eggshells used do have known embryonic remains associated, and thus provide us with important calibrations in the cladograms generated by the systematic analysis. We hypothesized that to some degree, egg evolution has mirrored morphological evolution among archosaurian tetrapods and by applying this matrix to unknown oospecies, that at least a family level of identification can be confidently achieved. Preliminary results show a strong correlation between the evolution of egg morphology and overall archosaurian systematics. When properly utilized, this matrix has significant diagnostic ability for the identification of problematic dinosaur oospecies.

Poster Session II, (Monday)

PALEONTOLOGICAL AND HISTORICAL SIGNIFICANCE OF THE LATE EOCENE EXPOSURES NEAR COPENHAGEN, CALDWELL PARISH, LOUISIANA

STRINGER, Gary, University of Louisiana at Monroe, Monroe, LA, USA; KING, Lorin, South Louisiana Community College, Lafayette, LA, USA

Late Eocene exposures, primarily the Yazoo Clay, near Copenhagen along the Ouachita River in Caldwell Parish, Louisiana, have been known for fossil vertebrates for nearly 200 years. Renowned paleontologists and geologists have been involved with the investigation of the fossil marine vertebrates and have included Richard Harlan, Richard Owen, Robert Gibbes, Charles Lyell, Eugene Hilgard, Thomas Vaughan, Gilbert Harris, Arthur Veatch, Timothy Conrad, and Remington Kellogg. The area first received scientific notice in the 1830's when Henry Bry discovered large fossil bones, mainly vertebrae, in marine strata along the Ouachita River. Bry first sent a letter relating his discoveries and later specimens to Harlan. Harlan mistakenly attributed the bones to a large, lizard-like, marine reptile similar to a plesiosaur. In 1834, Harlan described the specimens and proposed the name *Basilosaurus* ("king lizard") in reference to its reptilian features and size. This was the first discovery and description of an archaeocete in the paleontological record. Harlan later sent the specimens to Owen who recognized the mammalian characteristics and the cetacean affinities and pronounced the colossal creature as one of the most extraordinary mammals ever to live. *Basilosaurus*, with a length of approximately 20 meters, remains the largest fossil known from Louisiana. Later, a second and smaller archaeocete, *Zygorhiza kochii*, was recognized from the area. Studies of the exposures near Copenhagen have continued into the 21st century, and the localities are now recognized as the having the most diverse marine vertebrates from Louisiana and one of the richest Paleogene faunas from the Gulf coastal plain. Studies of the marine vertebrates have revealed over 80 taxa with at least 14 sharks, 6 rays, 56 teleosts (based on skeletal remains and otoliths), 3 reptiles, 1 bird, and 2 mammals. In addition to *Basilosaurus*, eight teleostean fish (based on otoliths) and one ray have also been discovered there. New vertebrate species have been reported from there as recently as 2003, which is amazing considering that paleontological studies have been conducted there for almost 200 years.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 11:30

WAS THE EVOLUTION OF HYPSODONTY IN SOUTH AMERICA A RESPONSE TO THE SPREAD OF GRASSLAND VEGETATION?: NEW PHYTOLITH RECORDS FROM GRAN BARRANCA, ARGENTINA

STROMBERG, Caroline, University of Washington, Seattle, WA, USA; DUNN, Regan, University of Washington, Seattle, WA, USA; KOHN, Matthew, Boise State University, Boise, ID, USA; MADDEN, Richard, Duke University, Durham, NC, USA; CARLINI, Alfredo, Museo de La Plata, Buenos Aires, Argentina

Faunas from Patagonia, South America show incremental increases in hypsodonty in several meridiungulate lineages from the Middle Eocene (~38 Ma) onward. Hypsodonty is generally assumed to have evolved as an adaptation to feeding on silica-rich grasses or in open, dusty habitats, so this pattern of faunal change has been thought to indicate that savanna grasslands spread ~20 million years earlier in South America than on any other continent. In contrast, paleobotanical data from Patagonia either indicate closed forests during the Eocene and Oligocene (macrofossils, palynofloras) or support the idea of open, grassy habitats by the Late Eocene [plant silica (phytolith) assemblages].

We tested the South American early grassland hypothesis through a high-resolution study of phytolith assemblages in the Sarmiento Formation at Gran Barranca, Chubut Province, Argentina. Spanning 42-18.5 Ma, this section is arguably the most complete and important record of South American faunal change, and contains a rich phytolith record. Our preliminary data show that various forest indicators, including palms and woody dicotyledons, dominated phytolith assemblages throughout the section. In particular, palms were very abundant in the Eocene and Oligocene. Grasses were present from the base of the section (42 Ma), but initially consisted primarily of what were likely bambusoid grasses. Phytoliths typical of open-habitat grasses (pooids, PACMADs) do appear by 38 Ma, marking the earliest occurrence of these two clades, but are rare. Late Oligocene/Early Miocene grass phytoliths, now dominantly pooid open-habitat types, increased in abundance to ≤30% of the assemblages. This expansion of grasses coincided with a marked decrease in palm phytoliths, potentially indicating drier or colder climates. Nevertheless, this record rejects the notion that grass-dominated habitats spread in southern South America before at least the late Early Miocene (18.5 Ma). Instead, ingested grit from volcanic ash, rather than silica in grasses, may have been the proximal driver of hypsodonty in South America.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 11:30

SUBCHONDRAL AND TRABECULAR BONE MORPHOLOGICAL CORRELATES OF LOCOMOTOR BEHAVIOR

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Studies of the external morphology of fossil hominid postcrania commonly reveal a controversial mosaic of traits that are argued to suggest varying levels of obligate bipedal and arboreal abilities. In this study, we investigate whether the internal bone morphology of joints holds a locomotor signal that may further clarify the nature of early hominid locomotor repertoires. Using medical CT and micro-CT scans of several joint articular surfaces (e.g., distal tibiae and tali) of *Homo*, *Pan*, *Gorilla*, *Pongo, and Papio*, this study quantified and compared the internal subchondral and trabecular bone morphology to determine which structural variables can discriminate among these taxa and may be considered correlates of different modes of extant hominid locomotion. Site-specificity and variation of structure within a joint was assessed by comparisons amongst several local anatomical regions. In the case of the ankle, each species was found to have distinct patterns of subchondral bone radiodensity across the joint that agree with current concepts of differences in habitual locomotor behavior. The great apes display greater radiodensity in the anterior aspect of the distal tibia and lateral aspect of the talus compared to humans, likely related to the high degree of dorsiflexion and obliquely oriented tibia and fibula over the ankle during habitual climbing. Mean subchondral radiodensity in each region was found to correlate well with mean subchondral bone thickness. Each species was also found to have distinct patterns of trabecular bone architecture. Bone volume fraction was found to be greater in the great apes compared to humans; however humans had greater degree of trabecular anisotropy, particularly in the lateral aspect of the talus. This study presents comparative data of subchondral and trabecular bone morphology in joints (e.g., the ankle) of extant hominids, and demonstrates the potential of these structures for inferring joint function from isolated fossil elements.

Technical Session XVII, Wednesday 3:45

OXYGEN ISOTOPIC COMPOSITION OF VERTEBRATE PHOSPHATE FROM THE CEDAR MOUNTAIN FORMATION, UT: A TOOL FOR DECIPHERING BOTH GLOBAL AND SMALL-SCALE CLIMATE CHANGE AND ECOLOGIC PARTITIONING

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Stable isotopic analyses of phosphate oxygen from continental faunas of the Early Cretaceous (Barremian – early Cenomanian) Cedar Mountain Formation (CMF), UT, were conducted to determine differences in water utilization among taxa and changes in regional climate. We analyzed a robust data set of aquatic (fish scales), semi-aquatic (turtles and crocodiles), and terrestrial (dinosaurs) taxa and compared them to pedogenic carbonates. Samples were grouped into four stratigraphic faunas (the lower Yellow Cat (YCM), upper YCM, Ruby Ranch (RRM), and Mussentuchit (MM) members). At the formation scale, turtles and crocodiles document water compositions within the zonal range for meteoric water (MW) at 34°N paleolatitude (-4.8 to -6.6‰) as established by pedogenic carbonates. Consistency between multiple MW proxies gives credence to the use of pedogenic carbonates for global paleohydrologic studies. Within the formation (differences between taxa and faunas) turtles record local MW slightly lighter than that recorded by pedogenic calcites, which are slightly biased toward enriched local MW due to their formation under evaporative conditions. Crocodiles are isotopically more enriched than turtles, perhaps because they lived in shallower bodies of water affected by evaporative enrichment. Sauropods were isotopically enriched and sensitive to aridity because of hypothesized reliance on plants as a major source of water. Ornithischians and smaller theropods appear to have acquired much of their water from rivers and were more obligate drinkers than sauropods, while large theropods seem to have obtained water from a combination of river and food water (other dinosaurs). The control on climate in the CMF is the Sevier Orogeny. We confirm presence of a rainshadow caused by the mountains, which caused aridity during upper YCM deposition, and reached sufficient elevations by the end of RRM deposition to allow seasonal snow accumulation. The rainshadow attenuated influences of Pacific moisture on the foreland basin. By MM time, the incursion of the Western Interior Seaway dominated climate by providing moisture to the region, despite the continued rise of the Sevier Mountains.

Technical Session XIV, Wednesday 9:15

A NEW BASAL THEROPOD DINOSAUR FROM THE *COELOPHYSIS* QUARRY (UPPER TRIASSIC) OF GHOST RANCH, NEW MEXICO

SUES, Hans-Dieter, National Museum of Natural History, Washington, DC, USA; NESBITT, Sterling, University of Texas at Austin, Austin, TX, USA; BERMAN, David, Carnegie Museum of Natural History, Pittsburgh, PA, USA; HENRICI, Amy, Carnegie Museum of Natural History, Pittsburgh, PA, USA; SULLIVAN, Robert, State Museum of Pennsylvania, Harrisburg, PA, USA

The initial evolutionary diversification of Dinosauria occurred during the early Late Triassic. The first members of this radiation of dinosaurs (such as *Eoraptor*, *Herrerasaurus*, and *Panphagia*) had simple body plans and, by the end of the Norian, these forms were replaced by members of more specialized groups (e.g., coelophysoids, more derived sauropodomorphs). We report on a new basal theropod dinosaur from the Upper Triassic (Rhaetian) "siltstone member" of the Chinle Formation of the *Coelophysis* Quarry at Ghost Ranch, New Mexico. This find documents the presence of a second theropod taxon in the *Coelophysis*-dominated bonebed. The new taxon is known from a transversely crushed but fairly complete skull with several associated cervical vertebrae and ribs. Its skull is distinguished from those of other known basal theropods in being proportionately deep and narrow, having a proportionately short antorbital region, having much enlarged premaxillary and anterior maxillary teeth, and that the anterior two dentary teeth are large and somewhat procumbent. Other features of the skull of the new theropod include a long, broad posterolateral process of the premaxilla, a prominent lateral ridge on the jugal, an extensive prefrontal, and a rounded lateral surface of the nasal. The centra of the axis and third cervical lack ventral keels. The lateral surface of the third cervical centrum bears a deep, rimmed and oval fossa (pleurocoel) that appears to be unique among Theropoda. Our phylogenetic analysis places the new theropod as the sister-taxon to a clade comprising the recently described *Tawa hallae* and Neotheropoda. The new taxon demonstrates that (1) members of the "first wave" of dinosaurian evolution survived almost to the end of the Triassic and were contemporaneous with more derived dinosaurs (e.g., coelophysoids) and (2) that theropod dinosaurs had a previously unrecorded diversity in skull shape prior to the Triassic-Jurassic boundary.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 11:45

FUNCTION AND EVOLUTION OF THE ANKLE JOINT IN THEROPOD DINOSAURS

SULLIVAN, Corwin, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHANG, Fucheng, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; DRAKE, Abby, College of the Holy Cross, Worcester, MA, USA; COOPER, Megan, College of the Holy Cross, Worcester, MA, USA

The functional repertoire of any joint is partly determined by the ability of muscles to generate torques about the joint's various possible axes of motion. For the ankle, the gastrocnemius and other muscles on the posterior surface of the hind limb contribute to support and propulsion during terrestrial locomotion by producing plantarflexor (extensor) torque about the joint. Bony structures that increase the moment arm of the gastrocnemius, such as the calcaneal heel of mammals, are common among amniotes. Extant crocodilians and other suchian archosaurs have an analogous calcaneal process, and a calcaneal process was almost certainly primitively present within the archosaur crown group. However, the calcaneal process is absent in the other archosaur lineage that has survived to the present, the theropod dinosaurs. In most theropods the gastrocnemius moment arm is slightly increased by the tendency of the proximal ends of the metatarsals to expand in both the extensor and flexor directions. Some taxa have more distinct structures that enhance the moment arm, such as the flange-like hypotarsus of birds. An analogous flange exists on metatarsal II in ornithomimids, and in some theropods the distal tarsals protrude to form a slight heel. In all cases, however, the gastrocnemius moment arm is relatively small. The moment arm can be approximated as the depth (below the midshaft) of the proximal end of the metatarsus in theropods and the length of the calcaneal heel in suchians, and preliminary measurements indicate that the ratio of the moment arm to the length of the tarsometatarsus ranges from about 0.05 to 0.17 in the former group and 0.20 to 0.30 in the latter. The most extreme values at both ends of the theropod distribution occur in birds, probably reflecting their greater ecological range in comparison to non-avian theropods. The low values for theropods in general probably relate to their digitigrade posture, which would have reduced the moment arm of the ground reaction force and allowed the ankle to operate with lower torque. The evolution of digitigrady altered the functional context of the ankle and was accompanied by a change in its architecture.

Poster Session I, (Sunday)

LATE CRETACEOUS (KIRTLANDIAN) TURTLES FROM THE FRUITLAND AND KIRTLAND FORMATIONS, SAN JUAN BASIN NEW MEXICO

SULLIVAN, Robert, State Museum of Pennsylvania, Harrisburg, PA, USA; JASINSKI, Steven, State Museum of Pennsylvania, Harrisburg, PA, USA; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA

The fossil turtles from the Upper Cretaceous Fruitland and Kirtland formations (late Campanian; Kirtlandian), San Juan Basin, New Mexico, USA, have been known for more than 100 years. We re-assess and revise the testudine taxa and recognize 15 valid taxa, including: the bothremydid *Chedighaii hutchinsoni*; the pleurosternid *Compsemys* sp.; the baenodds *Denazinemys nodosa*, "*Denazinemys" ornata* (which pertains to a new genus) and the baenodd *Boremys grandis*, though it is a rare taxon. The non-baenodd baenid *Neurankylus eximius* is present; *Neurankylus baueri* is a subjective junior synonym of *N. eximius*. Two additional non-baenodd taxa, *Thescelus hemispherica* and *T. rapiens*, are distinct species and are not synonymous with *T. insiliens*. We also recognize an indeterminate kinosternoid similar, if not identical, to that reported from the Campanian of Mexico. The two adocids, *Adocus bossi* and *A. kirtlandius*, are retained as distinct species. The nanhsiungchelyid *Basilemys* "*nobilis*" (a nomen dubium) is present as well. We recognize three trionychids: *Aspideretoides austerus* and *A.* ("*Plastomenus*") *robustus,* and an unnamed plastominine. We synomize *Aspideretoides fontanus* and *A. vorax* with *A. austerus.* The unnamed plastominine may represent a new genus and species. The upper Fruitland and lower Kirtland formations (Hunter Wash local fauna) have greater turtle taxonomic diversity than the upper Kirtland Formation (Willow Wash local fauna). This apparent decrease in taxonomic diversity reflects a shift in depositional (channel) environments to a more terrestrial one, a pattern which is seen in other North American Late Cretaceous settings.

Poster Session I, (Sunday)

PARTIAL BODY RECONSTRUCTION OF THE BASAL PELYCOSAURIAN-GRADE SYNAPSID *OEDALEOPS*

SUMIDA, Stuart, California State University, San Bernardino, CA, USA; PELLETIER, Valerie, California State University, San Bernardino, CA, USA

Oedaleops, together with *Eothyris,* comprises the basal-most family of pelycosaurian-grade synapsids, the Eothyrididae. To date, published descriptions of *Oedaleops* are restricted almost exclusively to a single partial skull and referred dentigerous elements. Analysis of materials from the Lower Permian Cutler Formation of Rio Arriba County New Mexico has resulted in the identification of enough elements of the axial and appendicular skeletons to allow the first tentative hypothesis of body size in *Oedaleops*. If a primitive synapsid condition of 25 presacral vertebrae is assumed, the snout-vent length for *Oedaleops* would have been approximately 25 cm. Both the pectoral and pelvic girdles are well preserved and together with measures of the humerus, femur, and tibia the dorsal body margin would have been approximately 7-8 cm above the substrate. Additionally, newly described cranial elements suggest the dermal elements of the skull were more sculptured that previously thought. Of the three different pelycosaurs found in the deposit, including the varanopid *Aerosaurus* andprobablyasphenacodont, *Oedaleops* was easily the smallest.

Poster Session III, (Tuesday)

PATHOLOGY AND LIFE EXPECTANCY: RECOGNITION OF AN ANCIENT TUMOR

SUNDELL, Kent, Tate Museum, Casper College, Casper, WY, USA; ROTHSCHILD, Bruce, University of Kansas, Lawrence, KS, USA

A preconceived notion, generally untested in the fossil record, is that pathology routinely shortens life span. Perspective has been generated by comparison of size of a given species through time. Comparison of healthy and "diseased" population samples (e.g, *Mammuthus*) is compromised by limited availability of sufficient number of associated skeletons for which age can be assessed. Outliers may not be representative of the population, but do illustrate disease acquisition and survival. Tate V15163 is a specimen of *Mammuthus columbi* found in northwest Converse County, Wyoming, standing 13'8" at the shoulder, with chronologic age estimated at 65-70 years (on the basis of last molar tooth worn to gum line). Radiocarbon and optical stimulation luminescence dating place its geologic age at 11,600 ybp. One tusk (4.5 feet in length) had been broken off and its tip polished. Erosion and reactive new bone formation supports diagnosis of spondyloarthropathy, as previously recognized in 16% of mammoths. While spondyloarthropathy produces erosion within joints, it does not explain those occurring adjacent to joints. The latter was recognized as a pressure erosion adjacent to a zygapophyseal joint.

Tumors (recognized on the basis of characteristic bone damage producing defects) have only rarely been suspected in the fossil record. Those that have been confirmed have demonstrated remarkable phylogenetic susceptibility. Common in hadrosaurs, apparently absent in other dinosaurs, the record for extinct mammals is quite limited. Malignant tumors typically have ill-defined margins, while benign tumors are well-defined. While there are a variety of causes/diagnoses, few actually invade joints. Pressure erosions affecting articular surfaces have been observed in gout and pigmented villonodular synovitis (PVS). Those associated with gout are characterized by formation of new bone, producing a sclerotic margin. This contrasts with PVS, in which there is no new reactive bone formation and the margins are smooth. The damage from PVS is easily distinguished from the sharp margins noted with aneurismal pulsations and with hydatid (echinococcal) cysts.

The zygapophyseal joint lesion in *Mammutus americanus*, Tate V15163 is the first recognition of pigmented villonodular synovities in the fossil record. Occurrence in an individual with spondyloarthopathy is probably coincidental, given the background frequency of that pathology in *Mammutus*.It is unclear how much longer Tate V15163 would have survived, if it had not had these diseases.

Technical Session XV, Wednesday 8:30

THE FIRST TRISTICHOPTERID (STEM-TETRAPOD) FROM THE MIDDLE DEVONIAN OF WESTERN NORTH AMERICA: FURTHER EVIDENCE OF PARALLELISM IN THE TETRAPOD STEM-GROUP

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Devonian stem-tetrapods, including tristichopterids and elpistostegids, are known from near global exposures on all major Devonian continental provinces. Elpistostegids, which include the first digited sarcopterygians, are known from well-preserved trackways from the lower Middle Devonian of Poland, suggesting that the elpistostegid fossil record extends deeper in time than the body fossil evidence might otherwise suggest. By contrast, the stratigraphic range of tristichopterids (the elpistostegid sister group) begins in the upper Middle Devonian of Scotland, and subsequently underscores the lengthy ghost ranges implied by the trackway evidence. Here I report the first known tristichopterid from the upper Middle Devonian of western North America, a locality and time that extends and reinforces the biogeographic and chronostratigraphic range of tristichopterids to what would be predicted by current evidence.

This new taxon is known from six specimens, including a fully articulated individual measuring about 1m in length. A phylogenetic analysis recovers this taxon as the earliest diverging tristichopterid. Moreover, its morphology reveals an interesting mosaic of previously unknown trait combinations. The cheek is fused into a plate and the internal caudal skeleton is upturned, as in more basal tetrapodomorphs. However, its intracranial roofing bones are fused in paired tongue-and-groove sutures, even though it retains an endochondral intracranial joint. This condition resembles that of elpistostegids such as*Panderichthys*, suggesting that large body size, branched radials, and an elongate snout—recognized by previous authors—are not the only tetrapodomorph traits to evolve 'independently'.The tristichopterid fossil record now suggests that like other traits, the 'one-part' tetrapod skull may have had its origin in ontogenetically directed variants that evolved in parallel during the early evolutionary history of sarcopterygians. Such observations help us understand the specific evolutionary trajectories that non-isotropic variation in stem-tetrapods might have imparted on the morphologies seen in the first tetrapods.

Evolution of the Modern African Fauna, Wednesday 9:30

SOLVING THE MYSTERY OF THE ENIGMATIC MAMMAL *HELIOSEUS INSOLITUS*: A HIGHLY DERIVED HYRAX FROM THE EOCENE OF GOUR LAZIB, ALGERIA

TABUCE, Rodolphe, CNRS - University of Montpellier, Montpellier, France; ADACI, Mohammed, University of Tlemcen, Tlemcen, Algeria; HAUTIER, Lionel, University of Cambridge, Cambridge, United Kingdom; MENNECART, Bastien, University of Fribourg, Fribourg, Switzerland; MAHBOUBI, Mohammed, University of Oran, Oran, Algeria

The Gour Lazib area is nowadays famous for its diverse mammalian fauna dating from the early or early middle Eocene. In the mid 1970's, the hyraxes *Megalohyrax gevini* and *Microhyrax lavocati*, the primate *Azibius trerki*, and the enigmatic *Helioseus insolitus* were the first fossil mammals to be recorded in the region. At that time, these species represented the earliest known eutherian mammals from Africa. *Helioseus* was defined based on a unique specimen, a fragmentary lower jaw bearing two premolars showing an unusual elevated blade-like longitudinal crest having weak apical serrations. During more than thirty years, this odd morphology and the lack of additional specimens did not allow us to propose an ordinal allocation for *Helioseus*. Recent fieldwork in the region of the Gour Lazib led to the discovery of numerous well preserved specimens of this genus. The dentition of *Helioseus* consists of an enlarged and tusk-like I1; procumbent and chisel-shaped i1-2; reduced I3/3; premolariform C1/1; and brachydont molars. The paraconid is absent on the lower molars; the lingual cusps are higher and more laterally compressed than the buccal ones; two short transversally crests arise between the protoconid/metaconid and hypoconid/entoconid evoking an incipient lophodonty; the postmetacristid is as inflated as a metastylid; the hypoconulid forms a small third lobe on the m3; a distal fovea occurs from m1 to m3; the ectoloph is weakly W-shaped on upper molars; the parastyle lobe is labially expanded; and the metacone is tiny on M3. *Helioseus* is, as a result, unambiguously referred to the order Hyracoidea and shares numerous features with *Seggeurius* and *Microhyrax*, which are the most primitive hyraxes yet recorded. *Helioseus* is however exclusive within the order by the plagiaulacoid modification of its hypertrophied and trenchant p1-4, which occlude with the corresponding gutter-shaped longitudinal basin of the massive P1-4. This premolar complex, convergent with that of some multituberculates, marsupials, and plesiadapiform primates, reveals an unexpected degree of dental adaptation and diversity among early Paleogene hyraxes.

Poster Session I, (Sunday)

TEMPORAL VARIABILITY IN THE COMPOSITION OF A FOSSIL SMALL MAMMAL ASSEMBLAGE FROM SOUTH INDIA

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Quantifying changes in the temporal composition of mammalian communities has provided tremendous insight into the effects of climate and ecological disturbances on their structure and composition. While individual species may respond to climate change in different ways, the collective effect of such responses on the maintenance of ecosystem stability provides an interesting area of study. The effect of the Pleistocene glacial-interglacial events on community structure and organization has been widely studied in temperate regions. Significant changes in monsoon precipitation and a marked aridity regime are thought to be characteristic of the effect of these glacial-interglacial cycles in the Indian sub-continent. Were climatic changes in the Indian sub-continent sufficient to cause changes in mammalian community structure and organization? In order to address this question we investigated a raptor-generated small mammal fossil and sub-fossil assemblage from a limestone cave in Kurnool, South India. Small mammals are sensitive to changes in their micro-habitats, and hence are susceptible to the effects of climate change. Initial results from our study indicate that there has been a change in the relative abundances of rodent species in the fossil assemblage over time. Species with differing life history strategies show contrasting patterns in population change. We are currently investigating the possible use of one of the species as an 'indicator species', one that is sensitive to changes in climatic/environmental factors. Live trapping of small mammals helps determine the composition of the current community and track population dynamics in response to short-term fluctuations in environmental variables. Initial trapping results suggest that that there is continuity in community composition of small mammal communities from that in the fossil record to the present community.

Poster Session II, (Monday)

RAPID DIVERSIFICATION OF THE ODOBENIDS (CARNIVORA: PINNIPEDIA) IN THE LATE MIDDLE MIOCENE OF THE NORTH PACIFIC: IMPLICATIONS OF A NEW FOSSIL FROM HOKKAIDO, JAPAN

TANAKA, Yoshihiro, Hokkaido university Museum, chiba, Japan; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

The diversification of the crown group odobenids (i.e., walruses) of the family Odobenidae is thought to lie within the Late Miocene, and in fact, a number of fossil odobenids have been known from such a time period in the circum North Pacific. In contrast, the late Middle Miocene *Pseudotaria muramotoi* from Hokkaido, northern Japan, might be a possible ancestor (i. e., metataxon) for the highly diversified Late Miocene odobenids because of the lack of any autapomorphy that diagnoses the taxon itself and any synapomorphy of the later diversifying odobenids. However, a new fossil from the same horizon in the same locality area reported here may represent an earlier diversification of the later diversing odobenids in the late Middle Miocene. The new fossil is a partial skeleton, evidently belonging to the Family Odobenidae based mainly on the cranial and dental characters. Phylogenetic analysis also revealed that the new fossil was nested with *P. muramotoi* and the later diversing odobenids as a tritomy. In addition, like *P. muramotoi*, the new fossil lacks any synapomorphy of the later diversing odobenids. However, the new fossil differs from *P. muramotoi* in size and shape of the occipital condyle, foramen magnum and mastoid process of the cranium, and other postcranial characters, and therefore, they are not conspecific. Consequently, two

closely related stem odobenids lived at the same area at the same time, approximately 12-10 Ma. Perhaps the rapid diversification of the stem odobenids might already have occurred in the late Middle Miocene in a restricted area, preceding the diversification of the later diversing odobenids in the Late Miocene. It is well known that the Earth's environment has been cooling during the late Middle Miocene. The new discovery implies that the diversification of the later diversing odobenids including *Pseudotaria* species might have started soon after and/or simultaneously with the global cooling during the late Middle Miocene.

Poster Session I, (Sunday)

JAW MECHANICS IN LAMNIFORM SHARKS AND ITS EVOLUTIONARY IMPLICATIONS

TANOUE, Kyo, National Museum of Nature and Science, Tokyo, Japan; SHIMADA, Kenshu, DePaul University, Chicago, IL, USA; RIGSBY, Cynthia, Children's Memorial Hospital, Chicago, IL, USA; NICHOLAS, Angela, Children's Memorial Hospital, Chicago, IL, USA

Jaw mechanics of lamniform sharks was examined three-dimensionally to understand the variability in jaw shape and the evolution of the masticatory system based on the following seven extant macrophagous species: *Mitsukurina owstoni*, *Carcharias taurus*, *Alopias vulpinus*, *Carcharodon carcharias*, *Isurus oxyrinchus*, *I. paucus*, and *Lamna nasus*. Bite forces calculated using two-dimensional analysis increase caudally. Input force remains constant because only working-side jaw adductor muscles are considered, and bite force varies only with distance from the quadratomandibular joint. In contrast, three-dimensional analysis uses input from both working- and balancing-side adductors. Input force varies along the jaw because the contribution by balancing side muscles is not constant. In three-dimensional analysis, the effect of mediolateral tooth position on bite force can also be discovered. This analysis allows more realistic bite force reconstruction. Our calculation of maximum bite force at each tooth position suggests that the phylogenetically basalmost species, *Mitsukurina owstoni*, has the least efficient jaws, with bite force lower than that of derived lamniforms throughout the tooth row due to posteriorly positioned jaw adductor muscles. Jaws of *Carcharodon* and *Isurus* are more efficient than other examined taxa, especially in anterior dentition, owing to anterior extension of jaw adductor muscles. *Alopias vulpinus* has widely divergent jaws, resulting in low bite force because of longer output lever than in narrowly-diverging jaws. However, *A. vulpinus* has larger oral cavity to bite off larger parts of their prey in each bite compared to species of same size with narrowly-diverging jaws. This study shows the increased efficiency of masticatory apparatus and diversity of feeding adaptations through lamniform phylogeny. This analysis also makes it possible to reconstruct the masticatory apparatus of fossil lamniform taxa.

Poster Session IV, (Wednesday)

PRELIMINARY REPORT OF A WELL PRESERVED PERISSODACTYL TRACK SET FROM CENTRAL UINTAH BASIN, UT

TEMME IV, Thomas, SWCA Environmental Consultants, Vernal, UT, USA; SROKA, Steve, Utah Field House of Natural History State Park Museum, Vernal , UT, USA; FINLAYSON, Heather, Utah Field House of Natural History State Park Museum, Vernal, UT, USA

Well preserved perissodactyl tracks were discovered 18 miles southeast of the town of Myton in the Gilsonite Draw area of the Ashley National Forest, Duchesne County, UT. The tracks occur on a sandstone slab approximately five feet by two feet, found at the base of a vertical outcrop of variegated beds of light tan, orangish tan and light yellowish gray, fine-grained sandstones, mudstones and shale interbedded with resistant beds of tan, medium-grained, parallel bedded sandstone. The track-bearing slab has been collected by and reposited at the Utah Field House of Natural History State Park Museum in Vernal, UT. The Gilsonite Draw locality has traditionally been mapped as the Lower member of the Uinta Formation. Other mammal track sites have been reported from the delta facies of the Green River Formation, 40 miles to the west of the Gilsonite Draw locality and from two localities in the Uinta Formation, 18 miles to the northwest and seven miles to the northeast. The tracks are complete natural casts of the left manus (tetradactyl) and right pes (tridactyl), with the manus in line to and preceding the pes by 12cm, centered on the slab. No other track casts are visible on the slab. The tracks are relatively large, the manus measuring 15.7cm long and the pes 11.9cm long. Both are about three centimeters in relief. The tracks have short (approximately five centimeters long) rounded digits with divarication angels of about 30 degrees and a rounded heel. Likely trackmakers for the specimen include brontotheres and tapiroids of Uintan affinity. The specimen compares well with modern tapir tracks. Laterally extensive beds of tidal or costal sandstones and mudstones with ripple marks and mudcracks are abundant in the lower sections of the eastern and western Uintah Basin, where Uinta and Green River formations inter-tongue. These beds are good candidates for producing more Eocene mammal trackways.

Technical Session IX, Tuesday 10:15

PREDICTING SPECIES RESPONSES TO CLIMATIC WARMING: HINDCASTING THE PAST USING THE MODERN GEOGRAPHIC RANGE

TERRY, Rebecca, Stanford University, Stanford, CA, USA; LI, Cheng, Stanford University, Stanford, CA, USA; HADLY, Elizabeth, Stanford University, Stanford, CA, USA

Forecasting how species will respond to ongoing environmental change requires knowledge of the processes that have shaped biodiversity in the past. In general, we expect species to track warming conditions by shifting their geographic ranges poleward. At a given locality this should be reflected by an increased dominance in the identity and abundance of more equatorial species. Here we test this hypothesis using time series data from the Holocene small mammal fossil record. More specifically, we evaluate how community dynamics over the last 7,000 years have been shaped by contrasting and variable local paleoclimates at two replicate caves in the Great Basin from the same latitude.

Counter to expectation, both records exhibit a constant proportion of southern species through time. The proportion of southern individuals in both communities, however, is strongly and positively correlated with temperature and precipitation dynamics. This result is robust to temporal autocorrelation and time-averaging, and suggests that community-level responses occurred *in situ* rather than by the immigration of taxa.

Despite the predictability of community-scale dynamics, species-specific abundance-climate relationships were variable and poorly explained by a species' geographic affinity. Nevertheless, species present at both sites exhibited the same response to climate at one site as at the other. Species life histories therefore play important roles in determining their responses to climatic warming. These results are corroborated by an analysis of functional groups: while the abundance of granivores shows a significant and positive relationship with warming, omnivores and herbivores show significant negative relationships. Further evidence suggests that species interactions may also be important.

In summary, while community-level dynamics are consistent with expectations of species responses to climatic warming, species-level dynamics are less predictable. Although a species' current geographic range may reflect many ecological and evolutionary factors, intrinsic biology and interspecific interactions may be more important for predicting responses to future warming.

Poster Session III, (Tuesday)

STEGODONTID (PROBOSCIDEA, MAMMALIA) FOSSILS FROM THA CHANG SAND PITS, NAKHON RATCHASIMA PROVINCE, THAILAND

THASOD, Yupa, Northeastern Research Institute of Petrified Wood and Mineral Resources, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand; SAEGUSA, Haruo, Museum of Nature and Human Activities, Sanda, Hyogo, Hyogo, Japan; RATANASTHIEN, Benjavun, Department of Geological Sciences, Faculty of Science, Chiang Mai University, Chiang Mai, Thailand; JINTASAKUL, Pratueng, Northeastern Research Institute of Petrified Wood and Mineral Resources, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, Thailand; HANTA, Ratanaphorn, Northeastern Research Institute of Petrified Wood and Mineral Resources, Nakhon Ratchasima Rajabhat University, Nakhon Ratchasima, The Gambia

In the area of about 30 square kilometers of Tha Chang sand pit, Nakhon Ratchasima province, northeastern Thailand, many Neogene faunal and floral remains were found. The disarticulated teeth and skeletal elements of stegodontid were found from channel and flood plain deposits together with of various mammalian fossils, including, *Khoratpitacus piriyai* and *Merycopotamus thachangensis*. The stegodontid fossils were studied based on the tooth morphology. They are composed of *Sl*. cf. *stegodontoides* and other four new species of *Stegolophodon*, and *S*. cf. *elephantoides*, *S*.cf. *orientalis*, *S*. cf. *insignis*, and at least three new species of *Stegodon*. These stegodontid fossils are comparable to those found from Pakistan, China, and Myanmar. These stegolophodont and stegodont fossils may indicate the age of the Late Miocene to Pliocene and the Late Miocene to Pleistocene, respectively, though the stratigraphic position of these fossils in the sand pits are not known.

Technical Session XVI, Wednesday 2:15

MORPHOLOGY OF THE AUDITORY REGION OF *HYPISODUS MINIMUS*: IMPLICATIONS FOR THE EVOLUTION OF THE MASTOID FOSSA OF ARTIODACTYLS

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Detailed Computed Tomographic (CT) scan study of the auditory region of the small hypertragulid *Hypisodus minimus* (AMNH:FM 9354) reveals previously undescribed anatomical features. Much of the basicranium is externally obscured by the greatly inflated hollow auditory bullae. The bullae meet in the midline, extending rostrally beyond the jaw articulation, and caudally to the occipital condyles. The bullae are partially subdivided by a horizontal septum, into a dorsal and ventral chamber caudal to the cochlea. As in *Hypertragulus*, *Hypisodus* shows a deep subarcuate fossa. However, unlike the reported morphology for *Hypertragulus*, there is also a deep and distinct mastoid fossa present. The mastoid fossa is known in *Bunomeryx*, camelids, anoplotheres, cainotheres and xiphodontids, and has been thought to represent a tylopod synapomorphy. Its presence in *Hypisodus* is the first reported occurrence of this feature within Ruminantia, and suggests that the mastoid fossa may be primitively present in basal ruminants, or might represent a convergent feature among artiodactyls with inflated auditory bullae.

The periotic shows a sharp crest dividing the cranial cavity into cerebral and cerebellar surfaces, as in other ruminants and protoceratids. Endocranially, the periotics meet the basisphenoid near the midline rostral to the cochlea, nearly obscuring it. The petrobasilar canal appears to run in a groove within the periotic, immediately lateral to the basisphenoid.

AMNH:FM 9354 shows no evidence of an enlarged sinus venosus temporalis between the periotic and the squamosal, a feature shared by camelids, protoceratids, *Leptotragulus*,

Bunomeryx, cainotheres and oreodonts.

Hypisodus presents several features that are derived within ruminants, but also shares with more basal artiodactyls a deep subarcuate fossa. The deep mastoid fossa observed in AMNH:FM 9354 suggests that the presence of a mastoid fossa may be a convergent feature in taxa with inflated auditory bullae.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 9:00

TOOTH USE AND DIET ACROSS THE ARTIODACTYL-CETACEAN TRANSITION

THEWISSEN, J.G.M., NE Ohio Univ Col of Med, Rootstown, OH, USA; SENSOR, Jennifer, NE Ohio Univ Col of Med, Rootstown, OH, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA; BAJPAI, Sunil, Indian Institute of Technology, Roorkee, India

Tooth functional morphology is affected by at least three factors: crown morphology, mastication, and diet. Study of these can increase our understanding of the artiodactyl-cetacean transition and resolve the paradox that early whales, generally thought as being carnivorous or piscivorous, are derived from herbivorous or omnivorous artiodactyls. Eocene cetaceans have a highly derived lower molar morphology with a single high protoconid on the trigonid, and one (or a linear series of) small cusp(s) behind it. This morphology is derived from a bunodont quadritubercular artiodactyl morphology. We studied the wear facets to determine the evolution of mastication in this lineage. Basal artiodactyls (dichobunids) have generalized molars showing a complex series of abrasional and attritional facets, whereas Eocene cetaceans (pakicetids, most protocetids, and basilosaurids) have wear facets that indicate wear in Phase I of the masticatory power stroke only. Surprisingly, the cetacean sister group, *Indohyus*, has wear facets that trend toward the cetacean specialization in spite of having a molar morphology that is still firmly quadritubercular.We collected diet information by analyzing the stable carbon isotope composition of tooth enamel. Isotope values of cetaceans (pakicetids, ambulocetids) are extremely low and consistent with a carnivorous or piscivorous diet. This is in contrast to the stable isotopes of *Indohyus*, which are indistinguishable from those of the enamel of associated land mammals. These similarities suggest terrestrial herbivory, as do the values of dichobunids. Taken together, this implies that a change in dental function (wear facets) preceded the dietary shift documented by stable isotopes at the origin of cetaceans, even while crown morphology retained its archaic morphology.

Poster Session IV, (Wednesday)

A DESCRIPTION OF THE CRANIAL ANATOMY OF AN EXCEPTIONALLY WELL-PRESERVED SPECIMEN OF *TENONTOSAURUS TILLETTI* (ORNITHOPODA, DINOSAURIA) FROM THE ANTLERS FORMATION OF OKLAHOMA

THOMAS, D. Andrew, University of Oklahoma, Norman, OK, USA

Since the original description of a transversely compressed and highly fractured specimen, no cranial material of *Tenontosaurus tilletti* has been described. *T. tilletti* is a basal member of the Iguanodontia, an ornithopod clade which includes tenontosaurs and their allies, together with the highly derived and successful Hadrosauria. The last decade has seen an increase both in the amount of research conducted on Iguanodontia and in the number of taxa assigned to it, with increasingly fine phylogenetic resolution.

In the early part of this century, a beautifully preserved specimen of *T. tilletti* was found in the Antlers Formation (Aptian-Albian) near Atoka in southeastern Oklahoma. The specimen preserves nearly all elements of the skull (only the palpebrae and right premaxilla are absent and both hyoids are present), largely in their original orientation and relative position (right facial bones are detached, articulated, from the skull and the right pterygojugal complex is shifted slightly anteromedially).

In the winter and spring of 2009-2010, the skull was taken to the High-Resolution X-ray Computed Tomography Facility at the University of Texas for CT scanning.

Digital renderings of the skull and of its isolated elements were made, including an endocast. The renderings were then used to produce three-dimensional copies through the use of a rapid-prototyping machine at the University of Oklahoma. Both the renderings and the copies aid in further analysis of the paleobiological aspects of the animal, including the extent of cranial kinesis, the nature of the cranial musculature, and the operation of the dental apparatus.

The scans also illuminate the relative positions of the first three pairs of cranial nerves, along with the canals and foramina for the remaining cranial nerves and vasculature. The semicircular canals and other portions of the vestibulocochlear apparatus are preserved as well. These features provide evidence crucial to furthering the phylogenetic resolution and evolutionary understanding of this particularly diverse and abundant group of dinosaurs.

Romer Prize Session, Monday 11:30

EVOLUTION OF HEAT RETENTION IN PENGUINS

THOMAS, Daniel, University of Cape Town, Cape Town, South Africa

Penguins (Sphenisciformes) inhabit the most extreme range of environments of any avian group, breeding from equatorial deserts to polar sea ice shelves. Further, the 60+ million year (Ma) fossil record of penguins spans dramatic temperature shifts in Cenozoic oceans, indicating a long and complex relationship between penguin evolution and environmental change. A major adaptation that allows penguins to forage in cold water is the humeral arterial plexus, a vascular counter-current heat exchanger (CCHE) which limits heat loss through the flipper to water cooler than the body core. Cool-water habits and thermal adaptations in extant penguins have been proposed to reflect evolution driven by cooling on geological time scales, suggesting the plexus may represent an adaptation to Antarctic environments. However, fossils show that penguins diversified well before the 40-35 Ma onset of Cenozoic cooling and the development of Antarctic ice sheets; thus other drivers must account for the early evolution of stem-penguins. Osteological correlates of vascular structures have revealed an origin of the humeral arterial plexus deep within the stem lineage of penguins. Fossil evidence reveals that the humeral plexus arose at least 49 million years ago during a “greenhouse Earth” interval, and is thus unrelated to global cooling or development of Antarctic ice. Oxygen isotopic reconstruction of CCHEs along fossil penguin wings further support this conclusion. Consequently, it is proposed that penguin CCHEs initially were an adaptation for foraging in subsurface waters in temperate latitudes. Though first arising under greenhouse conditions, the humeral plexus is considered the key to later invasion of thermally more-demanding environments.

Poster Session IV, (Wednesday)

HIDDEN SUPPORT IN INSECTIVORAN-GRADE MAMMAL PHYLOGENY

THOMPSON, Richard, The University of Cambridge, Cambridge, United Kingdom; ASHER, Robert, The University of Cambridge, Cambridge, United Kingdom

It has been demonstrated that a given clade may receive phylogenetic support from a combined dataset even when that clade is unsupported by partitions analyzed in isolation. For example, at high taxonomic levels within placental mammals, morphology (among other partitions) has been shown to contribute positively to clade support in a combined analysis, whether or not that clade is present in a tree derived from morphological data alone. We investigated the amount of hidden support among insectivoran-grade mammals. Among African insectivorans, the addition of a morphological partition improves branch support for about 75% of nodes present in both the optimal MP and Bayesian topologies of a DNA-indel dataset, even though many clades are not present in the morphology-only analysis. This result is consistent with that derived from independent datasets, indicating that data-combination can increase support beyond that obtained from partitions in isolation (i.e., “hidden support”). We discuss the extent to which these results justify confidence in the placement of fossil clades for which no neontological data (DNA, soft-tissue, behavior) are available.

Poster Session III, (Tuesday)

FIRST OCCURRENCE OF A TYRANNOSAURID (DINOSAURIA, THEROPODA) FROM THE NESLEN FORMATION (LATE CRETACEOUS), BOOK CLIFFS AREA, UTAH

THOMSON, Tracy, University of Utah, Salt Lake City, UT, USA; IRMIS, Randall, University of Utah, Salt Lake City, UT, USA

Although rich Campanian dinosaur assemblages are known from southern Utah, specimens are extremely rare from Campanian strata in central and eastern Utah that were closer to the paleoshoreline of the Western Interior Seaway. We report the discovery of a theropod dinosaur partial hindlimb from the Book Cliffs area northeast of Green River, Utah. The specimen was recovered from just beneath the Palisade Coal Zone in the Neslen Formation (Mesa Verde Group), which is dated to the mid-Campanian (75.19 ±0.28 Ma) based on its stratigraphic location within the *Didymoceras nebrascense* ammonite zone. This stratigraphic interval correlates with the lower Kaiparowits Formation of southern Utah, the Dinosaur Park Formation of Alberta, and the Judith River and Two Medicine formations of Montana. The specimen comprises a partial fibula, the distal half of metatarsal II, and a complete metatarsal IV. The arctometatarsalian condition of the pes indicates its placement in the theropod clade Coelurosauria, and the specimen can be assigned to the clade Tyrannosauridae based on the presence of unambiguous synapomorphies such as a deep groove on the medial surface distal to the iliofibularis tubercle on the fibula, and a teardrop shaped articular surface for metatarsal III on the medial surface of the distal portion of metatarsal IV. The specimen is similar to *Daspletosaurus torosus* in the presence of a slender ridge along the posterior surface of metatarsal IV proximal to the distal metatarsal III attachment site, in contrast to the flat or concave condition in *Tyrannosaurus rex*. This represents the first unambiguous evidence of a tyrannosaurid dinosaur from the Mesa Verde Group, and represents an important biogeographic record situated between southerly coeval strata in the Kaiparowits (southern Utah) and San Juan (New Mexico) basins, and equivalent strata in Montana and Alberta.

Poster Session IV, (Wednesday)

NEW SPECIES OF *ALLOPTOX* (OCHOTONIDAE; LAGOMORPHA), FIRST RECORD OF THE GENUS FROM JAPAN, AND SUBGENERIC DISTINCTION

TOMIDA, Yukimitsu, National Museum of Nature and Science, Tokyo, Japan

A nearly complete mandible with full dentition of a large ochotonid lagomorph was recently found from late Early Miocene (ca. 17.5 Ma) deposits (Akeyo Formation, Mizunami Group) in central Japan. General morphology of p3 clearly indicates that the specimen belongs to the genus *Alloptox*. Five species of the genus from China (*A. gobiensis, A. minor, A. chinghaiensis, A. sihongensis, A. xichuanensis*) and one from Turkey (*A. anatoriensis*) have been described. Direct comparisons with the holotypes and/or referred specimens of all these species

indicate that the new specimen can be easily distinguished from all known species by the following characters: (1) largest in size, (2) protoflexid is deep, (3) hypoflexid is very deep, reaching about 1/2 of the tooth width, (4) lateral depth of paraflexid is rather shallow, reaching about 1/3 of the tooth width, then bending posteriorly being centroflexid, (5) paraflexid and centroflexid are wide, making the metaconid narrower in width, (6) anteroconid is relatively large in size, oval in outline, and its long axis is nearly perpendicular to the tooth axis. Thus, the new specimen from Japan is considered to be a new species of the genus. Except for the size, all six species from China and Turkey are similar to each other in morphology: (1) the protoflexid is very shallow, (2) the hypoflexid is shallow, reaching about 1/3 of the tooth width, (3) the paraflexid is relatively deep, reaching about 1/2 of the tooth width, except for *A. xichuanensis*, (4) the paraflexid and centroflexid are narrow, and (5) long axis of the anteroconid is oblique to the tooth axis in most specimens. In the new Japanesespecies, all these characters are opposite in status, suggesting that it can be distinguished at subgeneric level. Geologic age of the new species is about 17.5 Ma, the late Early Miocene, which is almost the same as *A. sihongensis*, the smallest and probably earliest species in continental Eurasia, suggesting that the distinction between the new species and other species was present from the early stage of generic evolution.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

ORIGIN OF SHARK JAW PROTRUSIONS: EVOLUTION OF SUCTION FEEDING CAPABILITIES IN FOSSIL SHARKS RECONSTRUCTED FROM THEIR HYOID ARCHES

TOMITA, Taketeru, University of Tokyo, Tokyo, Japan

Jaw-protrusion is a widely distributed feeding behavior in extant sharks. Evolutionary history of feeding strategies (suction- and ram-feeding) reconstructed by their hyoid arches suggested that the origin of jaw-protrusion mechanisms was related to the occurrence of suction-feeding. We reconstructed the feeding behaviors of fossil sharks based on the second moments of area of their ceratohyals. The results indicatethat the cladodont sharks (†*Cladoselache*, †*Deania*, †*Cobelodus*, and †*Akmonistion*), the ctanacanthoid shark (†*Heslerodus*, and †*Xenacanthus*), the basal hybodontiform shark (†*Tristychius*) and the basal neoselachii (†*Palaeospinax*) were ram-feeding sharks, and hybodontid sharks (†*Hybodus*) and fossil Squalea (†*Protospinax*) were suction-feeding sharks. Reconstructed evolutionary sequence of ram- and suction-feedings indicate that "Paleozoic sharks" (cladodont sharks and ctenacanthoid sharks) were ram-feeding sharks and, from this state, suction-feedings evolved within three independent lineages; Hybodontiformes, Galeomorphii, and Squalea. These shifts of feeding strategies from ram- to suction-feeding coincide with the timing of the increases of jaw mobility. This suggests that jaw-protrusion was originally related to the evolution of suction-feeding. Some ram-feeding sharks (Lamniformes and Carcharhiniformes) have jaw-protrusive capabilities. Their jaw-protrusive capabilities were inherited from suction-feeding ancestors.

Poster Session II, (Monday)

NEW CARNIVORAMORPHANS (MAMMALIA) FROM THE MIDDLE-EOCENE SANTIAGO FORMATION OF CALIFORNIA, U.S.A., AND PHYLOGENETIC IMPLICATIONS FOR THE ORIGIN OF CROWN-ORDER CARNIVORA

TOMIYA, Susumu, University of California Museum of Paleontology, Berkeley, CA, USA

Despite recent advances in the study of carnivoramorphan evolution, the phylogenetic and ecological context of the origin of crown-order Carnivora remains elusive. The middle-Eocene Santiago Formation of San Diego County, California, has yielded taxonomically and ecomorphologically diverse assemblages of carnivorous mammals from the Uintan and Duchesnean North American Land Mammal Ages, which likely constituted a critical period in the evolutionary history of carnivorans in North America. Parsimony analysis was conducted for 24 taxa of Paleogene carnivoramorphans using recently-published character matrices and data for a new genus from the Santiago Formation. The strict consensus tree for this dataset places within the crown-clade Carnivora several "miacid" carnivoramorphans that were suggested by recent studies to lie outside this clade. In comparison to these previous studies, the new phylogenetic hypothesis reported here pushes back the minimum age of divergence between the two major branches of Carnivora (i.e., Caniformia and Feliformia) by 4-5 million years to approximately 48 million years ago, or prior to the first stratigraphic occurrence of *Miacis sylvestris* in the Br2 substage of the Bridgerian NALMA. However, the nodal support values for the new cladistic toplogy are generally low as in previously-reported trees, and a substantial temporal gap remains between the minimum divergence age obtained from the fossil record and divergence age estimates based on molecular data for extant carnivorans. Further taxonomic work on Eocene carnivoramporphans and reassessment of phylogenetically-informative traits—particularly in light of intraspecific morphological variations observed in extant carnivorans—are needed to resolve the early phase of carnivoran evolution.

Poster Session I, (Sunday)

THE NEW CENOMANIAN VERTEBRATE SITE ALGORA; (GUADALAJARA, SPAIN)

TORICES, Angelica, Universidad Complutense de Madrid, Madrid, Spain; BARROSO-BARCENILLA, Fernando, Universidad de Alcalá de Henares, Alcalá de Henares, Spain; CAMBRA-MOO, Oscar, Universidad Nacional de Educación a Distancia, Madrid, Spain; PÉREZ GARCÍA, Adán, Universidad Complutense de Madrid, Madrid, Spain; SEGURA, Manuel, Universidad de Alcalá de Henares, Alcalá de Henares, Spain

A new middle-upper Cenomanian fossil site has been located in the Castilian Branch of the Iberian Ranges, in central Spain. This site corresponds with the upper part of the "Arenas de Utrillas" Formation. Vertebrate fossils from this period are scarce in Europe, so this finding is particularly noteworthy. The outcrop is located in a sandy interval with interbedded mudstones, interpreted as coastal deposits with subtidal and intertidal intervals. The beds contain numerous silicified/ferruginized trunk fragments and ferruginized vertebrate remains, especially at the bases of the sandy intervals. Macrofossils show well preserved tissues and evidence of taphonomical alteration, probably due to transport or reworking events during fossilization.The diversity recognized in this site is high, with fish and reptiles as the best represented groups. Fish remains include scales and teeth. One morphotype of ganoid scales could be attributed to the problematic taxon *Stromerichthys,* and another morphotype could belong to semionotids or lepisosteids. The teeth are very small and subconical, which is typical of lepisosteids. Chelonian specimens include plates with granulation decorations that suggest the probable presence of representatives of Solemydidae. However, most chelonian specimens are assignable to Panpleurodira, whereas Dortokidae was previously the only group recognized in Cretaceous European outcrops before the Senonian. Crocodyliforms are represented by osteoderms, bones and teeth of a probable advanced taxon of Neosuchia, although the phylogenetic relationships of the basal radiation of this clade are currently poorly understood. Theropod teeth have been found and assignated to Carcharodontosauridae indet. They have rough enamel and arcuate wrinkles, similar to those found in southern France. This unique locality in the Iberian Peninsula is very significant because, due to its geographical position, it will be very important for establishing similarities with the few Cenomanian European sites and North African sites and will expand the relatively poor knowledge of the fauna for this period.

Poster Session I, (Sunday)

A MORPHOMETRIC ANALYSIS OF CRANIAL SEXUAL VARIATION IN THE EXTANT PHYLOGENETIC BRACKET OF THE DINOSAURIA: IMPLICATIONS FOR FOSSIL STUDIES

TREVETHAN, Ian, Montana State University, Bozeman, MT, USA; SCANNELLA, John, Museum of the Rockies, Montana State University, Bozeman, MT, USA

Sexual dimorphism has been proposed as a significant source of cranial variation in non-avian dinosaurs, potentially affecting systematic and ecological hypotheses. Here we present the results of a preliminary morphometric analysis of intrapopulation cranial sexual variation within the dinosaur extant phylogenetic bracket. Principal components analysis and bivariate plots of skulls from a single population of *Alligator mississippiensis* confirms that sexual variation in *Alligator* is fairly subtle, the major difference being size of the largest representatives of each sex. When the data are normalized by skull length, discrete grouping by sex is no longer apparent. *Ceratogymna atrata*, the black casqued hornbill, represents the opposite end-member of the spectrum of sexual variation and is truly dimorphic. Not only are males typically larger than females, but they possess a far more elaborate cranial casque. Hornbill genders plot in distinct clusters. When the data are normalized by skull length, sexual differences in the cranial casque still segregate males from females. Sexual variation in non-avian dinosaurs may range from being largely undetectable (as in *Alligator*) to being so extreme as the two sexes might easily be misinterpreted as separate taxa (as in *Ceratogymna*). If true dimorphism was present in the non-avian dinosaurs, once data are normalized to account for size the major differences between genders would likely be expressed in cranial ornamentation or other visual cues upon which sexual selection could act. Sexual selection would inherently produce a radical divergence in ornamentation between genders. This degree of sexual variation in non-avian dinosaurs has yet to be demonstrated but is not untenable. It is thus critical to understand ontogenetic and stratigraphic morphological trends within taxa as once these dimensions of variation are accounted for, the possibility of sexual variation can be explored.

Technical Session IX, Tuesday 11:00

LATE QUATERNARY MAMMALS FROM RUSINGA ISLAND, KENYA: IMPLICATIONS FOR ENVIRONMENTAL CHANGE AND MEGAFAUNAL EXTINCTIONS

TRYON, Christian, New York University, New York, NY, USA; FAITH, John, George Washington University, Washington, DC, USA; PEPPE, Daniel, Baylor University, Waco, TX, USA

The Wasiriya Beds of Rusinga Island, Kenya, preserve a Pleistocene sedimentary archive containing abundant well-preserved fossil fauna in stratigraphic association with Middle Stone Age artifacts. AMS (accelerator mass spectrometry) radiocarbon dates on the carbonate fraction of gastropod shells provide a minimum age of 33,000 – 45,000 calendar years ago for the fossil-bearing deposits. Alcelaphine bovids dominate the mammalian fossil assemblage and suggest the prevalence of open grassland vegetation. In particular, the presence of oryx (*Oryx gazella*) and Grevy's zebra (*Equus grevyi*), both of which are historically absent from this region, suggest a pre-Last Glacial Maximum (LGM) expansion of arid grasslands. This environmental reconstruction is further supported by the presence of several extinct specialized grazers that are unknown from Holocene deposits in eastern Africa. These include the giant long-horn buffalo (*Pelorovis antiquus*), the giant wildebeest (*Megalotragus sp.*) and a small, unnamed alcelaphine antelope. Taken into consideration with sediment li-

thology, the available evidence indicates a local fluvial system and associated riparian woodland habitat within an arid grassland setting that differs substantially from the modern environment.We propose that the pre-LGM expansion of arid grasslands supported a facilitating grazing system similar to the grazing succession documented in the East African Serengeti plains. This system provided ecological niches for multiple specialized grazers, characterized by either large body size and/or extreme hypsodonty. Both faunal and paleobotanical evidence indicate wetter and more densely vegetated environments in the Lake Victoria basin at the onset of the Holocene. This environmental change likely disrupted the Pleistocene grazing succession and led to the extinction of both large and medium sized grazers.

Poster Session III, (Tuesday)

CHRONIC EXERCISE DOES NOT ALTER LIMB BONE MORPHOLOGY OR MICROSTRUCTURE IN THE AMERICAN ALLIGATOR (*ALLIGATOR MISSISSIPPIENSIS*)

TSAI, Henry, University of California, Irvine, Irvine, CA, USA; OWERKOWICZ, Tomasz, University of California, Irvine, Irvine, CA, USA; FELBINGER, Krista, University of California, Irvine, Irvine, CA, USA; ANDRADE, Fernando, University of California, Irvine, Irvine, CA, USA; HICKS, James, University of California, Irvine, Irvine, CA, USA

Bone microstructure has been a useful tool for paleontologists to infer preferred limb posture, amount of locomotor activity, and life history of extinct vertebrates. To date, most such inferences were based mostly on limb bones of extant mammals and birds, and hence were applicable to their close extinct relatives. In contrast, effects of exercise on bone microstructure in non-avian reptiles have received scant attention. We investigated the effects of long-term exercise on a treadmill or in a flume on limb bones of the American alligator. Juvenile female alligators were run or swum to exhaustion every other day for 17 months. Animals were measured every other week, and received injections of fluorochrome dyes (calcein and alizarin) to determine mineral apposition rates in the skeleton. We found no significant differences in whole bone morphology, cross-sectional geometry and cortical bone deposition rates in the humeral midshaft, regardless of exercise regimen. Similarly, we found no effects of exercise on cancellous bone architecture (bone volume fraction, bone surface density, bone specific surface, as well as trabecular number, thickness and separation) in the distal femur. Bone mineral fraction was similar across exercise groups. Altogether, this suggests that long-term locomotor exercise has no discernible effect on bone microstructure and material composition in alligators. These results stand in contrast to studies on mammals and birds where limb loading is known to affect both macro- and microstructural architecture of the skeleton. The disparity could be due to metabolic differences between ectothermic and endothermic vertebrates. Alternatively, alligator limb bones are subjected to insufficient strain levels or load cycles during short exercise bouts, which may account for their lack of skeletal plasticity in response to exercise. We suggest that exercise habits cannot be inferred from long bone microstructure of extinct crocodilians. Since non-avian dinosaurs are nested within the extant phylogenetic bracket of crocodilians and birds, did they show skeletal plasticity in response to exercise?

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

BONY OVERGROWTH IN PHALANGES OF A *CAMARASAURUS* (DINOSAURIA: SAUROPODA) INDICATES OLD ONTOGENETIC AGE AND PROVIDES INSIGHTS INTO THE PROCESS OF PHALANGEAL REDUCTION IN SAUROPODS

TSCHOPP, Emanuel, Universidade Nova de Lisboa, Lisbon, Portugal

Different types of bony overgrowth are known from various dinosaur taxa. While quite common in the axial skeleton, bony spurs are rarely reported from appendicular elements. They were often interpreted as indicating diseases like primary (age-related) or secondary (injury-induced) osteoarthritis when affecting appendicular bones or diffuse idiopathic skeletal hyperostosis (DISH) when present in vertebrae.Four different types of osteophytes (bony spurs) found in manual and pedal phalanges of a *Camarasaurus* sp. (SMA 0002) are described. Comparisons to corresponding elements of other *Camarasaurus* specimens as well as other sauropod taxa show that the observed degree of overgrowth in SMA 0002 is unusual. The first type of osteophyte is present in almost every proximal phalanx: the borders of the proximal articular surfaces of the affected phalanges are expanded transversely and dorsopalmarly, which is herein interpreted as the first occurrence of primary osteoarthritis in dinosaurs. A second type at the proximal articular surfaces of the pedal unguals projects proximally. It is located where the tendon for claw retraction inserts and most probably represents a rare case of ossified tendon insertions (enthesophytes). The other two variants affect only a single phalanx: the proximal phalanx of the left pedal digit IV has a knob-like overgrowth at its laterodistal edge, indicating secondary osteoarthritis, and the right manual phalanx IV exhibits a distally projecting spur at its distal articular surface. Whereas osteoarthritic overgrowth is widespread in vertebrates, and also enthesophytes are known at least in humans and rats, such a distally extending osteophyte seems extremely rare. Together with an unambiguous second vestigial phalanx in the left manual digit II, this last variant of osteophyte implies that the phalangeal reduction in the sauropod manus was due to a degeneration of the second phalanges, followed by the fusion with their precedent elements. These results are supported by histological studies of SMA 0002, and corroborate hypotheses on the importance of bone fusion as a driving force in the reduction of the sauropod wrist.

Technical Session XIII, Tuesday 2:30

EVOLUTION OF STRESS CHANNELING MECHANISM IN THE SKULLS OF HYENAS: FINITE ELEMENT ANALYSIS OF KEY ECOMORPHOLOGIES

TSENG, Zhijie Jack, University of Southern California, Los Angeles, CA, USA; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA, USA

Living spotted hyenas *Crocuta crocuta* are large predators with skulls and teeth adapted for cracking bones. Previous analyses of the functional mechanics of bone-cracking using finite element analysis (FEA) showed that strong and efficient skulls capable of bone-cracking premolar bites evolved convergently in at least three carnivoran lineages: hyaenids, percrocutids, and borophagine canids. Here we present a new FEA study of craniodental mechanics in the Hyaenidae covering omnivorous ancestral forms to osteophagous descendent species. Six skulls representing the range of ecomorphological diversity in the Hyaenidae were used: an outgroup viverrid, *Ictitherium*, *Chasmaporthetes*, *Proteles* (aardwolf), *Parahyaena* (brown hyena), and *C. crocuta*. Relative bite forces and skull efficiency for six masticatory scenarios (unilateral C1, P2~4, and M1 bites, respectively) were measured. Bite force increased through hyaenid evolution regardless of bite position; however, hyena skulls evolved for efficiency in anterior premolar bites at the expense of P4~M1 bites, corresponding to evolutionary reduction of the posterior dentition in the family. Contrary to expectation, skull shape evolution in Hyaenidae did not correspond with adaptation for more widespread dissipation of stresses incurred during mastication; instead, evolutionary trends observed were towards concentration of tensile and compressive stress in the frontal region during P3/P4 biting, with less derived species showing more widespread stress. Building on previous hypotheses regarding the role of caudally expanded frontal sinuses and domed foreheads in stress conduction, our results show that the skull of *Crocuta* performs particularly well at diverting stresses incurred on the skull from both muscle contraction and bite point by pooling maximum and minimum principal stresses within the domed frontals. These findings suggest that skull evolution in Hyaenidae involved a combination of increased overall bite force, channelization of stress into the frontal region, and biomechanical optimization of the skull for P3 bites at the expense of masticatory efficiency of other cheek teeth.

Poster Session IV, (Wednesday)

REAPPRAISAL OF "*BRACHYODUS*" *JAPONICUS*, AN OLIGOCENE ANTHRACOTHERIID ARTIODACTYL (MAMMALIA) FROM JAPAN

TSUBAMOTO, Takehisa, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

We reappraise and review "*Brachyodus*" *japonicus* Matsumoto in Tokunaga, which is an Oligocene anthracothere (Mammalia, Artiodactyla) discovered from the Nakazato Formation of the Sasebo Group (western Japan) in the early 20th Century and described in 1925. This species is represented by the type and only known specimen, a left mandibular fragment with p4-m2. Although the whereabouts of the specimen had been unknown for many years since 1925, it has become clear that the specimen is now stored in the National Museum of Japanese History (Sakura, Japan). The geologic age of the species is correlated to the middle part of the Oligocene on the basis of fission-track dating. The present specimen is much smaller than species of *Brachyodus* and has a more mesiodistally elongated p4, indicating that it is not referable to *Brachyodus*. Instead, its dental morphology indicates that it should be referred to *Elomeryx* in having moderately selenodont molars and mesiodistally elongated p4 with a distinct paraconid and metaconid. The p4 of the specimen differs from that of the other named species of *Elomeryx* in having a better-developed distobuccal cingulum and a wider talonid, suggesting that "*Brachyodus*" *japonicus* is a valid species and is an additional species in the genus *Elomeryx*.This species gives significant information for the biochronology and paleobiogeography of poorly-understood East Asian Oligocene anthracotheres and for the evolution and migration of Eurasian Oligocene *Elomeryx*.

Technical Session XIV, Wednesday 11:45

A NEW TROODONTID (DINOSAURIA: THEROPODA) FROM THE LATE CRETACEOUS OF THE GOBI DESERT IN MONGOLIA

TSUIHIJI, Takanobu, National Museum of Nature and Science, Tokyo, Japan; WATABE, Mahito, Center for Paleobiological Research, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolian Paleontological Center , Ulaanbaatar, Mongolia; SUZUKI, Shigeru, Center for Paleobiological Research, Hayashibara Biochemical Laboratories, Inc., Okayama, Japan; BARSBOLD, Rinchen, Mongolian Paleontolgoical Center, Ulaanbaatar, Mongolia

Remains of troodontid theropods, especially articulated skeletons, are extremely rare worldwide. The Gobi Desert of Mongolia is no exception despite the fact that numerous remains of other clades of dinosaurs have been found in this region. We here report on an articulated skeleton of a new troodontid found from the Campanian Djadokhta Formation of the Dzamin Khond locality in the central Gobi Desert. The specimen, missing only middle cervical vertebrae, forelimbs distal to humeri, parts of hind limbs, and most gastralia, represents the most complete skeleton of a Late Cretaceous troodontid presently known. With the total body length approximately 160 cm, this specimen is comparable to *Saurornithoides mongoliensis* in size. The skull, mostly undistorted and lacking only the tip of the snout, shows typical troodontid features such as an enlarged maxillary fenestra and the anterior process of the lacrimal much longer than the supraorbital process. The well-preserved postcranial skeleton provides detailed information on poorly-understood anatomy of Troodontidae. For example, it is confirmed for the first time that the proatlas is present in front of the atlas as in some

other coelurosaurians. Anterior cervical ribs are thin and long unlike short posterior cervical ribs. 35 caudal vertebrae are preserved with the transition point located at around the tenth caudal. The ischium is short, with the length being 55% of that of the pubis. The present specimen shares such apomorphies as lateral teeth lacking serrations and presence of a shallow groove along the buccal margin of the maxilla with the coeval *Byronosaurus jaffei*, with a preliminary cladistic analysis placing these two as sister taxa. Unlike in *B. jaffei*, however, the interfenestral bar of the maxilla is recessed medially and the lacrimal lacks a laterally-open fossa at the posterodorsal corner of the antorbital fenestra in the present specimen. Combination of these features thus indicates that this is a new, distinct taxon. This represents the third troodontid taxon discovered from the Djadokhta Formation, thus revealing a high diversity of this clade of theropods in the Campanian of Central Asia.

Technical Session XVIII, Wednesday 4:00

THE LATE PERMIAN REPTILE *EMEROLETER LEVIS* FROM RUSSIA AND THE PHYLOGENY OF THE NYCTEROLETER PARAREPTILES

TSUJI, Linda, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Berlin, Germany; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada; MÜLLER, Johannes, Leibniz-Institut für Evolutions- und Biodiversitätsforschung an der Humboldt-Universität zu Berlin, Berlin, Germany

The Kotel'nich locality from the Late Permian of central Russia has produced numerous well-preserved fossils from a diverse assemblage of taxa. This fauna includes multiple parareptiles; the pareiasaur *Deltavjatia vjatkensis*, the enigmatic *Nyctiphruretus acudens*, and the nycteroleter *Emeroleter levis*. Known previously from only isolated skull material, new, complete and articulated specimens including postcrania of the latter taxon,have recently been recovered, for the first time allowing a complete description. The skull of *Emeroleter* is triangular and characterized by evenly-spaced, small, round pits. Despite the lack of preservation of other structures indicative of tympanic hearing, the presence of an otic notch of larger proportion than that of the morphologically similar *Macroleter poezicus* indicates that *Emeroleter* had sensitive hearing. The postcranial anatomy of *Emeroleter* shows limb elements that are remarkably gracile in comparison with its close relatives, with a highly reduced olecranon process of the ulna, and a slightly sigmoid curve to the shaft of the femur. The taxon also has a single element in the proximal tarsus. The presence of a lumbar region in the taxon confirms a morphology shared by all sufficiently-known nycteroleter taxa.A new phylogenetic analysis of parareptilian relationships, using both parsimony and Bayesian inference, includes for the first time all named nycteroleters (*Nycteroleter ineptus*, *Bashkyroleter mesensis*, *Bashkyroleter bashkyricus*, *Emeroleter levis*, *Macroleter poezicus*, and *Rhipaeosaurus tricuspidens*). While the parsimony analysis recovers a monophyletic nycteroleter clade, the Bayesian analysis suggests a grading into Pareiasauria. Each result, however, supports a close relationship between the nycteroleters and the pareiasaurs. The monophyly of the genus *Bashkyroleter* is not recovered in any of the analyses, indicating that the genus should be reassessed, whereas *Tokosaurus perforatus* and *Macroleter poezicus* are synonymous.

Poster Session III, (Tuesday)

HIGH-RESOLUTION TEMPORAL VARIATIONS IN SIZE AND SHAPE OF MOLAR DENTITION AMONG *NOTHARCTUS* FROM THE MIDDLE EOCENE BRIDGER FORMATION, BRIDGER BASIN, SW WYOMING

TSUKUI, Kaori, American Museum of Natural History, New York, NY, USA; MENG, Jin , American Museum of Natural History, New York, NY, USA

New dental morphometric data for middle Eocene *Notharctus* specimens collected from a ~2 my interval (Bridger B - D) were binned into fourteen ~0.15 my long intervals to elucidate temporal changes in size and shape variables of the lower molars. Mesial-distal crown length and buccal-lingual crown width of the lower molar dentition were measured on 241 catalogued specimens from the AMNH and YPM collections. The size measurements and morphology were used in conjunction with stratigraphic occurrence data to make species identification of the sample. Three species of *Notharctus* were recognized: *N. pugnax* and *N. tenebrosus* from the lower Bridger Formation (Blacks Fork Member) and *N. robustior* from the upper Bridger (Twin Buttes Member).

A replacement of the two smaller lower Bridger species (*N. tenebrosus* and *N. pugnax*) by larger *N. robustior* in the upper Bridger is observed in the measurements of m1 crown area and is in agreement with a previous study. However, the current analysis adds more detailed information about the nature of the transition, at a finer temporal resolution than has been achieved previously. *N. tenebrosus* shows a gradual increase in tooth area within the Bridger B, whereas *N. pugnax* shows a lack of unidirectional change during the same interval. *N. robustior* from the upper Bridger shows an abrupt increase within the Bridger C and a decrease from the Bridger C to D although the precise rate of the decrease cannot be determined because of sparser sampling within the Bridger D. Unlike the size variable, variations in shape quotient in m1 do not show strong signs of an unidirectional change during each of the three species' durations, indicating that dental morphological changes in species of *Notharctus* during the study interval involved mostly size changes without significant shape changes. This study suggests that near the peak of Cenozoic warming, *Notharctus* exhibited an overall trend towards larger body size (as inferred by the molar size), although when viewed at a fine temporal resolution, the changes exhibited within each species of *Notharctus* were more variable, both in direction and rate.

Poster Session II, (Monday)

CARNIVORES FROM THE PIPE CREEK SINKHOLE (LATEST HEMPHILLIAN), GRANT COUNTY, INDIANA

TUCKER, Shane, University of Nebraska State Museum, Lincoln, NE, USA; FARLOW, James, IPFW, Fort Wayne, IN, USA

The Pipe Creek Sinkhole, located in Grant County, Indiana, is one of two Late Neogene localities in the interior of the eastern United States. This fossiliferous pond deposit occurred in a sinkhole developed in Silurian-age limestone and is unconformably overlain by Pleistocene glacial till. Several thousand identifiable botanical, invertebrate, and vertebrate specimens were recovered from spoil piles and *in situ* sediments over several field seasons. Carnivores make up a small percentage (<1%) of the overall vertebrate fauna yet are useful biochronologic indicators. At least seven taxa representing four families are identified from two partial mandibles and isolated dental and postcranial elements. The Pipe Creek carnivore fauna contains three canids, one felid (*Lynx* cf. *L. rexroadensis*), one ursid (*Plionarctos edensis*), and two mustelids. Canids include the widespread taxa *Borophagus* and *Vulpes*. Mustelid remains belong to a badger and small mephitine, *Buisnictis schoffi*.The co-occurrence of *Plionarctos edensis*, *Buisnictis schoffi*, and *Lynx rexroadensis* suggests a latest Hemphillian(early Pliocene) age which agrees with the biochronologic age previously reported based on the rodents and associated fauna.

Poster Session I, (Sunday)

BIOGEOGRAPHY OF THE LATE CRETACEOUS CHONDRICHTHYAN FAUNA FROM THE JUDITH RIVER FORMATION (CAMPANIAN), MONTANA: WHEN TO USE GENERIC LEVEL DATA OVER SPECIES LEVEL DATA IN PARSIMONY ANALYSIS OF ENDEMICITY

TULU, Yasemin, Michigan State University, East Lansing, MI, USA

Recent studies of the Judith River Formation (JRF) chondrichthyans of Montana show that the fauna consists both of cosmopolitan and endemic members totalling 26-28 identifiable taxa, is homogenous, and similar to several contemporaneous faunas from the Western Interior Seaway (WIS) as shown by hierarchical cluster analyses and Parsimony Analysis of Endemicity (PAE). The fauna is diverse, composed of lamniforms and rajiforms that inhabited a shallow marine/estuarine environment of the WIS. When examined in the context of 18 other contemporaneous (Cenomanian to Maastrichtian) faunas of the WIS, the JRF fauna is most similar in composition to faunas of Campanian age, similar geography, and/or similar environment. The JRF is most similar to the "Mesaverde" Formation (Campanian) of Wyoming and the JRF (Campanian) and Dinosaur Park Formation (DPF) (Campanian), both of Alberta. These observations are corroborated with a PAE where at the generic level the JRF fauna forms a province, that is geographically and temporally defined, with the DPF, the "Mesaverde" Formation, and the Hell Creek Formation (Maastrichtian) in North Dakota, implying more shared endemic genera between these formations than with the other formations studied. The remaining formations are similarly grouped. However, a PAE performed at the species level plots the JRF in a province that is more temporally defined, being grouped with the "Mesaverde" Formation, the Taylor Group of Texas (Campanian), and the Navarro Group of Texas (Maastrichtian), all at the end of the Late Cretaceous with the rest of the formations also grouped by time spanning from the Cenomanian to the Santonian. The addition of the species in the PAE seems to override any geographic grouping of shared endemic species and instead groups taxa temporally into provinces. This may demonstrate excessive splitting at the species level in previous studies, thereby overriding any concrete generic signal amongst the taxa of the JRF and of the WIS overall. These results would suggest that both generic and species level analyses should be completed in order to determine what level of classification is needed to produce the most reliable results.

Technical Session XII, Tuesday 2:30

A REEVALUATION OF THE CROCODYLIFORM *ACYNODON* FROM THE LATE CRETACEOUS OF EUROPE

TURNER, Alan, Stony Brook University, Stony Brook, NY, USA; BROCHU, Christopher, University of Iowa, Iowa City, IA, USA

Acynodon is a small short-snouted crocodyliform known from several localities of latest Cretaceous age throughout Europe. It is cranially similar to basal globidontan alligatoroids, and some phylogenetic analyses support such a relationship. This relationship would be important both biogeographically and stratigraphically - all other known Cretaceous alligatoroids are from North America, and the oldestspecies (Santonian-Campanian *A. adriaticus*) may be the oldest known crocodylian - but previous analyses relied on matrices intended to reflect variation within Crocodylia or subordinate clades, such as Alligatoroidea. We conducted maximum parsimony analyses with a larger sample of characters and taxa, and the results instead support a close relationship with the European basal eusuchians *Hylaeochampsa* and *Iharkutosuchus*. These taxa share a progressive mesiodistal increase in maxillary alveolar diameter along the toothrow and a distinctive hypertrophied tubercle on the ventral surface of the quadrate ramus for the posterior mandibular adductor. The results also suggest non-monophyly of *Acynodon*; *A. adriaticus* shares greatly enlarged posterior maxillary teeth with *Hylaeochampsa* and *Iharkutosuchus*, features absent from a younger species (*A. iberoccitanus*). These results support the view that globidontans represent an ancestrally North American clade and indicate that hylaeochampsines may form a diverse Cretaceous radiation endemic to Europe. This study also reinforces the importance of comprehensive taxonomic sampling in phylogenetic analyses; limited taxon sampling hinders rigorous hypotheses testing.

Poster Session IV, (Wednesday)

TEN YEARS EXCAVATION AT AN EXTENSIVE LANCIAN *EDMONTOSAURUS* BONEBED IN NORTHEASTERN WYOMING

TURNER, Lawrence, Southwestern Adventist University, Keene, TX, USA; NEUFELD, Berney, Southwestern Adventist University, Keene, TX, USA; CHADWICK, Arthur, Southwestern Adventist University, Keene, TX, USA; SPENCER, Lee, Southern Adventist University, Collegedale, TN, USA

We have been working for ten years in an extensive *Edmontosaurus* bonebed in eastern Wyoming in the Upper Cretaceous Lance Formation. Our application of high-resolution GPS technology has enabled us to maintain precise positional information on all recovered objects. We have been able to reconstruct virtual quarries with centimeter accuracy in the computer using GIS software and field photographs of the bones. Although we have only examined a small percentage of the total extent of the deposit in detail, test quarries in remote areas have afforded an opportunity to evaluate the deposit as a whole. Based on excavation of 500 of an estimated 250,000 square meters of bonebed in ten localities, we estimate the deposit contains the remains of more than 10,000 animals. The disarticulated bones appear pristine, exhibiting little evidence of weathering or abrasion. The association of numerous shed theropod teeth suggests scavenging occurred prior to final transport and burial.

The bonebed was deposited with a matrix of clay as a normally graded bed, possibly from a debris flow in relatively deep water. Contact with an overlying fine grained immature sandstone is sharp and flat. Extensive dewatering structures in the sandstone are consistent with rapid accumulation of these sediments. We are suggesting that an unknown catastrophe, perhaps volcanic in nature resulted in the rapid extinction of a large number of mature animals, whose carcasses accumulated on a shoreline where scavenging, rotting and disarticulation took place. Subsequent remobilization of the fetid mass, along with the sediments encasing the bones, perhaps triggered by local or regional tectonics resulted in transport for an undetermined distance into deeper water where they were finally buried in a meter thick, normally graded bed.

Poster Session IV, (Wednesday)

A NOVEL APPROACH TO SERIAL SECTIONING AND THREE-DIMENSIONAL VISUALIZATION OF ENAMEL MICROSTRUCTURE

TURRIN, Danielle, New York College of Osteopathic Medicine, Old Westbury, NY, USA; BEATTY, Brian, New York College of Osteopathic Medicine, Old Westbury, NY, USA

Dental enamel is a complex structure, composed of prisms of enamel packed in various orientations to allow it to function akin to plywood or fiberglass as a material to minimize crack propagation. Modeling the mechanical behavior of enamel due to prism orientation has had limitations due to limitations of observation of prism orientation to two-dimensional SEM of sectioned teeth, inferring orientation of prisms from sections at various orthogonal planes, and whose sections are always too thick to allow for observations of the continuity of individual prisms through a series. We attempted to solve this by application of a century-old method used in paleobotany by making acetate peels and digitally connecting serial sections, creating volumes of individual prisms in the volume rendering program, Amira. We succeeded in linking micrographs and rendering volumes, yet several potential problems persist. One, the method is time consuming. Two, the etching process that removes the enamel prism and leaves the interprismatic matrix may not be ideal for use with fossil dentitions because little to no organic matter would remain to peel with the acetate sheet and observe. Still, it is our hope that this might someday be used for fossil dentitions, and that in the least it may be utilized to make closer, inference-free observations of enamel prism orientation in modern mammals that can help make more informed hypotheses of enamel microstructure for related taxa.

Technical Session XVI, Wednesday 3:30

LIFE HISTORY AND ECOLOGICAL INFORMATION INFERRED FROM STABLE ISOTOPE ANALYSIS OF THE DENTITION OF *ZYGORHIZA KOCHII* (CETACEA: BASILOSAURIDAE)

UHEN, Mark, George Mason University, Fairfax, VA, USA; CLEMENTZ, Mark, University of Wyoming, Laramie, WY, USA

Direct evidence of life history information (i.e., growth rate, sexual maturity, gestation, etc.) is often difficult to obtain for extinct cetacean species. For living species, study of incremental growth layers in various tissues (e.g., dentin, baleen, earwax) can record this information, but the poor preservation or complete lack of these materials in the fossil record limits extension of these proxies to fossil species. However, the retention of the primitive mammalian trait of diphyodonty by Eocene cetaceans (archaeocetes and basal Pelagiceti) provides an opportunity to examine changes in the stable isotopic composition of tooth enamel that formed during three important stages of an individual's life: Stage I (*in utero*); Stage II (post-birth and pre-weaning); and Stage III (post-weaning). Changes in the carbon and oxygen isotopic composition of enamel that formed during each of these stages can be used to infer changes in feeding and habitat preferences through ontogeny. Correlation between these ecological and life history traits may provide a novel means for new insight into at least the early stages in the development of individual archaeocetes and basal pelagicetes.

To examine the utility of applying this proxy to questions of life history in fossil cetaceans, we analyzed the carbon and oxygen isotope composition of multiple teeth along the lower tooth row of a single specimen of the basilosaurid *Zygorhiza kochii* (USNM 16638). Enamel powders from deciduous and permanent molars, premolars and anterior teeth were sampled and were compared to isotopic patterns observed in the dentition of two extant artiodactyls (*Odocoileus virginianus, Bos taurus*) and published values for one extinct species of archaeocete (*Pakicetus inachus*). Trends in isotopic values for extant artiodactyls and *P. inachus* were surprisingly consistent; though teeth from Stages I and III had nearly identical values, enamel $\delta^{18}O$ and $\delta^{13}C$ values for teeth that formed in Stage II were significantly different and consistent with a milk-based diet. Inclusion of enamel isotope data from *Z. kochii* will show whether this trend is evident in later, more derived archaeocetes as well.

Poster Session I, (Sunday)

TAPHONOMY AND TAXONOMY OF A VERTEBRATE MICROSITE IN THE CRETACEOUS BLACKLEAF FORMATION IN SOUTHWEST MONTANA

ULLMANN, Paul, Drexel University, Philadelphia, PA, USA; VARRICCHIO, David, Montana State University, Bozeman, MT, USA; KNELL, Michael, Montana State University, Bozeman, MT, USA; LACOVARA, Kenneth, Drexel University, Philadelphia, PA, USA

The vertebrate fauna of the Cretaceous Blackleaf Formation of southwest Montana remains largely undocumented. A microsite, BL1, discovered in the Vaughn Member in the Lima Peaks area, Montana, consists of a green siltstone and yields fossils previously unreported from the formation, including several dinosaur taxa: a hypsilophodont, dromaeosaurid, tyrannosaurid, hadrosaurid, and an ankylosaurian. Non-dinosaurian taxa include atoposaurid and *Bernissartia* crocodilians; *Glyptops*, chelydrid, and other turtles; and at least two neopterygiian fish. This diversity is consistent with the fluvial-deltaic environment interpreted for the Vaughn Member. Taphonomic data and sedimentologic relationships suggest this assemblage represents a floodplain depression accumulation. Comparisons with contemporaneous faunas from around the Western Interior of the United States suggest a remarkably consistent faunal makeup existed along the western coast of the mid-Cretaceous Seaway in North America.

Evolution of the Modern African Fauna, Wednesday 11:15

DIFFERENTIAL DIET CHANGE AMONG EAST AFRICAN HERBIVORES FROM THE LATE MIOCENE TO PLIOCENE BASED ON CARBON ISOTOPE DATA FROM FOSSIL ENAMEL

UNO, Kevin, University of Utah, Salt Lake City, UT, USA; CERLING, Thure, University of Utah, Salt Lake City, UT, USA; HARRIS, John, George C. Page Museuem, Los Angeles, CA, USA; LEAKEY, Meave, Turkana Basin Institute, Stony Brook University, Stony Brook, NY, USA; NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan

Stable carbon isotope analyses of enamel from ~450 fossil teeth provide a detailed record of the dietary transition from C3 to C4 resources in a majority of herbivore families from the Late Miocene to the Pliocene in East Africa. Data from two fossil sites in the Suguta Depression and one site in the Turkana Basin record differential rates of diet change among equids, rhinos, gomphotheres and elephants, bovids, hippos, suids, deinotheres, and giraffids from 9.9 Ma to 3.2 Ma. K/Ar, $^{40}Ar/^{39}Ar$, and paleomagnetic data from the three sites constrain the age ranges of fossil-bearing sediments from 9.9 to 9.8 Ma at Nakali, from 9.6 to 9.3 Ma at the Samburu Hills, and from 7.4 to 3.2 Ma at Lothagam.

Perissodactyls develop C4 dominated diets before artiodactyls or proboscideans, despite lacking the digestive physiology for efficiently breaking down cellulose. Equids rapidly shift from a nearly exclusive C3 diet to a C4 dominated diet around 9.8 to 9.3 Ma. Rhinos likewise begin incorporating a significant amount of C4 resources into their diet by 9.6 Ma, but maintain a diverse diet throughout most of the record. Gomphothere and elephant diet remains C3-dominated until the period from 9.3 to 6.5 Ma, when transition to a C4 diet occurs. As for the artiodactyls, bovids incorporate C4 resources into their diet by 9.6 Ma, but do not have $\delta^{13}C$ values associated with a pure C4 diet until 7.4 Ma. Hippos change from a C3 diet at 9.8 Ma to an intermediate C3-C4 diet at 9.6 to 9.3 Ma. By 7.4 Ma, the $\delta^{13}C$ range in hippo enamel dramatically increases to 8 ‰ and remains high throughout the record. Suids maintain a predominantly C3 diet until 6.5 Ma, when they become mixed feeders. By 3.2 Ma, suids have C4 dominated diets. Deinotheres and giraffids maintain a C3 diet throughout the entire record.

Technical Session X, Tuesday 8:15

SEX IN PTEROSAURS

UNWIN, David, University of Leicester, Leicester, United Kingdom; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; LIU, Yongqing, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; JIN, Xingsheng, Zhejiang Museum of Natural History, Hangzhou, China

Determination of gender is one of the holy grails of vertebrate paleontology and of prime importance for understanding anatomy, behavior, reproductive biology and taxonomy. In pterosaurs gender related skeletal dimorphisms have been hypothesized for size, relative lengths of the head, neck and limbs, the pelvis and, most frequently, for cranial crests which occur in about 40% of known genera. So far, however, direct evidence for gender, which is extremely rare in all extinct terrestrial vertebrates, has been lacking. A new specimen of *Darwinopterus* preserved in direct association with an egg demonstrates that this individual, from the Middle/Upper Jurassic Tiaojishan Formation of China, was a sexually mature female. The co-occurrence of relatively deep puboischiadic plates and absence of a cranial

crest are exactly as expected for female pterosaurs and contrast sharply with the relatively shallow and seemingly more convergent puboischiadic plates and prominent cranial crest found in other similarly sized, presumably male, individuals of *Darwinopterus*. These dimorphisms suggest that females had a deeper pelvic canal that, most likely, facilitated passage of the egg. They also provide strong support for the idea that the principal function of cranial crests was for display, a hypothesis that best accounts for the widespread distribution of crests across Pterosauria, their remarkable variation in size, shape and position and their simultaneous presence/absence in particular species. This, in turn, points to sexual selection as the most likely explanation for the evolution of spectacular crests in several clades, most notably Pteranodontia and Azhdarchoidea. A preliminary reanalysis of species taxonomy incorporating this improved understanding of anatomical variation in pterosaurs confirmed current hypotheses of sexual dimorphism in *Anhanguera*, *Pteranodon*, *Nyctosaurus*, and *Ctenochasma*, and identified another nine candidate examples of sexual dimorphism involving 19 species of pterosaur. By contrast to *Pteranodon*, little evidence was found for gender related size dimorphism or 'harems' in this group.

Technical Session XIV, Wednesday 8:15

NEW INFORMATION ON THE TAXONOMY AND PHYLOGENETIC RELATIONSHIPS OF MIDDLE AND LATE JURASSIC SAUROPODS FROM CHINA

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There are currently some 15 genera of sauropod dinosaur known from the Middle and Late Jurassic of China. Many of these comprise multiple species - up to 10 in the case of *Mamenchisaurus*. The diagnoses of these taxa are often problematic, partly because more recent discoveries have rendered previously diagnostic features 'obsolescent'. Examination of key type specimens and comparisons with non-Chinese forms provide a suite of new characters that help to diagnose the Chinese taxa, resolve some taxonomic issues, and contribute to phylogenetic analysis. One of the best known species of *Mamenchisaurus*, *M. hochuanensis*, can be diagnosed by 15 autapomorphies, including: (1) double prezygapophyseal and double centroprezygapophyseal laminae on anterior dorsal vertebrae; (2) large divided coels on the posterior surfaces of the diapophyses of anterior dorsal vertebrae; and (3) flattened striated scars on the upper part of the neural arch in anterior caudals. *Klamelisaurus* is characterised by 10 autapomorphies, including: (1) a spinodiapophyseal lamina joins the spinoprezygapophyseal (rather than the spinopostzygapophyseal lamina) on anterior dorsals; (2) middle and posterior dorsals have prominent parapophyses placed on sheet-like centroparapophyseal laminae that project anterolaterally; and (3) an anterodorsally facing depression on the proximal end of the humerus, close to its medial edge. Phylogenetic analysis indicates that characters (such as the presence of 3–4 coels on the lateral surfaces of cervical neural spines, a shallowly bifurcated neural spine in mid-presacrals, and strongly procoelous anterior caudal centra) support the existence of a monophyletic mamenchisaurid clade that contains *Mamenchisaurus*, *Klamelisaurus* and probably *Bellusaurus*. This clade is placed among basal eusauropods, lying outside of Neosauropoda. Cladistic biogeographic studies suggest that a group of eusauropods dispersed across Eurasia prior to the formation of the Turgai Sea in the Middle Jurassic, which then resulted in endemism among the East Asian forms. These taxa became extinct by the Early Cretaceous and were replaced by an immigrant fauna dominated by titanosauriforms.

Poster Session II, (Monday)

A NEW TRUE SEAL MORPHOTYPE (PHOCIDAE, CARNIVORA) FROM BAHIA INGLESA FORMATION, CHILE

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Phocid remains have been previoulsy recovered from the Bahia Inglesa Formation (middle Miocene-late Pliocene, Northern Chile), but only fragmentary remains of taxa already known from the Pisco Formation, *Piscophoca pacifica* and *Acrophoca longirostris* (Monachinae, Pisco Fm., Peru) have been recognized to this unit. Here we report a new dentary morphotype of a Monachinae (Phocidae). This specimen was recovered from the marine sediments of the "bonebed" level (late Miocene), corresponding to a complete right dentary ramus. Descriptive measurement and preliminary morphometric analysis were performed with seven specimens, *Piscophoca* sp. (SGOPV 1080a), cf. *Piscophoca* sp. (SGOPV1049 a y b), *Acrophoca* sp. (SGOPV 1019) and the new morphotype (SGOPV 1080c) from the Bahia Inglesa Formation, the holotypes of *P. pacifica* (MNHNSAS 564) and *A. longirostris* (MNHNSAS 563). The new morphotype differs from other fossil Monachinae species by being robust, having a high abrupt elevation of the coronoid process that spreads until half length of the dentary, overall dentary height, and by having a conspicuous V-shaped masseter fossa in contrast to the anteroposteriorly elongate and divided fossa for masseters found in *Piscophoca* and *Acrophoca*. The dentary is laterally deviated from the very short symphysis, which must have an impact on mouth shape and mostly width, denoting a different morphotype from the contemporaneous narrow rostrum forms, mainly in *A. longirostris* but also when compared to *P. pacifica*. On the PCA (transformed to avoid size effect, PC1 explains 88,8% of variation) SGOPV 1080c appears distant from all other specimens, being more distant than the holotypes of *P. pacifica* and *A. longirostris* are from each other. Kruskal-wallis tests performed to test differences between taxa with pairs of measurements were significant to all. SGOPV 1080c also seems to correspond to an ecologically distinct form, at least due to its relatively wide and robust mouth, which could imply different prey sizes or types. The new morphotype suggests a greater diversity of Monachinae in the late Miocene of northern Chile.

Preparators' Session, Monday 11:15

PREPARATION OF MICRO-FEATURES OF EOCENE GREEN RIVER SPECIMENS: METHODS AND MATERIALS

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The locality known as Fossil Lake of the Eocene Green River Formation of Wyoming has yielded a wealth of exquisitely fossilized flora and fauna, 52 million years old. A fine-grained limestone matrix has preserved morphological features with impressive detail: from insect wings and fish embryos, to delicate veining on leaves. Micro-features have been beautifully preserved, such as bird feathers; body and skin impressions of mammals; and scales and fin rays of fishes, their jaws filled with teeth and denticles. These micro-features need special attention for proper preparation. In addition, the bones of birds, fishes and small tetrapods are often thin and hollow. Plant material is equally delicate: leaves, stems and flowers provide extraordinary detail, but may be easily damaged during preparation.These detailed specimens present a unique challenge: how to effectively remove matrix without damaging their micro-features or delicate structures. Air-abrasion is too forceful and leaves behind powder residue that cannot be removed completely. Acid preparation is a possibility, but the specimen must be permanently embedded in resin, and this method may still prove too damaging. Pneumatic and hand tools are often frustrating to use on such fragile material.Appreciable success was achieved in preparing and preserving a variety of these Fossil Lake specimens and their micro-features by refining hand tools and mechanical preparation techniques. Specialized pin vise tips were developed through alternative sharpening methods that proved useful in removing matrix without damage to the specimen. Blunted air scribes removed matrix effectively if oriented correctly to the specimen surface, and with 'choked down' air flow.Precision was maintained by holding tools in a manner that provided ultimate stability and control. Angled orientation of the specimen itself was extremely important. Finally, some consolidation was used to keep delicate surfaces and bones intact.By observing the unique challenges each specimen provided, and then applying and modifying these techniques, preparation of this material with little or no damage was possible. Implementation of these methods was an important part of uncovering the delicate features of specimens such as the ones found in this particular formation.

Poster Session IV, (Wednesday)

PRESERVATION OF ORGANIC MOLECULES IN A HADROSAUR DINOSAUR FROM THE HELL CREEK FORMATION, NORTH DAKOTA (USA)

VAN DONGEN, Bart, University of Manchester, Manchester, United Kingdom; WOGELIUS, Roy, University of Manchester, Manchester, United Kingdom; BUCKLEY, Mike, University of Bournemouth, Bournemouth, United Kingdom; LYSON, Tyler, University of Yale, New Haven, CT, USA; MANNING, Phillip, University of Manchester, Manchester, United Kingdom

The recognition of dinosaur tissue structure and organic molecules preserved inside bone has been previously reported. In contrast, the presence of both organic structures and molecules in dinosaur soft tissues, such as skin, terminal ungual phalanx sheath, or tendon, has not been recognized. A recently discovered extremely well-preserved dinosaur (*Edmontosaurus* sp.) found in the Hell Creek Formation (Upper Cretaceous, North Dakota, USA) maintains soft-tissue structures which might help in these endeavours.

The presence of organic compounds in the soft-tissue is demonstrated by results from Fourier Transform Infra-red Spectroscopy (FTIR), Pyrolysis Gas Chromatography Mass Spectrometry (Py-GCMS), and amino acid composition analyses. FTIR of materials recovered from the skin and terminal ungual phalanx material indicates the presence of compounds containing amide groups. The position/appearance of the FTIR bands of the amide I and II groups were similar to what was measured in a modern □-keratin sample taken from pigeon down and crocodile integument. Amino acid composition and racemisation analyses of a skin envelope sample exhibits a distinct composition clearly different from the surrounding matrix. High glycine:alanine concentrations were observed indicative of fibrous structural proteins such as collagens and keratins. However, intact proteins could not be obtained using protein mass spectrometry. Py-GCMS revealed the presence of an aliphatic polymer in the skin. The distinct *n*-alkanes/*n*-alken-1-ene homologues distribution pattern associated with this polymer differ considerably compared to the enclosing sediment. The observed differences are inconsistent with an origin solely via migration from enclosing sediment and are tentatively interrupted as being endogenous to the dinosaur. This suggests that the organics present in the skin envelope consist of a macromolecule that is in part aliphatic, presumably the result of a process of in situ polymerisation. Combined, the results suggest a preservation of soft-tissue organic material, probably caused by a rapid burial outpacing microbial decay processes.

Poster Session III, (Tuesday)

BONE ABRASION AND TRANSPORT DISTANCE: TAPHONOMIC EXPERIMENTS IN THE EAST FORK RIVER, WYOMING

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Fossil bones occurring in fluvial deposits often show varying degrees of abrasion, with smoothing or polishing of surfaces and rounding of edges and processes. It is commonly assumed that the progressive development of such features (e.g., degree of abrasion) in bones is proportional to the distance they traveled prior to final burial and fossilization. An experiment in the East Fork River, Wyoming, tested this assumption by evaluating pre- and post-transport characteristics of recent bones in a natural river system. Clean, unabraded bones of domestic cow, horse, and goat were introduced into the East Fork prior to spring floods in 1974, 1975, and 1983, and 27 of these were collected after interacting with fluvial processes for up to 10 years over transport distances up to ~5 km. Edge and break rounding, surface smoothing and polishing, and other surface features such as evidence of chemical corrosion were recorded in this experimental set and comparisons were made with descriptions, measurements, and photographs of the same bones prior to transport. When categorized on a scale of 0 (least abraded in the experimental set) to 5 (most abraded), the experimental bones showed no correlation of abrasion with average annual transport distance. The distances traveled by different skeletal parts in the experimental set are consistent with the predictions of the Voorhies Groups (VG-1 to VG-3 = most to least easily transported), with average annual distances of 388 m for VG-1 (e.g., vertebra), 215 m for VG-2 (limb elements), and 159 m for VG-3 (mandibles). Contrary to expectation, VG-3 has a higher average abrasion score than VG-1 or -2. The East Fork experiment indicates that degree of abrasion in fluvially transported bones is not necessarily proportional to distance traveled. Instead, abrasion may be more simply linked to the degree of interaction of sediment and bone, with greater abrasion occurring in heavier, stabilized or slow-moving bones that are "sand-blasted" by faster-moving sediment. Lighter, more-easily transported bones have lower levels of abrasion because they move at rates similar to those of other sedimentary particles.

Poster Session IV, (Wednesday)

A NEW SITE OF EOCENE WHALES AND SIRENIANS IN EGYPT

VAN VLIET, Henk Jan, Altrecht, Utrecht, Netherlands; ABU EL KHAIR, Gebely, EEAA Qaroun Protected Area Office, Shakshouk, Egypt

We report the discovery a new and extraordinarily rich fossil site in Tibaghbagh, in the Western Desert of Egypt, yielding late Eocene archeocetes and sirenians. With the possible exception of Khashm el-Raqaba in Wadi Tarfa, this is the first new fossil site in Egypt where a significant number of Eocene marine mammals has been found in more than a century. At this stage, only a preliminary assessment has been made without systematic excavations, but already some 75 (semi)-articulated skeletons have been documented.

Thibaghbagh is located near Siwa, 360 km west of the UNESCO World Heritage site of Wadi el Hitan in the Fayum Region. Its fauna bears strong resemblances with this famous place; a comparable age is likely (latest Bartonian and earliest Priabonian). About 20 partial skeletons of *Basilosaurus (Zeuglodon) isis* have been identified so far, as well as remains of small archeocetes (possibly *Dorudon atrox*) and other vertebrate (sharks, crocodiles, turtles). There are, however, also marked differences; at Tibaghbagh about 40% of the bone clusters are remains of sirenians. In Wadi el Hitan it is only 6%. The presence of teeth of large sharks and *Nautilus* shells suggests a different depositional setting in comparison with Wadi el Hitan.

Another parallel, however, with the Fayum Region, i.e. Birket Qarun, is found by the nearby presence of a stratum with fossil land mammals (*Palaeomastodon,* hyraxes*,* anthracotheres), presumably late Eocene or early Oligocene in age.

Technical Session I, Sunday 8:15

A DISTINCT DINOSAUR LIFE HISTORY?

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Five factors, 1) mobile terrestrial lifestyle, 2) oviparity, 3) parental care, 4) multi-year maturation, and 5) sociality of juvenile non-breeders, are hypothesized to contribute to a distinct life history for Mesozoic dinosaurs in comparison to extant archosaurs and mammals. The evidence supporting these five attributes is reviewed within a phylogenetic context. An upright, para-sagittal gait reflects several synapomorphies of the Dinosauria, and a terrestrial active lifestyle appears universal for nonavian dinosaurs. Wide histologic sampling suggests multi-year maturation typified dinosaurs across a wide range of body sizes and taxa. Fossil evidence for oviparity, parental care, and juvenile sociality consists of exceptional associations of combinations of adults, juveniles, embryos, eggs or traces. Assemblages supporting immature sociality exceed those for both oviparity and parental care. Implications of these factors include: temporal segregation of adults for an extended, perhaps months-long reproductive cycle; spatial separation of adults and perhaps hatchlings to suitable nesting sites; an increased likelihood for territoriality; reduced potential for long migrations; intraspecific niche segregation by age; population and community structure; and possibly macroevolutionary patterns. Recognition of oviparity, parental care, and juvenile sociality depends upon accurate interpretation of fossil localities and thus emphasizes the importance of bonebeds and taphonomy in understanding dinosaur reproduction and life history strategies. Oviparity and parental care, both predicted for dinosaurs by their extant phylogenetic bracket, have the least support from fossil evidence and cautions against overextending parsimonious interpretations to extinct taxa with the risk of obscuring novel or intermediate behaviors. Consequently, given the great diversity of Mesozoic dinosaurs, the proposed life history is hypothesized to represent only a general tendency.

Poster Session III, (Tuesday)

THE OLIGOCENE AND MIOCENE SIRENIAN FAUNA OF PUERTO RICO: REVIEW AND NEW ADDITIONS

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Fossil sirenians collected from several Oligocene and Miocene localities in the northern part of the island of Puerto Rico provide additional information about their evolution and diversity in the Western Atlantic and Caribbean (WAC) region. Cranial and postcranial material from the early Oligocene San Sebastian Formation represents a halitheriine dugongid, evidently a species of *Metaxytherium*. It is very similar to cranial material from the early and late Oligocene of the east coast of North America. Altogether, these represent the earliest species assignable to *Metaxytherium* and suggest that this Miocene-Pliocene Old and New World genus originated in the WAC during the Oligocene. Additional cranial and postcranial material collected from the late Oligocene Lares and Montebello limestones represents a dugongine very similar to *Dioplotherium* spp. from North and South America. However, the Lares dugongine also displays plesiomorphic characters not observed in *Dioplotherium* spp. or in most post-Oligocene dugongines. Postcranial material referred to the Lares dugongine shows that this species had ribs and vertebrae that are osteosclerotic (dense), but not pachyostotic (swollen) like those of other dugongids. Additional fossils, a mandible and a scapula from the late Oligocene Mucarabones Sand, appear to represent a halitheriine and a dugongine respectively. The scapula differs from other known sirenian scapulae in having a very short neck. Ribs and vertebrae from the early Miocene Cibao Formation are comparable to *Nanosiren* spp. and might represent an early species of this dugongine genus. A mandible previously reported from the Cibao Fm., formerly designated as *Metaxytherium* cf. *M. calvertense*, is reassigned as Dugonginae gen. et sp. indet. The dental formula of ?*Halitherium antillense* is re-interpreted based on the current understanding of sirenian tooth homologies. With the addition of these new reports, the fossil sirenian fauna of Puerto Rico is now nearly doubled, demonstrating how important this region is for the progress of our understanding of sirenian evolution and diversification.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 10:15

TAIL AUTOTOMY IN THE FOSSIL RECORD: NEW INFORMATION ABOUT VOLUNTARY TAIL LOSS IN CAPTORHINID REPTILES

VICKARYOUS, Matthew, University of Guelph, Guelph, ON, Canada; REISZ, Robert, University of Toronto at Mississauga, Mississauga, ON, Canada; MODESTO, Sean, Cape Breton University, Sydney, NS, Canada; HEAD, Jason, University of Toronto at Mississauga, Mississauga, ON, Canada

Many lizards are able to voluntarily self-detach or autotomize a portion of the tail as a predation avoidance strategy. Various anatomical adaptations are associated with tail autotomy, including a specialized joint that transversely partitions the caudal vertebra and permits controlled breakage of the skeleton. Similar intravertebral joints have been reported in a number of Paleozoic and Mesozoic reptiles, but to date none have been investigated in detail. The oldest known reptiles to which caudal autotomy has been ascribed are captorhinids and mesosaurs of the Early Permian. Whereas recent research on mesosaurs indicates that these reptiles did not have fracture planes facilitating tail autotomy, it has long been established that intravertebral joints are present in the captorhinid genera *Captorhinus* and *Labidosaurus*. We present new data on the intravertebral joints of small captorhinids (cf. *Captorhinus* sp.) from the Richards Spur fissure-fill locality of Oklahoma. The autotomous vertebrae form a short series in the middle portion of the tail and are absent from the proximalmost and distalmost segments. Where present the intravertebral joint divides the centrum but not the neural arch, suggesting that the latter structure is fractured during autotomy. Among modern lizards, progressive fusion and loss of the intravertebral joint often occurs during ontogeny, and in each vertebra fusion begins dorsally at the top of the neural arch and proceeds ventrally. This pattern is similar to the condition seen in the autotomous caudal vertebrae of captorhinids. The presence of intravertebral joints in captorhinids indicates that early in reptilian history (at least by the Sakmarian) the tail had evolved from an indispensible locomotory organ to an expendable appendage. Captorhinids are widely recognized as the most common reptiles in Lower Permian rocks of the American southwest. Indeed, captorhinids are usually locally abundant (e.g., Richards Spur, McCann Rock Quarry, Mitchell Creek) where they occur in Texas and Oklahoma. We propose that caudal autotomy was a key factor in the ecological success of these early reptiles.

Technical Session IV, Sunday 1:45

PRELIMINARY DESIGNATION OF MARINE TETRAPOD TAPHOFACIES

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Comparable marine sedimentary features observed from late Paleozoic strata through modern day deposits indicate that the gamut of marine sedimentary processes (e.g., beach development, storms, animal-sediment interactions) has remained roughly constant for at least the last 300 Ma. Thus, the variety of taphonomic processes impacting vertebrate remains is expected to be similar over this interval and different marine tetrapod clades should have comparable subaqueous weathering patterns. To test this hypothesis, we reviewed 47 taphonomic studies of mesosaur, ichthyosaur, plesiosaur, mosasaur, and marine mammal bone accumulations ranging from the Permian to the Recent to determine if they have comparable taphonomic characteristics. Three distinct taphofacies were identified. The nearshore taphofacies corresponds to wave-influenced, well-oxygenated environments. Bones in this taphofacies are affected by waves, currents, and storms, and are abraded, broken, rounded, sorted and generally dispersed. Moreover, they are often preferentially oriented to the current direction or shoreline. The shelf taphofacies includes deposits from storm-weather wave base to the oxygen minimum zone (OMZ). Low energy and oxygenated bottom waters promote scavenging, epibionts, and microbial activity and, as a result, bones commonly exhibit tooth marks, encrustation, and corrosion. The deep-sea taphofacies includes occurrences below the OMZ to the abyssal plain. Lower oxygen concentrations and higher pressures decrease the diversity of biota utilizing bone nutrients, and bone destruction is primarily the result of corrosion, coupled with the activity of chemotrophic specialists, and possibly *Osedax* worms. Evidence of scavenging and encrustation is low compared to the shelf taphofacies. These taphofacies do not encompass all depositional environments preserving marine tetrapods, but they allow recognition of reworked assemblages that include material derived originally from more than one of these taphofacies. Recognition of distinct taphofacies common to diverse marine tetrapod clades will facilitate assessment of marine tetrapod paleoecology and paleobiology in an isotaphonomic context.

Poster Session IV, (Wednesday)

GEOGRAPHIC VARIATION IN HORN SIZE IN THE IMPALA, *AEPYCEROS MELAMPUS*, WITH APPLICATIONS TO THE AFRICAN FOSSIL RECORD

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The Pliocene Hadar Formation, Ethiopia is well known for its 400 ka record of mammalian (including hominin) evolution. Independent lines of evidence indicate that the youngest part of the formation, the Kada Hadar 2 (KH-2) submember (3.11–2.96 Ma) is the most arid and seasonal environment recorded at Hadar. A significant turnover in the faunal assemblage is noted and, additionally, anagenetic changes in the size of the KH-2 fauna have been suggested. For example, impalas, *Aepyceros* sp. nov., from the KH-2 have the largest basal horn size observed in the Hadar Formation. To determine if horn size increase in the Hadar impalas might reflect changing environmental conditions, this study examined the relationship between horn size, aridity, and seasonality in the geographically and ecologically widespread extant *Aepyceros melampus*. Male horn size from four subspecies of *A. melampus* (n=59) was measured. The specimens were grouped based on their collection locality and data on monthly rainfall for each collection locality was acquired from the Oxford African Climate Model. Five variables were used to quantify aridity and seasonality: minimum/maximum monthly rainfall, average monthly rainfall, coefficient of variation for yearly rainfall, maximum length of any one dry season, and modality pattern (either bimodal or unimodal). Correlations between environmental predictors and horn size were analyzed, as were multiple regressions (forward and backward step-wise). The relationship between rainfall modality, a categorical predictor, and horn size was determined using an ANOVA and Tukey's post-hoc tests. Specimens from localities with a bimodal rainfall distribution (i.e., two rainy seasons) are significantly larger than those from localities with a unimodal distribution ($p < .01$). A significant positive correlation ($p= 0.25$) also is observed for horn size and annual rainfall; that is, specimens from drier habitats have a smaller basal horn size and length than those from wetter climates. The results suggest that increases in seasonality and not simply increasing aridity drove the increase in horn size observed in the youngest impala specimens from the Hadar Formation.

Technical Session X, Tuesday 9:30

FOSSILIZED COLORS OF BIRDS AND OTHER DINOSAURS: IMPLICATIONS FOR UNDERSTANDING THE EVOLUTION OF FEATHERS

VINTHER, Jakob, Yale University, New Haven, CT, USA; D'ALBA, Liliana, University of Akron, Akron, OH, USA; LI, Quanguo, Peking Natural History Museum, Beijing, China; CLARKE, Julia, University of Texas, Austin, Austin, TX, USA; GAO, Ke-Qin, Peking University, Beijing, China

Feathers are complex integumental appendages in birds and their stem groups. Recent discoveries indicate an earlier appearance than theropods in the common ancestor to ornithiscians or maybe even pterosaurs. Studies of the nature of early feathers have primarily been restricted to their shape and distribution. Recent discoveriesindicates the ubiquitous presence of color imparting melanosomes in fossilized feathers. This has interesting implications to further our understanding of the evolution and function of feathers. Melanosomes can provide pigmentary and structural colors, also rigidity to the feather and color patterns provide display and camouflage. The studies of color patterns in the avian stem group therefore have obvious importance for understanding the functional evolution of feathers.

We have used a canonical discriminant analysis to characterize modern bird feather color and found several variables that confidently characterize typical colors that can be determined in fossils. We used this to characterize colors of the Late Jurassic *Anchiornis huxleyi*. The colors and color patterns are clearly useful for display, but other aspects show potential functionality in durability. Plotting feather morphology and observed color patterns in feathered theropods to the inferred phylogeny of dinosaurs suggest a coincident occurence of more complex within-feather color patterns and the appearance of pinnate feathers in pre-aerodynamic dinosaurs. This suggest that a driving force in early feather evolution could be the utility for display rather than aerodynamics subsequent to insulation.

Continued studies of fossil melanosomes and the resulting color patterns will be valuable to understand avian evolution and its colorful history.

Poster Session I, (Sunday)

CHARACTER REINTERPRETATION AND FOSSIL SOFT-SHELLED TURTLE TAXA (TRIONYCHIDAE) WORK TOGETHER TO RECOVER NEW RELATIONSHIPS

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The addition of several fossil taxa to a matrix of extant soft-shelled turtles (Trionychidae) provides a good opportunity to test the effects of character reinterpretations on tree topology. "*Trionyx*" *tritor*, "*T.*" *egregius*, and "*T.*" *serialis* from the North American Eocene Bridger Formation were scored and added to a 76-character matrix. Previously scored North American fossil taxa from the Cretaceous (*Aspideretoides foveatus* and *A. splendidus*), Paleocene (*Hutchemys remedium*, and *H. arctochelys*), and Eocene (*Plastomenus* aff. *thomasii*), were also included in the matrix. Two revisions were made. The first changed characters that coded polymorphism as a single character state into characters that coded each form as a separate character state. This revision allows scores for any taxon with multiple specimens to be polymorphic, while any single specimen can only have one character state. The second revision took the original interpretation of neural reversal along the carapace as a change in neural shape and reinterpreted the character such that "reversal" referred to a switching point in the comparison between neural and costal sutures instead of any particular neural. Revised and unrevised matrices were run through parsimony analysis. Analysis with a revised matrix using only extant taxa did not overturn existing hypotheses about trionychid phylogeny. However, when fossil taxa were added to the revised matrices, several new relationships were recovered among both extant and fossil taxa. These relationships were not recovered when fossil taxa were added to the unrevised matrices. Interestingly, when each revision was tested separately, they recovered trees that were nearly identical to each other, the only difference being a loss in resolution for "*T.*" *tritor* within Trionychini. It is important to note that these revisions do not record new observations, nor do they contradict old data. They use the same observations that older characters use, but change how the observations are coded. Without the addition of fossil taxa, the effects of reinterpreting characters may go undetected.

Poster Session I, (Sunday)

COMPLEX TETRAPOD BURROWS FROM THE TRIASSIC TIMEZGADIOUINE FORMATION (ARGANA BASIN, WESTERN HIGH ATLAS, MOROCCO)

VOIGT, Sebastian, TU Bergakademie Freiberg, Freiberg, Germany; SCHNEIDER, Jörg, TU Bergakademie Freiberg, Freiberg, Germany; SABER, Hafid, Chouaïb Doukkali University, El Jadida, Morocco; KLEIN, Hendrik, TU Bergakademie Freiberg, Freiberg, Germany; HMINNA, Abdelkbir, Chouaïb Doukkali University, El Jadida, Morocco

An occurrence of remarkably abundant, complex tetrapod burrows was recently discovered in fluvial red beds of the middle part of the Timezgadiouine Formation (Aglegal Sandstone Member; T4). Closely associated, well preserved tetrapod footprints assigned to *Chirotherium*, *Isochirotherium*, *Synaptichnium*, *Rotodactylus*, *Rhynchosauroides*, *Procolophonichnium*, and *Apatopus* suggest a Middle Triassic age for the studied horizon. These commonly scratch-marked burrows occur in several discrete layers of interbedded tabular sandstone and sandy siltstone we interpret as sheet-flood and overbank deposits of ephemeral rivers in a generally dry area with periodic or episodic, heavy rainfall. All recorded burrows apparently start from the top of decimetre thick sandstone beds and step down as moderately inclined (10-30°), partially spiral, coiled tunnels to enlarged terminal chambers that are laterally extended in the underlying sandy siltstone. Individual tunnels are usually uniform in cross-section and represent mostly plan-convex structures up to 20 cm in width and 12 cm in maximum height. Slightly sinuous courses (= 35-45 cm; f = 10-20 cm) observed for numerous tunnel segments seems to be a peculiar feature of these systems. Winged to gallery-like extended terminal chambers, some with possibly more than one access, and horizontal clustering of cross-cut burrow segments suggest cohabitant networks of multiple occupants. Based on the architecture and depositional context, the described burrows most likely served as seasonal shelter from environmental extremes. Although similar burrows from Late Paleozoic and Early Mesozoic occurrences have primarily been attributed to therapsid origin we explicitly include procolophonids as potential producers considering some unique burrow features and the local footprint record. However, skeletal fossil remains, which could be used to clarify the systematic position of the potential producers, are unlikely to be recovered from the sandy siltstone burrow fills inasmuch as lamination and lithology indicate somewhat incremental burial by overbank deposits rather than catastrophic flooding.

Technical Session VI, Monday 2:30

THREE MAJOR ASPECTS DESCRIBING THE DIVERSITY OF HYPSODONTY IN MAMMALIAN DENTITIONS

VON KOENIGSWALD, Wighart, University of Bonn, Bonn, Germany

Hypsodonty is a wide spread phenomenon in mammalian teeth, but it lacks a consistent definition and characterization for all tooth positions and/or taxonomic groups. I provide a uniform classification that covers the full range of structural diversity in hypsodont teeth. Hypsodont teeth are defined as higher than wide or long, either in the cheek or in the anterior region. Three major aspects are involved. The first aspect describes the degree that hypsodonty can vary from just reaching hypsodonty to continuous growth. The second aspect describes the relation between tooth eruption and abrasion, separating "internal hypsodonty" and "external hypsodonty". Internal hypsodonty is characterized by equilibrium of the rates of eruption and abrasion (e.g. in molars and rodent incisors), thus the occlusal surface keeps a constant position despite further eruption. In external hypsodonty the growth is not limited by abrasion thus teeth may protrude from the mouth (e.g. canines of carnivores or tusks of elephants). The third and most significant of the three aspects is the timing change during tooth formation (heterochrony). Five ontogenetic phases are defined: 1. formation of the occlusal surface; 2. formation of the side walls; 3. formation of the crown base; 4. dentine formation of the upper most part of the root; 5. diversification of the root. In hypsodont tooth growth one or two of these ontogenetic phases are extended at the expense of all others. *Examples*: In hypsodont elephant molars, phase 1 forming lophs is elongated. The subsequent phases are very short. – In molars of *Equus* the first phase is short and the second phase forming side walls is prolonged. – In some arvicolid molars the duration of this second phase does not end before the animal dies, thus these teeth are euhypsodont. – In rodent incisors the phase 1 and 2 are insignificant, while phase 3 with a differentiated crown base forming a severe dentine tract is dominant. – In xenarthran molars the phase 4 of dentine formation is extended while the phases for enamel formation are reduced. The fossil record supports the reduction of phase 1 to 3 since *Eutatus* still has an initial enamel cap.

Poster Session II, (Monday)

SIRENIAN DIVERSITY IN THE OLIGOCENE OF GERMANY

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Since the establishment of the genus *Halitherium* in the course of the erection of the species *Halitherium schinzii*, sea cow remains from the German Oligocene are usually assigned to this taxon assuming that this is the only sirenian species there.

However, the morphological re-investigation of lower Oligocene sirenians from Germany reveal the existence of a new species. Several finds of localities being extensively sampled for *Halitherium schinzii*, like the Mainz Basin, were revised or described for the first time. While complete skeletons are rare, many isolated or partly associated cranial elements are present. These are often skullcaps consisting of parietal and/or supraoccipital bones, sometimes associated with the frontals and squamosals. Significant differences, especially in the area of the supraoccipital, are documented. Two morphological types can be distinguished. The supraoccipital of type one has a very prominent superficial anatomy. The dorsal margin shows a thick and prominent nuchal crest from which a prominent crown-like external occipital protuberance arises in the median plane. The dorsal surface of the supraoccipital is divided by a prominent median ridge accompanied by two shorter lateral ridges and extends from the protuberance up to two-thirds or more of the supraoccipital height.

Type two has a reduced external occipital protuberance and median ridge. The dorsal margin of the supraoccipital is anteriorly concave in the median plane with a rostrad extending median ridge and protuberance reflecting a completely opposite structure as is in type one.

A skullcap with fused parietal and supraoccipital, which displays a rostrad extending nuchal crest, is known under the name "*Halitherium bronni*". However, this taxon was not considered to be valid until today. The current results indicate that there is support for the presence of two distinguishable morpho-species in the German Oligocene and the validity of "*H. bronni"*. The supraoccipital has never before considered to be diagnostic, but the observations show that this element may contribute to a wider knowledge of intra- and/or interspecific differences in the Sirenia.

Poster Session II, (Monday)

SALT GLAND STRUCTURES IDENTIFIED IN A LATE JURASSIC ICHTHYOSAUR

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Salt glands allow marine reptiles to drink sea water and have been noted on plesiosaurs and marine crocodiles. UW24816 is a large and almost complete opthalmosaurid ichthyosaur skull preserved in three dimensions, but fractured into a series of cross-sectional views. A section anterio-dorsal to the orbits revealed paired structures preserved within the sediment of the skull and these extend posterior to the external nares. The described pockets are subtriangular, bordered by the prefrontal/lacrimal contact anteriorly and by the nasal bones dorsally and suggest preserved paired salt glands.The interior surface of the lacrimal is strongly striated in *Opthalmosaurs* as is the prefrontal/lacrimal contact of this specimen. Striations have been noted on the surface of the preserved casts of salt glands in marine crocodiles. The interior surface of the prefrontal/nasal contact of UW24816 is blunt at the contact suggesting the salt gland structure did not extend internally to the nasal region. The interior and exterior portion of the external nares are intact, and display paired structures of rugose, ridged bone at the posterior border of the external nares on the anterior surface of the lacrimal. The funnel-shaped structures face anteriorly and are probably not involved in breathing nor as a support of a vascular valve. These features may increase drag on the streamline skull of an ichthyosaur and facilitate the removal of excess salt as a concentrated solution via a laterally oriented, post-nares structure that can be flushed with water. The exit point from the gland would have been through a single, short duct as noted in Lepidosauria.The nares in basal ichthyosaurs are dorsally situated, but on derived forms are laterally oriented and split. The orbits are more reduced in basal ichthyosaurs and it has been suggested that salt glands were situated at the parietal/frontal contact. Expansion of the eyes in derived forms may have moved the glands forward to the vomeral/nasal region anterior to the orbit.

Poster Session II, (Monday)

PHYLOGENETIC IMPLICATIONS OF *ARCTOMELES DIMOLODONTUS* USING CRANIAL MORPHOLOGY

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Relationships within fossil Melinae (Carnivora: Mustelidae) have traditionally been difficult to interpret due to the fragmentary nature of most specimens. For example, similarities in the dental morphology of extant genera *Arctonyx* (hog badgers) and *Meles* (Eurasian badger), to that of the extinct *Arctomeles* (woodland badger), have made phylogenetic placement of the latter within the subfamily problematic. *Arctomeles* may in fact represent a common ancestor to *Arctonyx* and *Meles*, however this hypothesis could not be adequately tested given the available material. Consequently, when originally described based on the upper dentition only,little new insight was offered. Subsequently, the recovery of two partial crania from the type locality (Gray Fossil Site of eastern Tennessee) provides an opportunity to revisit the systematic placement of the genus. Both skulls preserve the complete upper dentition allowing direct comparison to the holotype, and in combination, provide details on nearly every portion of the cranium. Of particular importance is the 3D preservation of both auditory bullae on one individual: the left bulla is intact, whereas the right is broken into three sections, affording a detailed examination at the interior. Additionally, a single lower jaw with complete (and unworn) dentition was recovered in direct associating with one of the skulls, providing additional characters for the species. Cladistical analysis utilizing this material provides new insight on the phylogenetic relationships of these badgers.

Poster Session IV, (Wednesday)

INFERRING THE FLIGHT STYLES OF EARLY BIRDS AND FLIGHT EVOLUTION FROM PRIMARY FEATHER LENGTH

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Functional wing length in birds is comprised of the forelimb bones (humerus, ulna/radius and manus) and primary feathers. While research has described the phylogenetic distribution and functional morphology of components of the avian bony wing skeleton, the contribution of feather length to wing length among birds has been largely ignored. Here, we examine the scaling relationship between primary feathers and total arm length (sum of humerus, ulna and manus) in fossil birds from the Mesozoic and show that there are significant differences in the composition of the wing between lineages of basal birds. Primary feathers are significantly shorter in *Archaeopteryx* and enantiornithines than in living birds and Confuciusornithidae. In contrast, although falling within the range of modern birds (Neornithes), primary feathers of *Confuciusornis* are significantly longer than are those of any other Mesozoic fossil bird. Based on outgroup comparisons with non-avian theropods that had forelimb primary feathers, we show that the possession of relatively shorter primary feathers is the primitive condition for Aves. There is also a trend towards a broadening of the range of primary feather length to total arm length ratios, which coincides with the enormous evolutionary radiation and ecological niche diversification at the base of modern birds. Understanding changes in the ratio of primary feather length to total arm length is important because the length of primary feathers relative to the whole wing relates to both flight ecology and performance in birds. Comparison of wing proportions amongst early birds suggests that the early Cretaceous *Confuciusornis*, in particular, had a flight style distinct to other extinct taxa.

Technical Session XVIII, Wednesday 3:15

POLYDACTYLY IN A MESOZOIC SALAMANDER FROM CHINA

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Polydactyly is an aberrant condition in extant tetrapods, and is only rarely documented in the fossil record of the group. With the exception of the earliest Devonian tetrapods, which typically had more than five digits, only a few fossil tetrapods (e.g. members of Ichthyosauria and Hupehsuchia) have been recovered with polydactylous autopodials. Here we report polydactyly in a Middle/Late Jurassic salamander, *Chunerpeton tianyiensis*, a neotenic and

basal member of the crown-group Cryptobranchidae, the clade that also includes the extant giant Chinese salamander. Fossils of the monotypic *Chunerpeton* have been discovered at the type locality of Daohugou in Inner Mongolia, China, as well as from neighbouring areas in Liaoning and Hebei provinces. Among the ca. 200 specimens in the IVPP collection, eleven have extra digits on the manus, the pes, or both. All of these specimens came from localities near Jianping, Liaoning, in strata that can be correlated to the Daohugou fossil bed.It is noteworthy that in fossil tetrapods, polydactyly and other aberrant body plans (e.g., double-head in the Early Cretaceous long-necked aquatic reptile *Hyphalosaurus* from Liaoning) seem to be more often correlated with an aquatic environment. The biased distribution of these phenotypes among terrestrial and aquatic vertebrates may indicate that the aquatic environment is somehow more permissive and less demanding in terms of gravitational support. Besides polydactyly, some *Chunerpeton* specimens from Jianping, uniquely to date, also show polymely (e.g., with an extra leg) and reduction or addition of phalanges. Although polydactyly can result from a malfunction of *Hox* complexes or a single-gene mutation, its asymmetrical occurrences in *Chunerpeton* would require a different interpretation. Comparison with extant polydactylous amphibians suggests that these phenomena may result during the regeneration of injured limbs as a result of parasitic infection, rather than from gene regulation.

Technical Session VI, Monday 2:00

UPDATED ASIAN PALEOCENE MAMMALIAN BIOCHRONOLOGY AND ITS IMPLICATIONS TO INTERCONTINENTAL FAUNAL INTERCHANGE

WANG, Yuan-Qing, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; TONG, Yong-Sheng, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; LI, Qian, Key Laboratory of Evolutionary Systematics of Vertebrates, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Paleocene Asian Land Mammal Ages (ALMA) have been widely accepted to include three ages: the Shanghuan, the Nongshanian, and the Gashatan. Absence of age constraint has hampered the intercontinental correlation as well as the understanding of faunal interchange. Recent investigation in both northern and southern China provided further information to constrain the boundaries of the Paleocene ALMAs. Paleomagnetic study provided evidence to correlate the Shanghuan/Nongshanian boundary with the Chron C27n-C26r transition of the Geomagnetic Polarity Time Scale (GPTS), roughly the Torrejonian/Tiffanian boundary of North American Land Mammal Ages (NALMA), which is supported by a newly measured U-Pb age, 60.76 ± 0.76 Ma, of zircon from a tuff in the lower part of the Datang Member of the Nongshan Formation in the Nanxiong Basin, southern China. The Nongshanian/Gashatan boundary has not been reported at a continuous section. But the Nongshanian strata have been reported to correlate with the Chron C26r, and the major Gashatan mammal horizon occurred in the Chron C25r of the GPTS in the Erlian Basin, Inner Mongolia, China. These limit the range of the Nongshanian/Gashatan boundary. Based on the available paleontological data, the Nongshanian/Gashatan boundary is tentatively placed at the Chron C26n-C25r transition, equivalent to that between Ti4 and Ti5 of NALMA. Given the updated Asian Paleocene mammalian biochronology, some possible mammalian dispersal events can be outlined as follows: 1) At the To2, Asian originated Pantodonta and Mesonychidae dispersed to North America and gave their first appearance there. 2) Carnivora that originated in North America migrated into Asia and first appeared at late Shanghuan, roughly equivalent to To3. 3) At the Ti5, Arctostylopidae dispersed from Asia to North America, while the migrational direction of Dinocerata remains uncertain. 4) At the beginning of Clarkforkian, Asian originated Rodentia and Tillodontia entered the North America, while Coryphodontidae probably migrated into Asia from North America.

Making Connections: The Evolution and Function of Joints in Vertebrates, Tuesday 11:00

HIP JOINT MORPHOLOGY AND HOMINOID EVOLUTION: FROM QUADRUPEDAL TO SUSPENSORY TO BIPEDAL LOCOMOTION

WARD, Carol, University of Missouri, Columbia, MO, USA; HAMMOND, Ashley, University of Missouri, Columbia, MO, USA; PLAVCAN, J. Michael, University of Arkansas, Fayetteville, AR, USA; BEGUN, David, University of Toronto, Toronto, ON, Canada; KORDOS, László, Geological Institute of Hungary, Budapest, Hungary

The evolution of hominoids was characterized by diversification in positional behavior and its associated morphology, but the nature and timing of the transitions in locomotor adaptation remain incompletely understood. The various forms of below-branch arboreality characteristic of extant ape lineages may have evolved partly as homoplasy among lineages, impacting reconstructions of the locomotor adaptations of the last common ape-human ancestor.The hip joint is a key indicator of posture and locomotion, yet has been represented in the pre-hominin hominoid fossil record only by *Proconsul nyanzae* (18 Ma), and the crushed pelvis of the autapomorphic *Oreopithecus bambolii* (7-9 Ma). However, a new partial pelvis of a likely sister taxon to the African ape and human clade, *Rudapithecus hungaricus* (10 Ma), provides new evidence of locomotor evolution with hominoids, which in turn has implications for understanding hominin origins.Unfortunately, this specimen is missing the cranial portion of the ilium and ischial tuberosity, and most of the ischiopubic ramus and pubis. Therefore, we employ novel 3D surface-based analyses of joint form based on laser scan data to compare the *Rudapithecus* fossil to those of extant and extinct anthropoid primates to assess functional anatomy of the hip joint. Here, we assess acetabular size, depth and structure, lunate surface distribution and hip joint orientation to infer variations in hip joint functional anatomy in hominoid evolution.Data suggest that *Rudapithecus* was indeed more orthograde with a more mobile hip than *Proconsul*, supporting the hypothesis that the last common ancestor of apes and humans was adapted for climbing and suspension, albeit not as morphologically specialized as the larger extant great apes. *Rudapithecus* lacked the deep acetabulum of extant African apes and the caudally-directed acetabulum of committed bipeds. Reorientation of the hip joint and modification of the sacrum with the evolution of committed bipedality in *Australopithecus* further altered the structure of the entire pelvis, but these changes do not appear to have characterized the Pliocene hominoid *Ardipithecus ramidus*.

Poster Session IV, (Wednesday)

TAXONOMIC REVISION OF LATE MIOCENE HIPPARIONS (EQUIDAE, PERISSODACTYLA) FROM THE EX-USSR REGION - THEIR WIDE GEOGRAPHIC DISTRIBUTION

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Groups of tridactyle horses, hipparions, are widely distributed in the Old World and North America in the late Miocene period. Although hipparions in local areas have been studied and new taxa erected, the taxonomic comparison among those areas has not been given. Hipparions of the mammalian fauna from the northern shore of the Black Sea region (Moldova and Ukraine) and inner Asia (Kazakhstan, Khirghis, and Mongolia) were compared with the well-known taxa from Greco-Iranian and Northern Chinese areas. Such hipparions from ex-USSR regions are especially important for reconstruction of phylogeny of hipparions and biogeographic discussion of Eurasian mammalian faunas in the Late Miocene. Four taxonomic groups are recognized in the hipparion specimens from those areas. They are: *Hipparion giganteum* group with large size and well developed oval preorbital fossa (POF); *H. moldavicum* group with medium to small size, well developed large POF close to the orbit; *H. verae* group with medium size and shallow POF far from the orbit; *H. urmiense* group with medium to large size and reduced POF close to the orbit. All of those groups are also recognized in the late Miocene faunas in Northern China and Greco-Iranian regions. This suggests that the there are two evolutionary phenomena that happened in the hipparions: wide geographic dispersal (immigration) and endemic specialization in each area. The specialized hipparions are *H. matthewi*, *H. proboscideum* (from Greece and Inner Asia), and *H. dermatorhinum* (from China). These phenomena are closely related with environmental change (increase of aridity) of the period in Eurasia.

Technical Session XVII, Wednesday 2:30

A LARGE SHORT-SNOUTED DROMAEOSAURID (THEROPODA: MANIRAPTORA) FROM INNER MONGOLIA

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Large-bodied dromaeosaurids with body lengths in excess of three meters are relatively rare in a family that is now the most diverse among nonavian maniraptoran theropods. Previously known large-bodied dromaeosaurids include two poorly known genera, *Utahraptor* from the mid Cretaceous Cedar Mountain Formation of North America and *Achillobator* from Upper Cretaceous (Cenomanian-Santonian) Bayan Shireh Formation of Outer Mongolia. We describe a new large bodied dromaeosaurid from the Upper Cretaceous (Cenomanian) Ulansuhai Formation in western portion of the Inner Mongolian Autonomous Region of northern China. Cranial bones include the premaxilla, maxilla, lacrimal, frontal, postorbital, quadrate, and ectopterygoid; and postcranial bones include the atlantal intercentrum, a mid dorsal neural arch and a complete ischium. Although 25% smaller than *Achillobator*, the disarticulated neural arch indicates that the individual was not mature. Recomposing the known cranial elements shows that the snout is relatively short and deep. Like *Utahraptor*, the lacrimal is strikingly primitive, with a transversely flattened ventral ramus. Likewise, the dorsomedial process of the postorbital arches onto the dorsal surface of the skull roof. A deep sagittal crest extending onto the frontals and an unusual hourglass-shaped hyposphene-hypantrum articulation in the dorsal vertebrae are among several outstanding autapomorphies. The ischium, which closely resembles that of *Achillobator*, has a deep, pendant obturator process, deeply arched posterior margin of the obturator foramen, and well developed pubic and iliac processes. Phylogenetic analysis tentatively links the new taxon with *Dromaeosaurus*, from the Upper Cretaceous (Campanian) of North America, and with the aforementioned large-bodied genera, *Utahraptor* and *Achillobator*. These findings suggest that there may have existed for much of the Cretaceous a basal clade of large-bodied, relatively short-snouted dromaeosaurids that gained a distribution in both western North America and central Asia.

Poster Session III, (Tuesday)

MARSUPIALS AND INSECTIVORES FROM THE OLIGOCENE OF SOUTHWESTERN NORTH DAKOTA FROM A PREVIOUSLY UNDESCRIBED COLLECTION FROM THE PIONEER TRAILS REGIONAL MUSEUM

WEILER, Matthew, University of North Dakota, Grand Forks, ND, USA; SCHUMAKER, Karew, University of North Dakota, Grand Forks, ND, USA; PEARSON, Dean, Pioneer Regional Trails Museum, Bowman, ND, USA

In the fall of 2008, a project was started in cooperation between the University of North Dakota (UND) and the Pioneer Trials Regional Museum (PTRM) in Bowman, North Dakota. The fossils for this study were collected from White River Group sediments in southwestern North Dakota and are curated within the PTRM collections. Over 2000 White River Group specimens are present in the PTRM collection representing a diverse assemblage containing fish, reptiles, and mammals. The PTRM White River collection includes approximately 75 specimens representing marsupial and insectivore taxa. These specimens are primarily from the Brule Formation, although some specimens have been recovered from the Arikaree Formation. Fossils from the Chadron Formation in North Dakota are extremely rare, with no insectivores reported in this collection. At present, seven species have been identified from the PTRM White River Group specimens. Two marsupial taxa are present, *Herpetotherium* sp., and cf. *Peradectes* sp. Insectivores include: *Leptictis* sp., *Ankylodon progressus*, *Centetodon marginalis*, *Domnina gradata*, and cf. *Proscalops* sp. To date, this project is the most detailed and comprehensive study of the Oligocene insectivores in North Dakota. Besides adding to the general knowledge of Oligocene insectivores, *Ankylodon progressus*, *Domnina gradata*, and cf. *Proscalops* sp. are first occurrences in North Dakota and represent biogeographic range extensions. This study will provide a basis to compare the Oligocene diversity in North Dakota with that of other Oligocene Northern Great Plains localities. Also, this study provides support and corroboration with earlier studies as to the Orellan age designation of the Brule Formation in North Dakota, especially with occurrence of the Orellan index taxon *Ankylodon progressus*.

Poster Session I, (Sunday)

A NEW VERTEBRATE FOSSIL LOCALITY IN THE UPPER TRIASSIC CHINLE FORMATION OF NORTHEASTERN ARIZONA

WEINBAUM, Jonathan, Southern Connecticut State University, New Haven, CT, USA; MARTZ, Jeffrey, Petrified Forest National Park, Petrified Forest, AZ, USA

A new and important fossil locality was discovered on private land just outside of the Petrified Forest National Park in northeastern Arizona during the 2009 summer field season. This collaborative effort between Southern Connecticut State University and the Petrified Forest National Park discovered a previously undocumented Triassic fossil site within the Sonsela Member of the Chinle Formation. The abundance of pedogenic carbonate nodules and unionid bivalves, the presence of yellowish sandstones and light blue-gray mudstones, and the presence of a thick sequence of monotonous purple mudstone just above the localities, all suggest that they lie in the Martha's Butte beds in the uppermost Sonsela Member, with an age probably between 215-210 Ma. The fossiliferous strata are two gravelly, yellowish sandstone layers with abundant unionids, indicating a freshwater stream or river environment. These layers produced at least five vertebrate taxa, including skeletal elements of metoposaurs, phytosaurs, aetosaurs, "rauisuchids" including *Postosuchus* and dinosaurs. Phytosaur and aetosaur material referable to the taxa *Pseudopalatus* and *Typothorax* indicate a Revueltian age for the localities, consistent with their referral to the Martha's Butte beds, and the site contains the only known occurrence of a theropod at this stratigraphic level in northeastern Arizona. A partial phytosaur skeleton including a complete skull was discovered and still awaits retrieval. This site is important as it expands our knowledge of Triassic vertebrates and the environments they lived in as well as how changing environments affected the evolution and extinction of various taxa.

Technical Session XI, Tuesday 4:00

WHAT ARE WE MISSING?: GEOLOGICAL COMPLETENESS OF PALEONTOLOGICAL SAMPLING IN THE TERRESTRIAL CENOZOIC OF NORTH AMERICA

WEINSTEIN, Deborah, University of Wisconsin-Madison, Madison, WI, USA; HEIM, Noel, University of Wisconsin-Madison, Madison, WI, USA; PETERS, Shanan, University of Wisconsin-Madison, Madison, WI, USA

Paleontologists study evolution based on physical evidence preserved in the fossil record, which varies in its fidelity due to unequal sampling and the vagaries of preservation. Recent analyses of the geological completeness of the North American fossil record documented a long-term increase in completeness during the Phanerozoic. The extent to which marine vs. terrestrial completeness differs and varies over time remains, however, unknown. Using the Macrostrat Database (MD; a comprehensive geologic compilation for the entire continent, including lithologic and depositional information for most known lithostratigraphic units) and the Paleobiology Database (PBDB; fossil collections with taxonomic and geologic data), we measured the geologic completeness of paleontological completeness in the Cenozoic of North America. The total number of lithostratigraphic units and gap-bound terrestrial sediment packages remains largely stable during the Cenozoic until the Pliocene, when the total number increases substantially. The contrast between the marine and terrestrial Cenozoic sedimentary records suggests that much of the volatility in total geologic completeness is due to variability in the marine record. Geological completeness of paleontological sampling in the terrestrial fossil record is approximately 35% for lithostratigraphic units and ~45% for gap-bound sediment packages. For comparison, mean Phanerozoic completeness for the entire fossil record is approximately 22%. To determine the cause of geological incompleteness in the terrestrial fossil record, we generated a list of all the named formations in MD that do not have any PBDB collections matched to them, and then performed a literature search for fossil data on a random sample of those formations. Preliminary analysis indicates that between 47% and 68% of the named formations without any fossil collections in the PBDB have literature sources that have not yet been entered into the database. Our results have important implications for understanding the history of terrestrial evolution in North America and for helping to accelerate the pace at which the PBDB can acquire truly new paleontological information.

Poster Session III, (Tuesday)

DIVERSITY OF CAUDAL FIN MORPHOLOGY IN LOWER TRIASSIC COELACANTHS FROM BRITISH COLUMBIA, CANADA

WENDRUFF, Andrew, University of Alberta, Edmonton, AB, Canada; SCOTT, Bradley, University of Alberta, edmonton, AB, Canada

Coelacanths first appear in the fossil record in the Upper Devonian and were cosmopolitan throughout much of their fossil record. Coelacanths have been known from the Lower Triassic Sulphur Mountain Formation in British Columbia since 1976. Within this formation, there is a broad range of morphological diversity in coelacanth caudal fins. We observed three distinct tail morphologies amongst the coelacanths of the Sulphur Mountain Formation: a general broadly, rounded *Latimeria*-like tail, a forked tail, and a longer, rounded tail with a broad, extended supplementary lobe. This diversity remains undescribed to this day. Little is known about how coelacanths used their tails which exhibit a wide array of morphologies in the fossil record. Most coelacanth tails have broad, rounded dorsal and ventral lobes. Between these is a supplementary lobe, a small terminal fin that varies in length and size among taxa. Based on direct observations of modern coelacanths (*Latimeria*), we know that they are slow moving, only using the caudal fin for rapid acceleration to catch prey. The new forked-tailed coelacanth is interpreted as being a relatively active, fast predator, while the other two morphologies suggest ambush predator lifestyles. The fin rays of the forked-tailed coelacanth are mostly unsegmented, a feature that likely stiffened the tail. The wide span of the fin and the unsegmented fin rays suggest a stiff, high aspect ratio tail adapted for rapid swimming that has not been previously attributed to coelacanths. In the other two morphologies, the aspect ratio is much lower. These tails have segmented fin rays as in the majority of coelacanths. The segmented fin rays create a more flexible tail that allows for greater acceleration from rest. These differences in caudal fin morphology denote a more diverse locomotory repertoire than was previously known in coelacanths supporting the idea that morphological diversity peaked in the Early Triassic.

Evolution of the Modern African Fauna, Wednesday 11:45

HOW ADEQUATE IS THE NEOGENE FOSSIL RECORD OF AFRICA? AN ANALYSIS BASED ON CARNIVORA

WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden; PEIGNÉ, Stéphane, Museum National d'Histoire Naturelle, Paris, France

The known African Neogene fossil record has expanded enormously in the past 30 years. Thus, its quality must have improved. But is it then adequate for analytic work on long-term trends in e.g., richness, extinction, and other evolutionary phenomena? We have compiled data on occurrences of Carnivora in the African Neogene record. Carnivores, though never common, are useful in this context because of their species richness and because they are readily identifiable at least to family levelfrom quite small fragments. Our compilation shows the record to have increased from ca 300 occurrences in 1978 to over 1000 today. It is well known that the data are geographically biased, but how biased are they temporally? We binned the data into 1 Ma bins and analyzed richness, originations, and extinctions over the past 20 Ma. The results of these analyses were compared to the available record (here defined as the number of localities sampled) in each time slice. Regressing diversity against number of localities shows that the number of taxa per time slice is almost entirely explained by the number of localities available ($r^2 = 0.84$ for raw data). Thus, the diversity curve as a whole is largely a reflection of sampling effort. However, the residuals from this regression still provide interesting, seemingly true, signals. For example, the 7-6 Ma time slice has a much greater and the 20-19 Ma time slice a lower than expected richness given the number of localities. It is encouraging that neither per capita originations nor extinctions are significantly correlated with number of localities. The absolute values of these parameters may be influenced by regression to the mean, but the fluctuations around the mean are still of significant interest, especially as their distributions differ in a way expected for originations and extinctions. Thus, although the record is still not adequate, we are cautiously optimistic that some phenomena can be validly analyzed today and that the record is improving so that more detailed analyses will be possible in the near future.

Technical Session VII, Monday 1:45

RECONSTRUCTING THE ONTOGENY OF THE TRIASSIC BASAL ARCHOSAUROMORPH *TRILOPHOSAURUS* USING BONE HISTOLOGY AND LIMB BONE MORPHOMETRICS

WERNING, Sarah, University of California, Berkeley, CA, USA; IRMIS, Randall, University of Utah, Salt Lake City, UT, USA

Despite extensive research on the evolution of bird-line archosaur growth strategies, the basal condition for archosaurian growth rates, bone histology, and ontogenetic changes in surface morphology remain undescribed. The basal archosauromorph *Trilophosaurus buettneri* is well-known from hundreds of individual elements from a monodominant bonebed near Otis Chalk, Texas, in the lower portion of the Upper Triassic Dockum Group. This large sample size across multiple ontogenetic stages presents an unusual opportunity to examine the growth strategy of a proximal outgroup to Archosauria. We measured over 300 humeri,

ulnae, femora, and tibiae across all sizes of *Trilophosaurus*, and constructed allometric growth curves for each element. Increases in the robusticity of muscle attachments and epiphyses generally do not occur until at least 2/3 total adult length for most bone features, several years after hatching. Furthermore, we histologically sampled ontogenetic series of femora and tibiae, as well as a representative adult ulna and humerus, and constructed growth curves for the hindlimb elements based on histological data. Throughout ontogeny, *Trilophosaurus* bone histology is characterized by a lamellar tissue organization, low-to-moderate levels of vascularity, and radially-organized simple longitudinal canals with few anastomoses. Osteocytes occur at moderate levels, but they are always well-organized in rows along the lamellae. We found growth lines (sometimes double or triple lines) in some of the smallest specimens we sampled, and external fundamental systems in the largest specimens (indicating cessation of skeletal growth). The growth curves and bone histology suggest slow growth throughout ontogeny for *Trilophosaurus*, and that the high growth and bone deposition rates achieved by more derived archosaurs are not characteristic of all members of Archosauromorpha. Our results help characterize the basal condition for growth, bone histology, and limb ontogenetic morphology for Archosauria.

Poster Session III, (Tuesday)

FIRST OCCURRENCE AND SIGNIFICANCE OF *MAHGARITA STEVENSI* IN A LATE MIDDLE EOCENE (LATE UINTAN) TETHYAN-INFLUENCED GULF COAST COMMUNITY

WESTGATE, James, Lamar University, Texas State University System, Beaumont, TX, USA; COPE, Dana, College of Charleston, Charleston, SC, USA; BEARD, K. Christopher, Carnegie Museum of Natural History, Pittsburgh, PA, USA

Mahgarita stevensi is here reported for the first time in the late middle Eocene (late Uintan) Casa Blanca community from the Laredo Formation in Laredo, Texas, based on a nearly unworn right M2. *M. stevensi* is a cercomiine adapid primate which displays traits of middle Eocene European (*Europolemur*, Germany) and late Eocene Egyptian (*Aframonius*, Fayum) adapids rather than typical North American notharctids. It has been reported previously from early Duchesnean strata in the Devil's Graveyard Formation (DGF), Brewster County, Trans-Pecos, Texas. Earlier workers suggested *Mahgarita* entered the Trans-Pecos region following colonization of a hypothetical area in eastern North America after dispersal from the Old World. The presence of *M. stevensi* in the Casa Blanca community suggests a more specific dispersal route. Associated taxa such as *Nypa* (Old World mangrove palm), cf. *Allaeochelys* (carretochelyid turtle from the European Eocene including Messel, Germany), *Pterosphenus* (giant snake known from the Tethyan Fayum region), *Galeocerdo eaglesomei* (tiger shark), *Diaphyodus* (wrasse), and an unnamed megalopid (tarpon), indicate the coastal Texas community had significant Tethyan influences. Although the Gulf Trough and Suwanee Straits of Florida and Georgia were barriers to some benthic and stenohaline Tethyan marine species which ranged west to the carbonate banks of Florida, the Gulf Trough would not have blocked euryhaline and arboreal species which dispersed westward via Gulf Coast estuaries. The appearance of *Mahgarita* on the Texas coast suggests it used a coastal route to colonize New World lowland tropical rain forests and estuarine mangroves. *Notharctus* is known from the early Uintan-age Lower Member of the Devil's Graveyard Formation, but no notharctine primates are known from late Uintan or Duchesnean strata of the DGF. *Mahgarita*'s presence in the late Uintan Casa Blanca fauna and in the early Duchesnean Bandolera Mesa Member of the Devil's Graveyard Formation, suggests that *Mahgarita* may have occupied the vacated adapid ecologic niche of *Notharctus*.

Romer Prize Session, Monday 11:45

EVOLUTION OF SALT-WATER TOLERANCE IN THE CROCODYLIA AND RELATED CROCODYLOMORPHS: NEW INSIGHTS FROM STABLE ISOTOPES

WHEATLEY, Patrick, University of California, Santa Cruz, Santa Cruz, CA, USA

Nearly all populations of living crocodylians are limited to freshwater habitats. However, many extant crocodylians have demonstrated a physiological ability to tolerate and/or excrete excess salt derived from drinking saline water in laboratory experiments. These experimental results suggest that long distance oceanic dispersals may have been important drivers of crocodylian paleobiogeography. Some researchers have even suggested that a marine ancestor gave rise to crown clade crocodylians, however these claims remain speculative.

To address the issue of salt-water tolerance among extinct crocodylomorphs, I first characterized the oxygen and carbon isotope composition and variability of modern reptile taxa that ranged from salt-water to freshwater habitats. Oxygen and carbon isotopic compositions proved distinct among salt-water and freshwater adapted species and provided a framework by which to distinguish the salt-water affinities of extinct taxa. Extinct crocodylomorphs from coastal deposits were then analyzed for isotopic composition and interpreted in this framework. Results indicate that Crocodylia likely originated as a salt-water tolerant clade. Furthermore, these data suggest that certain crocodylian grades were highly dependent on marine resources. The stable isotope compositions of dyrosaurs, which are close relatives of crocodylians, demonstrate an even greater dependence on marine environments. In addition, data from this study lend support for a recent theory that seeks to resolve the survivorship of marine adapted dyrosaurids accross the K-T boundary, when other marine reptiles went extinct. Taken together, these results have implications for past biogeography of the crown clade and figure into discussions regarding the phylogeny and origin of salt-water tolerance in the crocodyliforms.

Poster Session IV, (Wednesday)

WHO'S TRASH STASH? USING GEOMETRIC MORPHOMETRICS TO DIFFERENTIATE BETWEEN *NEOTOMA* MOLARS FOUND IN PALEOMIDDENS

WHITEMAN, Shawn, University of New Mexico, Department of Biology, Albuquerque, NM, USA; SMITH, Felisa, University of New Mexico, Department of Biology, Albuquerque, NM, USA

Neotoma leave behind environmental records in the form of paleomiddens. These middens, found in dry caves, commonly contain plant macrofossils, fecal pellets, pollen, archeological artifacts, and skeletal material. As long as the middens remain dry, they are preserved by crystallized urine for tens of thousands of years. In our lab, we use the fecal pellets in the middens to determine the size of the animal, which correlates well with environmental temperature. However, this method is only effective if we are confident what species created the midden. We use molars found in the middens in order to confirm our identification of species. In this study, we photographed *Neotoma* molars from the collections of the Smithsonian Institution, National Museum of Natural History, Division of Mammals. We included 396 individuals from nine species of *Neotoma*, plus a sister species. We used both outline and landmark methods of geometric morphometrics to discriminate between species in this dataset. Disparate species, such as *N. cinerea* and *N. lepida*, are easily distinguished using only landmarks. However, as more species are considered, more detail is required to differentiate species. We used these criteria to identify molars found in middens from Death Valley, CA, and compare this to using size to distinguish between species.

Technical Session XIV, Wednesday 8:30

TRENDS IN SAUROPOD TOOTH SIZE, SHAPE AND REPLACEMENT RATE

WHITLOCK, John, University of Michigan, Ann Arbor, MI, USA; D'EMIC, Michael, University of Michigan, Ann Arbor, MI, USA; FISHER, Daniel, University of Michigan, Ann Arbor, MI, USA; SMITH, Kathlyn, University of Michigan, Ann Arbor, MI, USA; WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA

Sauropods evolved from small, bipedal omnivores (e.g., *Panphagia*). Over time these basal sauropodomorphs became more reliant on herbivory and achieved larger body sizes, eventually becoming obligate quadrupeds. With this increase in body size and dietary shift came an increase in tooth wear, which reduced dental effectiveness. Sauropods responded to increased tooth wear by increasing crown volume and/or increasing tooth replacement rate. Here, we present data describing both responses and place them in a temporal and phylogenetic context. Replacement rate data are based on histological study when possible. In all other cases rate is approximated using a proxy, the height-corrected ratio (HCR), calculated as: (average height ratio of successive teeth in a family) * (1 cm / maximum tooth height in cm). Higher HCR scores indicate less time between tooth formation events and correspond to faster replacement rates. Basal sauropodomorphs (e.g., *Plateosaurus*) had low-crowned, leaf-shaped teeth and one replacement tooth per family. Spatulate tooth crowns with greatly increased volumes (~5x that of *Plateosaurus*) evolved in basal sauropods (e.g., *Tazoudasaurus*), which were more resistant to wear but resulted in slower replacement (HCR ~0.2) in these taxa. Replacement rate first increased in more derived eusauropod taxa on the stem leading to Neosauropoda (e.g., *Mamenchisaurus*). These taxa possessed up to two replacement teeth per family and higher HCRs (~0.4). A second increase in replacement rate occurred in Late Jurassic neosauropods. These taxa (e.g., *Camarasaurus*, *Diplodocus*) are observed to have three or more replacement teeth per family, which were replaced at least every 62 days. Within Neosauropoda, at least two secondary reductions in crown volume occurred, in the clades Diplodocoidea and Titanosauriformes. This reduction in volume (~14% that of spatulate crowns) was coupled with an increase in replacement rate in both instances (HCR 1.2+). Narrow-crowned taxa often have five or more replacement teeth per family; in diplodocoids (e.g., *Diplodocus*), replacement occurred twice as fast (30–35 days) as in spatulate-crowned neosauropods.

Advances in Paleoecology: Geochemistry, Microwear and Beyond, Sunday 9:30

DEFINING THE ECOLOGICAL NICHE OF PROBOSCIDEA AND *BISON* DURING THE LATE QUATERNARY THROUGH STABLE ISOTOPE ANALYSES (MIDWESTERN NORTH AMERICA)

WIDGA, Chris, Illinois State Museum, Springfield, IL, USA

Defining the ecological niche of megafaunal landscape elements is critical to understanding regional scale extinction processes during the terminal Pleistocene. Specifically, climate-induced changes in dietary niche overlap between competing herbivores or the seasonality of food resources could strongly affect the viability of stressed animal populations. This paper presents isotopic data (C, O, Sr) from Midwestern *Mammuthus*, *Mammut*, and *Bison* to understand patterns in late Pleistocene landscape-use of both extinct and surviving taxa. Serial enamel stable isotope samples of *Mammuthus jeffersonii* spanning the last glaciation, and *Bison* from terminal Pleistocene and Holocene contexts exhibit similarities in overall landscape-use. At an evolutionary time-scale both taxa exhibit a flexible niche structure that would be resilient to rapid climate-change events. Dietary niche breadth, as defined by variability in $\delta^{13}C$ at multiple scales (e.g., annual, millennial), is similar between the two taxa. $^{87}Sr/^{86}Sr$ analyses also indicate limited seasonal mobility (<50 km) with somewhat larger inter-annual ranges in both species. Lastly, $\delta^{13}C$ values of bone collagen from Midwestern proboscideans show an increase in inter-taxonomic niche overlap after the last glacial maximum. Although preliminary, these results demonstrate the potential of isotopic research in furthering our understanding of late Quaternary landscapes and extinction processes.

Technical Session VII, Monday 3:45

THE PHYLOGENETIC POSITION OF THALATTOSUCHIA (CROCODYLOMORPHA) AND THE IMPORTANCE OF OUTGROUP CHOICE

WILBERG, Eric, University of Iowa, Iowa City, IA, USA

Crocodyliform evolution spans over 200 million years and includes many major adaptive radiations. The evolutionary history of the group was traditionally based on development of the bony secondary palate through three evolutionary grades: "Protosuchia", "Mesosuchia", and Eusuchia. The earliest phylogenetic analyses supported this progression with "protosuchians" as the basal most members of the clade and the Triassic sphenosuchians as sister to the crocodyliforms. One of the earliest occurring groups of "mesosuchians", Thalattosuchia, was highly adapted to the marine environment. The phylogenetic relationships of this group are contentious—they are recovered in either a basal position or are nested high up in the tree. Thalattosuchians lack several crocodyliform apomorphies, but share several characters with highly derived forms sharing a similar ecological habit, suggesting their derived position may be a result of convergent evolution. A new analysis of broad taxonomic scope recovers the thalattosuchians as sister group to Crocodyliformes outside of the "protosuchians" and all other crocodyliforms. These results suggest that rooting trees on a "protosuchian", as in many previous analyses, may be obscuring basal relationships as well as affecting topology higher in the tree. When previously-published data sets are modified to include non-crocodyliform outgroup taxa, thalattosuchians move outside of Crocodyilformes or into a basal polytomy with the "protosuchians". This illustrates a case where analyses may have been constrained by prior assumptions. The relaxation of these assumptions allows for a more robust test of evolutionary relationships. If thalattosuchians are the sister group to the crocodyliforms, this brings into question traditionally accepted evolutionary scenarios for Crocodyliformes.

Romer Prize Session, Monday 12:00

OSTEOLOGICAL EVIDENCE FOR A TAIL FIN IN CRYPTOCLEIDOID PLESIOSAURS AND THE ROLE OF THE TAIL IN PLESIOSAUR LOCOMOTION

WILHELM, Benjamin, Marshall University, Huntington, WV, USA

The presence of a tail fin in plesiosaurs has been suggested for more than a century, but with little supporting evidence. Recent examination of two exceptionally well preserved caudal skeletons of the cryptocleidoid plesiosaurs *Cryptoclidus eurymerus* and *Muraenosaurus leedsi* has revealed a number of osteological features indicating that a tail fin was present in both taxa. These features include an increase in the height of the posterior caudal neural spines, with long and wide distal ends for articulation with cartilage. There is also a change in neural spine direction, resulting in a continuous surface for articulation of a large cartilaginous element. These cartilaginous extensions of the neural spines could have supported the soft tissues associated with a tail fin. Comparisons to the caudal region of thalattosuchians indicate that a change in neural spine direction is below the highest point of the tail fin, allowing some inference of shape in the plesiosaur fin. In addition to features indicating the presence of the fin, other vertebral features indicate the function of the tail during locomotion. Antero-posteriorly compressed centra with rounded edges and short caudal ribs at the base of the tail indicate increased flexibility in this region. Flexibility is also increased just before the start of the tail fin by the loss of interlocking zygapophyses. This pattern of flexibility is nearly identical to that seen in cetaceans that have two joints in the spine; one just below the dorsal fin and one anterior to the start of the tail fluke. An increase in caudal rib length between these two regions of flexibility in the plesiosaur is similar to the increase in chevron length between the two joints in whales. These long processes are muscle attachments in the plane of the direction of movement. Taken together, these data strongly suggest that the tail was involved, along with the limbs, in active thrust production during plesiosaur locomotion. This study is the first to document clear osteological evidence for a tail fin in plesiosaurs, and to infer its function via comparison to modern analogs.

Poster Session IV, (Wednesday)

APPENDICULAR JOINT RECONSTRUCTION IN SAUROPOD DINOSAURS BASED ON COMPUTED TOMOGRAPHY OF A MAMMAL, A BIRD AND A CROCODILIAN

WILHITE, Ray, Auburn College of Veterinary Medicine, Auburn, AL, USA; BONNAN, Matthew , Western Illinois University, Macomb, IL, USA; SANDERS, Richard, University of Utah, Salt Lake City, UT, USA

The exact nature of the joint surfaces in extinct archosaurs cannot be precisely measured due to the loss of articular and epiphyseal cartilage during fossilization. However, possible modern analogs can be examined and measurements used to generate theoretical joint morphologies. In this study, a preserved adult domestic cat *(Felis catus*), freshly deceased adult chicken (*Gallus gallus*), and a living sub-adult alligator (*Alligator mississippiensis*) were scanned at high resolution using computed tomography. Three-dimensional models of the in situ joint surfaces were rendered to examine the distances between the ossified portions of the appendicular joint surfaces. The relative distance between ossified joint surfaces was used to generate three possible appendicular joint configurations for the North American Upper Jurassic sauropod, *Apatosaurus*. *Felis catus* was used to show a "best case" scenario for joint articulation as the joints of mammals have limited articular cartilage over an ossified epiphysis. The bird analog yielded similar results to the mammal analog, with limited space for cartilage between the closest joint surfaces allowing for a good approximation of the range of motion of the appendicular joints. Conversely, the crocodilian model results in a large space between the ossified joint surfaces and, therefore, greater uncertainty regarding the range of motion in the limbs. As a sub-adult alligator was scanned for this study, adult specimens of deceased alligators were also examined and showed a similar large space between ossified joint surfaces. The vast differences in appendicular joint reconstructions based on these extant taxa shows the importance of choosing the best extant analog when reconstructing fossil archosaur appendicular joints. Further comparison between the ossified joint surfaces of birds and crocodilians with those of sauropods is necessary to determine which, if any, of these models best approximates those of a non-avian dinosaur.

Poster Session III, (Tuesday)

A NEW JUVENILE *TYRANNOSAURUS* AND A REASSESSMENT OF ONTOGENETIC AND PHYLOGENETIC CHANGES IN TYRANNOSAUROID FORELIMB PROPORTIONS

WILLIAMS, Scott, Burpee Museum of Natural History, Rockford, IL, USA; BRUSATTE, Stephen , American Museum of Natural History, New York, NY, USA; MATHEWS, Joshua, Augustana College, Rock Island, IL, USA; CURRIE, Philip , University of Alberta, Edmonton, AB, Canada

Tyrannosaurid theropods, including *Tyrannosaurus* and its closest relatives, are characterized by abnormally atrophied forelimbs. Little is known, however, about the evolution of this unusual feature, or whether small forelimbs were present throughout ontogeny or only in large-bodied adults. A new specimen of a juvenile *Tyrannosaurus* from the latest Maastrichtian Hell Creek Formation of Carter County, Montana helps address these questions. The partial associated skeleton is comprised of dorsal vertebrae, ribs, gastralia, front limb (scapulocoracoid, humerus, ulna, manual unguals) and hindlimb bones (femur, tibia, fibula, pedal ungual). Derived characters support referral to Tyrannosauridae (most likely *Tyrannosaurus*) and histological examination indicates that the specimen was a juvenile when it died. Most notably, several features of the forelimb show marked differences with adult tyrannosaurids. The humerus is longer in relation to the femur and more gracile when compared to adults, and has a slender, blade-like deltopectoral crest. The manual unguals, which include the first relatively complete second ungual described for *Tyrannosaurus*, are enormous. The large humerus and unguals indicate that the entire forelimb was relatively longer than in adults, demonstrating that forelimb proportions exhibited negative allometry during ontogeny. Juveniles, therefore, had larger forelimbs than adults, and the ontogenetic development of atrophied forelimbs occurred in concert with the development of the large, deep, and robust adult skull optimized for strong bite forces. This indicates a behavioral and dietary shift during ontogeny, which has not previously been documented in *Tyrannosaurus*. A similar trend of forelimb reduction is also seen in tyrannosauroid phylogeny. Small-bodied and gracile basal tyrannosauroids, such as *Guanlong* and *Dilong*, possess large arms and hands. Forelimb material is poorly known for most tyrannosauroids intermediate between basal forms and derived tyrannosaurids, but one such taxon, *Dryptosaurus*, has a small humerus but enormous hands, indicating that the proximal limb was reduced first in tyrannosauroid evolution.

Poster Session II, (Monday)

PHYLOGENY OF CRETACEOUS-PALEOCENE METATHERIANS: IMPLICATIONS FOR THE METATHERIAN RADIATION AND SURVIVORSHIP OF LINEAGES ACROSS THE K/PG BOUNDARY

WILLIAMSON, Thomas, New Mexico Museum of Natural History and Science, Albuquerque, NM, USA; BRUSATTE, Stephen, Columbia University, New York, NY, USA; WEIL, Anne, Oklahoma State University Center for Health Sciences, Tulsa, OK, USA

Metatheria experienced a major radiation in North America during the Late Cretaceous but endured a pronounced extinction at the Cretaceous – Paleogene boundary. The pattern of this radiation is poorly understood, but crucial for understanding the origin of Paleogene metatherians and crown group Marsupialia. As a first step to understanding the metatherian radiation and survivorship patterns across the K-Pg, it is necessary to have a robust phylogeny. We conducted a parsimony analysis based on a broad sample of North American, South American, and European Cretaceous and Paleogene metatherians scored for 83 dental characters. The presence of multiple clades that contain both Cretaceous and Paleogene metatherian taxa indicate that several metatherian clades successfully crossed the K-Pg boundary. Although previous workers have suggested that only two major metatherian clades were present in the early Paleogene of North America (Peradectidae and Herpetotheriidae) our analysis suggests the presence of a third major group composed of *Thylacodon* and *Swaindelphys*. This analysis also indicates that the Late Cretaceous, European *Maastrichtidelphys* is closely allied with the 'didelphoids' *Pucadelphys* and *Szalinia* rather than herpetotheriids. A close relationship is also supported between the latest Cretaceous *Glasbius* of North America and the early Paleocene *Roberthoffstetteria* of South America. Our results do not support a close relationship of *Nortedelphys* and Herpetheriidae. Peradectids, and therefore also presumably crown clade Marsupialia, are not known with certainty prior to the Paleocene. However, the lack of an obvious Cretaceous sister taxon to Paleogene metatherian taxa in western North America suggests that earliest Paleocene metatherians ("*Peradectes*," *Thylacodon*) originated elsewhere.

Technical Session IX, Tuesday 8:15

MAMMALIAN EXTINCTION, SURVIVAL, AND RECOVERY DYNAMICS ACROSS THE CRETACEOUS-PALEOGENE BOUNDARY IN NORTHEASTERN MONTANA

WILSON, Gregory, University of Washington, Seattle, WA, USA

The Cretaceous-Paleogene (K-Pg) interval was arguably the most critical transition in mammalian evolution. The well-documented and temporally-constrained succession of vertebrate microfossil localities from the Hell Creek Formation and Tullock Member of the Fort Union Formation of Garfield County, northeastern Montana, provides a ~3.2-myr-window into this interval. Using an extensive database of 4,769 mammalian specimens from the study area, I quantify high-resolution temporal patterns of taxonomic diversity and community structure that shed light on (i) the last ~1.9 myr of the Cretaceous; (ii) the K-Pg extinction and survival; and (iii) the Early Paleocene recovery and radiation of placentals. Mammalian communities remained relatively stable for most of the last ~1.9 myr of the Cretaceous, but the ecological abundance of metatherians and evenness of mammalian faunas as a whole began declining ~500–600 kyr before the K-Pg boundary. The ecological instability inferred from these changes may foreshadow the local extinction of 75% of species at or near the K-Pg boundary. The Pu1 survival fauna, from the first ~100–200 kyr of the Paleocene, is characterized by low species richness, a few locally-derived 'bloom taxa', and an influx of immigrants. The species-rich Pu2/3 fauna implies mammalian recovery occurred within ~600–700 kyr after the K-Pg event. The Pu2/3 and To1 faunas document the beginning of the radiation of placentals as the waning of 'bloom taxa' and multituberculates, an increasing richness and abundance of "archaic ungulates" and primates, and the first appearances of other placental groups that expand the taxonomic and ecomorphological diversity of mammalian faunas.

Technical Session XIV, Wednesday 9:00

A NOMENCLATURE FOR VERTEBRAL FOSSAE IN SAUROPODS AND OTHER SAURISCHIAN DINOSAURS

WILSON, Jeffrey, University of Michigan, Ann Arbor, MI, USA; D'EMIC, Michael, University of Michigan, Ann Arbor, MI, USA; IKEJIRI, Takehito, University of Michigan, Ann Arbor, MI, USA; MOACDIEH, Emile, University of Michigan, Ann Arbor, MI, USA; WHITLOCK, John, University of Michigan, Ann Arbor, MI, USA

The vertebrae and ribs of extinct saurischian dinosaurs (i.e., theropods, sauropods, prosauropods), like living birds, were pneumatized by epithelial outpocketings of the respiratory system. Pneumatic signatures in the vertebral column of fossil saurischians include complex branching chambers within the bone (internal pneumaticity) and large chambers visible externally that are bounded by neural arch laminae (external pneumaticity). Although general aspects of internal pneumaticity are synapomorphic for saurischian subgroups, the individual internal pneumatic spaces cannot be homologized across species or even along the vertebral column, due to their variability and absence of topographical landmarks. External pneumatic structures, in contrast, are defined by ready topological landmarks (vertebral laminae), but no comprehensive nomenclatural system exists that is flexible enough to accommodate a wide variety of morphologies and taxa. This deficiency has fostered confusion and precluded their use as character data in phylogenetic analysis. We present a simple system for naming external pneumatic fossae that parallels the one developed for the vertebral laminae that bound them. The nomenclatural system identifies pneumatic fossae by pointing to reference landmarks (e.g., neural spine, centrum, costal articulations, zygapophyses). We standardize the naming process by creating tripartite names from "primary landmarks", which form the zygo-diapophyseal table, "secondary landmarks", which orient with respect to that table, and "tertiary landmarks" that further delineate a given pneumatic fossa. The proposed nomenclatural system for lamina-bounded pneumatic fossae adds clarity to descriptions of otherwise complex vertebrae and allows these structures to be sourced as character data for phylogenetic analyses. These anatomical terms denote homologous pneumatic structures within Saurischia, but they could be applied to any vertebrate with vertebral laminae that enclose spaces, regardless of their developmental origin or phylogenetic distribution.

Poster Session III, (Tuesday)

A SURVEY OF BONE MICROSTRUCTURE IN THEROPOD FORELIMBS WITH REGARDS TO FUNCTION

WILSON, Laura, University of Colorado, Boulder, Boulder, CO, USA; DECECCHI, T. Alexander, McGill Unversity, Montreal, QB, Canada

Theropod dinosaur forelimbs serve a variety of purposes from grasping to flying to complete disuse. While function is not always obvious in extinct organisms, it can be inferred using selected proxies including bone microstructure. Analyzing bone tissue patterns from humeri of extinct and extant theropods in a phylogenetic and allometric framework can help us better understand and interpret growth and function in extinct theropods. Here we compare histologic patterns in humeri across several groups of avian and non-avian theropods to look for bone tissue patterns related to function in forelimbs. Comparisons are also made between different bones of the same animal to help account for size and phylogenetic influences on histologic patterns. The humeri of the large non-avian theropods *Tyrannosaurus rex* and *Allosaurus* exhibit extensive secondary reconstruction masking primary bone tissue patterns. Extensive forelimb remodeling is not unique to large theropods, as it has also been reported in smaller taxa such as *Deinonychus*. Vascular canals in the un-reconstructed primary bone along the periosteal margin of the larger theropods are mostly circumferentially and longitudinally oriented and dense Haverisan systems predominate the humeri internal cortex. While this could represent ontogentic or phylogenetic patterns, extensive secondary reconstruction may also reflect functional differences between bones. To examine what a vestigial humeri would be expected to look like in theropods, emu forelimbs were also sectioned to serve as a comparator. Bone microstructure patterns in the adult emu humerus exhibit overall low vascularization with mostly longitudinal vascular canals, a pattern possibly resulting from lower growth rates correlated with flightlessness and disuse. Differences between emu and large non-avian theropod forelimbs could also indicate that the latter retained more functional use than the former. Microstructure differences between hindlimb and forelimb bones are also considered in light of function and phylogeny in basal birds and extant birds such as the mallard, ostrich, and chinstrap penguin to set up a phylogenetic and functional bracket.

Poster Session II, (Monday)

A NEW MARINE CLUPEOMORPH FISH IN THE FAMILY SORBINICHTHYIDAE FROM THE EARLY LATE CRETACEOUS AKRABOU FORMATION OF MOROCCO

WILSON, Mark, University of Alberta, Edmonton, AB, Canada; MURRAY, Alison, University of Alberta, Edmonton, AB, Canada

The early Late Cretaceous saw the first appearances in the fossil record of many important clades of teleostean fishes. One such clade is the clupeomorph teleost family Sorbinichthyidae, which was only recently recognized as distinct from its closest relatives, the Paraclupeidae. The two families constitute the order Ellimmichthyiformes, which are known from the Early Cretaceous through the Eocene and are considered to be the sister group to the Late Cretaceous *Armigatus* within Clupeomorpha (herrings and relatives). Recent fieldwork by the University of Alberta in the early Late Cretaceous Akrabou Formation of Morocco has yielded several new marine ellimmichthyiforms, including two paraclupeids and one new sorbinichthyid. The sorbinichthyid is closely related to the only other species in the genus, *Sorbinichthys elusivo*, from the Cenomanian of Namoura, Lebanon, differing most strongly in number of predorsal bones and in relative length of the jaws. These two species of *Sorbinichthys* have Tethyan distributions, but other sorbinichthyids also occur in the Cretaceous of Lebanon and Britain, and in the Paleogene of China and Wyoming. This discovery reinforces the conclusion that the Akrabou Formation combines taxa such as *Sorbinichthys* that have Tethyan affinities with representatives of higher taxa (e.g., Sorbinichthyidae, Paraclupeidae, Macrosemiidae) having trans-Atlantic or near-cosmopolitan distributions.

Technical Session X, Tuesday 11:45

NEUROANATOMY, SKULL MORPHOLOGY AND THEIR BEHAVIORAL IMPLICATIONS FOR THE REMARKABLE, RECENTLY EXTINCT "PLATYPUS-DUCK" *TALPANAS LIPPA* (AVES: ANSERIFORMES) FROM KAUAI, HAWAII

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Divergent evolution of island birds is well documented, and *Talpanas lippa*, from ~5400-year-old lake deposits in Kauai, may be among the strangest cases. *Talpanas* has synapomorphies of Anatidae and potentially oxyurines. Postcranial bones indicate that *Talpanas* was probably flightless and terrestrial. We microCT scanned the preserved skull elements followed by 3D visualization of the brain endocast and inner ear. We also microCT scanned heads of other ducks (*Anas*, *Mergus*, *Oxyura*), as well as those of potential analogs (kiwi, platypus), and generated brain cast, inner ear, eyeball, and skull models. The neuroanatomy of *Talpanas* was like that of no other known bird. The visual system was extraordinarily reduced, as evidenced by the small optic nerves and the almost indiscernible optic lobes, which, consistent with the small eyeball size as judged by orbital osteology, suggest that *Talpanas* was not very reliant on sight. Kiwis (*Apteryx*) also have very reduced visual systems, but not to the extent seen in *Talpanas*. Kiwis, on the other hand, have dramatically expanded the olfactory apparatus, but, in *Talpanas*, the olfactory bulbs were unexpanded and comparable to those of other anatids. Without question, the major sensory modality used by *Talpanas* was the somatosensory (touch) system, as shown by the unparalleled expansion of the trigeminal system. Kiwis and, to a lesser extent, oxyurines have enlarged trigeminal ganglia, but in *Talpanas* they were enormous, dominating the ventral aspect of the brain cast and excavating the skull internally and externally. Perhaps a better extant analog for *Talpanas* is the platypus (*Ornithorhynchus*), which likewise has reduced vision, moderate olfaction, and is a somatosensory specialist with an expanded trigeminal system. The palate and braincase indicate that *Talpanas* had a broad low bill that was richly supplied with tactile nerve endings. Muscle scars and mandibular differences may signal a feeding apparatus that also diverged from its duck heritage. The picture of *Talpanas* that emerges is of a very different duck: a flightless, weakly-sighted, nocturnal animal foraging with its broad sensate bill in the moist underbrush of Kauai.

Poster Session IV, (Wednesday)

ARCHAEOPTERYX CHEMISTRY REVEALED VIA SYNCHROTRON RAPID SCANNING X-RAY FLUORESCENCE

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No detailed chemical analysis has ever been completed on any fossil of *Archaeopteryx*, despite its iconic status in the field of vertebrate paleontology. Ideally such analysis would measure and map the chemistry of bone, soft tissue structures, and the embedding rock matrix. Mapping the fossil in situ would place constraints on mass transfer between the limestone and the preserved specimen, and therefore aid in distinguishing taphonomic processes from original chemical zonation remnant from the *Archaeopteryx* itself. Conventional non-destructive analytical methods face serious problems in this case and most recent technological advances have been targeted at developing nanometer-scale rather than decimeter-scale capabilities. However, the recent development of Synchrotron Rapid Scanning X-ray Fluorescence (SRS-XRF) at the Stanford Synchrotron Radiation Lightsource (SSRL) now allows large paleontological specimens to be non-destructively analyzed and imaged using major, minor, and trace element concentrations. Here we present high-resolution maps covering an entire *Archaeopteryx* specimen (Thermopolis), along with large sections of the limestone matrix for Si, P, S, Cl, Ca, Ba, Mn, Fe, Zn, Cu, Br, and Pb. As a complement to the maps, spatially resolved point analyses provide quantitative results and have been used to convert mapped intensities to concentrations. Our results unequivocally show that the feathers in this *Archaeopteryx* specimen are not simply impressions. Several rachises are clearly visible in maps of both phosphorous and sulfur; thus, indicating that feather chemistry has been partially preserved. Furthermore, zinc and copper levels in the bone are similar to concentrations in extant avian species. We therefore conclude that part of the original bone composition is preserved in these critical macronutrients. Curation artefacts have also been resolved. Supplementary X-ray absorption spectroscopy showed that sulfur in the bone is dominantly present as fully oxidized sulfate. These results indicate that SRS-XRF provides a powerful new tool for the study of ancient life.

Poster Session I, (Sunday)

A NEW VARANOPID SYNAPSID FROM THE LOWER PERMIAN OF OKLAHOMA, WITH EVIDENCE OF HYPERCARNIVORY

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Varanopidae, a long-lived clade of Paleozoic synapsids, includes small to medium sized species ranging from 30 cm to more than 2 m in total length. Recent studies of several amniotes that were once considered to be diapsid reptiles have shown them to be varanopids, increasing dramatically the temporal range of this clade and its taxonomic diversity. Varanopids are now known from various parts of the world, including Russia, Europe and South Africa, and known to extend from the Late Pennsylvanian to the Middle Permian. Previous studies of this clade have suffered from a paucity of specimens, with most of the smaller, basal taxa being known only from single partial skeletons, resulting in a poor understanding of their cranial anatomy and phylogenetic relationships. The well-known Lower Permian fissure fills at the Dolese Brothers Limestone Quarry in Oklahoma are well known for the excellent preservation of terrestrial tetrapods, including numerous taxa of temnospondyl and lepospondyl tetrapods, as well as parareptiles and eureptiles. The known diversity of fossils at this locality has increased steadily during the last seventy years of collecting, yet the remains of synapsids are notably rare. The recent discovery of several well-preserved skulls and partial skeletons of a new varanopid synapsid provides significant new insights into varanopid evolution, and allows the first comprehensive analysis of basal varanopid cranial anatomy. This varanopid has an extremely slender snout with strongly recurved and serrated dentition, large caniniform teeth, extremely slender mandibles, in most respects similar to but nearly twice as large as *Mesenosaurus*, a varanopid from the younger, Middle Permian sediments of Northern Russia. Direct studies of the exposed cranial, dental, and postcranial features of this superbly preserved new varanopid, together with detailed internal cranial features revealed by CT data show that this gracile predator was an early synapsid hypercarnivore.

Technical Session IX, Tuesday 8:30

COORDINATED SHIFTS IN EARLY EOCENE EVOLUTIONARY AND PALEOENVIRONMENTAL RECORDS IN THE CLARKS FORK BASIN, WYOMING

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Paleocene-Eocene strata of the Clarks Fork and Bighorn Basins, Wyoming, provide an ideal record for studying links between evolutionary, environmental, and climatic change in the geological past. This is due to the availability of a high-resolution framework of biostratigraphic and geochemical proxy data growing out of investigations of biotic and abiotic responses to the Paleocene-Eocene Thermal Maximum (PETM). Here we present a new dispersed organic carbon (DOC) stable isotope record from the Clarks Fork Basin and use it in conjunction with mammalian morphological time series to investigate post-PETM correlates of environmental and evolutionary change. Bulk organic carbon was sampled from sediment across 20 kilometers of continuous exposure of the Willwood Formation. The resulting 629-sample, 680-meter composite record represents about 1.4 million years of early Eocene time. Morphological data were measured from eleven ecologically-disparate taxa, ranging from arboreal primates (e.g., *Cantius* and *Tetonius*) to terrestrial ungulates (e.g., *Diacodexis* and *Hyracotherium*). Time series dynamics (i.e., patterns of directional trends and stable values) were analyzed in the DOC record and in morphological time series using a new method called 'moving window' log-rate-interval analysis. Time series dynamics of tooth size and shape were compared to those of the DOC record to determine whether environmental changes seen in the DOC record explain evolutionary changes seen in the mammalian time series. None of the individual morphological time series showed a strong correlation with the DOC stable isotope record, indicating that no lineage evolved in simple response to environmental change manifested in DOC isotopes. However, shift points in time series dynamics (i.e., changes in directionality or mode) in the morphological and isotopic time series were concentrated in three narrow stratigraphic intervals, two of which correspond to faunal boundaries in the early Eocene. We interpret these concentrations of dynamic shifts as: 1) times of reorganization of environmental factors and selective pressures on faunas, and 2) target intervals for future intensive study.

Poster Session IV, (Wednesday)

BODY MASS, DIET PREFERENCE AND NICHE PARTITIONING IN THE MULTITUBERCULATES AND RODENTS OF NORTH AMERICA, EUROPE AND ASIA

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To test the hypothesis that the Rodentia contributed to the extinction of the Multituberculata via competition, this study investigated niche overlap between the two groups. Previous work suggested body size overlap between North American members of the Rodentia and Multituberculata. This study expands this original analysis to include many more taxa from North America, as well as taxa from Europe and Asia, and estimated body mass from first lower molar lengths. We also observed a correlation between body size and diet preference in living rodents, which mirrors observations of living primates and which facilitates dietary inference in extinct rodents and multituberculates. With this knowledge, it becomes possible to make reasonable estimates of diet preference and niche overlap in Paleocene and Eocene rodents and multituberculates. This study suggests a high degree of size overlap in North American and European multituberculates and rodents, suggesting that competition for food resources between these groups was likely in North America and Europe, but not in Asia. Frequency distributions based on living rodents provided thresholds with which to interpret diet preferences. A taxon with an average individual body mass of less than 200g can reasonably be assumed to eat insects, seeds, or both, and a taxon with a mass of more than 500g can reasonably be classified as an herbivore. Taxa that fall in between this range were considered mixed feeders. It is likely that many of the multituberculates and rodents in North America ate insects or seeds. Many representatives of both clades probably were mixed feeders at intermediate sizes. In Europe all of the rodents and all but one multituberculate, *Boffius*, fell into the insect-seed category at small body size. In Asia, all of the rodents were quite small and probably ate seeds and/or insects whereas the multituberculates were large and most likely herbivorous. This study corroborates the competition hypothesis for the extinction of the multituberculates in North America and Europe. There appears to have been little resource overlap between the multituberculates and rodents of Asia.

Poster Session IV, (Wednesday)

ONTOGENETIC INFLUENCE ON NEURAL SPINE BIFURCATION IN DIPLODOCOIDEA (DINOSAURIA: SAUROPODA): A CRITICAL PHYLOGENETIC CHARACTER

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Within Diplodocoidea (Dinosauria: Sauropoda), the phylogenetic positions of the three subclades Rebbachisauridae, Dicraeosauridae, and Diplodocidae are strongly influenced by a relatively small number of characters. Neural spine bifurcation, especially within the cervical vertebrae, has previously been considered to be a derived character within Diplodocoidea, with taxa that lack this feature positioned as relatively basal in phylogenetic analyses. Here we present results of our analysis of dorsal and cervical vertebrae from small-sized diplodocoids (representing at least 18 individuals), which has found that neural spine bifurcation is less well developed to absent in smaller specimens. New preparation of the roughly 200 cm long diplodocid juvenile SMA 0009 (Sauriermuseum Aathal, Switzerland) has revealed its cervical neural spines exhibit a simple non-bifurcated morphology strongly reminiscent of more basal sauropods such as Omeisaurus. An identical pattern of ontogenetically-linked bifurcation has also been observed in several specimens of the basal macronarian Camarasaurus, suggesting that this is characteristic of several clades of Sauropoda. We suggest that neural spine bifurcation performs a biomechanical function related to horizontal positioning of the neck that may become significant only at the onset of a larger body size, hence its apparent absence or weaker development in smaller specimens. These results have significant implications for sauropod phylogeny and taxonomy, bringing into question the phylogenetic position and validity of taxa based on specimens of small body size. Our findings emphasize the view that non-mature dinosaurs often exhibit morphologies more similar to their ancestral state, and may therefore occupy a more basal position in phylogenetic analyses than would mature specimens of the same species. In light of this, we stress the need for phylo-

genetic reanalysis of sauropod clades where neural spine bifurcation is a critical synapomorphy, particularly when data is derived from small individuals.

Technical Session III, Sunday 3:00

DISPARITY AND EVOLUTIONARY NOVELTY IN TWO PALEOGENE PRIMATE RADIATIONS

WOODRUFF, Emily, University of Bristol, Bristol, United Kingdom; RUTA, Marcello, University of Bristol, Bristol, United Kingdom; BLOCH, Jonathan, Florida Museum of Natural History, University of Florida, Gainesville, FL, USA; BENTON, Michael, University of Bristol, Bristol, United Kingdom

Primates, including extant lemurs, monkeys, apes, and humans encompass many diverse forms. A unique suite of features including a large brain, well-developed stereoscopic vision, and arboreal locomotion characterize the order but the rate and timing of the evolution of these features is uncertain. Understanding the relationship between taxonomic diversity and morphological disparity of fossil primates may help explain the biodiversity in modern primate clades.Forty-six species of euarchontans including Paleogene plesiadapiforms, Eocene euprimates, extant primates, scandentians, and dermopterans were analyzed in this study. We used a suite of novel numerical techniques to extract data on rates of evolution and morphospace occupation through time for different clades and character complexes. Euclidean distances were derived from a character-taxon matrix of 348 craniodental and postcranial skeletal characters. Principal coordinates analysis of a Euclidean distance matrix enabled the visualization of the disparity morphospace and inter-taxon relationships were quantified with several multivariate statistical tests.Our results show that different taxonomic groups of primates occupy a relatively small volume of the total disparity morphospace but within this area, differences in morphospace occupation mirror higher-level taxonomic divisions. The Eocene euprimates form two subgroups that contain the Tarsiiformes and Adapiformes, respectively. The plesiadapiforms comprise a third cluster, and two omomyid taxa fall between the plesiadapiform and the Eocene euprimate clusters. The three major clusters of fossil taxa in morphospace represent shifts in relative morphological disparity as new subclades arose in the Paleogene. The disparity of primate subclades has changed little since the Paleogene, demonstrated by the fact that extant taxa are scattered throughout the clusters of fossil taxa in the Paleogene disparity morphospace. Further study of character partitions will assess the relative importance of different character complexes during the early radiations of Primates.

Technical Session XII, Tuesday 3:45

OSTEOHISTOLOGICAL ANALYSIS OF *ALLIGATOR MISSISSIPPIENSIS* INDICATES ABSENCE OF FIBROLAMELLAR BONE IN CROCODYLIANS AND CONFIRMS DETERMINATE GROWTH WITH FIRST REPORT OF EXTERNAL FUNDAMENTAL SYSTEMS: IMPLICATIONS FOR TETRAPOD OSTEOHISTOLOGY

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Two common assumptions about alligators are that on occasion they deposit fibrolamellar bone tissue, and that their growth is indeterminate. Thin sections from skeletal elements of 80 alligators, both captive and wild and of various ontogenetic status, were examined for the presence of fibrolamellar tissue. In many cases samples displayed the lamellar-zonal pattern typical of crocodylians. However, tissues from some samples resembled those described elsewhere for alligators as fibrolamellar. These were compared with examples of fibrolamellar tissue from extant endotherms and non-avian dinosaurs demonstrating that the loosely parallel collagen fibers from the alligator tissues referred to as fibrolamellar lack the disorganized woven nature of fibrolamellar collagen fibers as well as the typical osteocyte arrangement within the lamellae of primary osteons. In addition, a subset of adults from the larger sample of 80 individuals was examined for evidence of determinate growth as indicated by the presence of an external fundamental system (EFS). This sample included femur thin sections from captive adults between 26 and 27 years of age. An EFS was present in all but three of the 30 specimens. The EFS resembled those observed in extant endotherms and non-avian dinosaurs, consisting of 3-11 closely spaced annuli within sparsely vascularized lamellar tissue in the outer cortex. This is the first report of an EFS in crocodylians and thus adds to the growing body of evidence from extensive mark and recapture programs that alligator growth is determinate. These results suggest that rather than having indeterminate growth, extant reptiles and extinct tetrapods lacking EFS may not be somatically mature. Due to developmental plasticity, wild alligators take longer to reach asymptotic size, thus causing the illusion of indeterminate growth. This developmental plasticity allows them to occasionally approach growth rates typical of endothermic animals, resulting in a more disorganized, but yet not truly fibrolamellar bone tissue. Thus, the 'fundamental split' in tissue types characterizing pseudosuchians and ornithodirans remains intact.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

CHARACTER WINNOWING: A NEW CHARACTER SELECTION PROTOCOL BASED ON PHYLOGENETIC SIGNAL

WORTHINGTON, Steven, New York University and New York Consortium in Evolutionary Primatology, New York, NY, USA

Phenotypic characters are the product of a complex interface of functional, phylogenetic and developmental processes. As a result, many of these traits carry mixed 'signals' that increase the degree of 'noise' in phylogenetic inference. One of the main goals of morphology-based-systematics is to increase the signal to noise ratio in character matrices. A new method of achieving this is presented here, based on selecting characters according to their phylogenetic signal for a group of taxa. Metric data on 100 morphological characters were collected for twelve extant anthropoid (primate) taxa (n=540). Each trait was ranked on its ability to recover phylogenetic information (topology and branch lengths) independently inferred from molecular data. Ranks were derived from maximum likelihood and parsimony-based null models (using the software R, Matlab and Mesquite), representing hypotheses of no phylogenetic signal in each character for the sampled taxa. Characters deemed to exhibit high-signal levels were then used preferentially in tree inference. Character matrices constructed from only highly-ranked traits performed significantly better than those composed of all traits. Preferentially selecting characters that are conserved over a phylogeny provides an effective means of winnowing a set of characters. Excluding traits that reflect more proximate influences demonstrably improves the resolution of tree inference (the most parsimonious trees have shorter lengths and greater support). This new technique can be applied to any taxonomic group for which there is a robust molecular-based tree. Although signal is measured for groups comprising only extant taxa, the method can be employed to identify characters useful for estimating the phylogeny of closely related fossil forms. The technique should be of wide utility in phylogenetic systematics, since winnowed character matrices will likely exhibit a better signal to noise to ratio for any sample of taxa.

Technical Session VII, Monday 2:00

CRETACEOUS CHORISTODERAN REPTILES GAVE BIRTH TO LIVE YOUNG

WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; JI, Qiang, Institute pf Geologay, Beijing, China; CHENG, Yen-nien, National Museum of Natural Science, Taichung, China

Choristodera is a lineage of semi-aquatic diapsid reptiles, with a fossil record from the Middle Jurassic, or ambiguously the Late Triassic, to the early Miocene. The crocodile-like Cretaceous champsosaurs are the best known choristoderans and typify the group. Recently, two long-necked and aquatic choristoderan genera (*Hyphalosaurus* and *Shikawa*) were described from the Lower Cretaceous of China and Japan. Since *Champsosaurus* (the first known choristoderan) was described, all known choristoderan reptiles are thought to have lived in freshwater ecosystems. As reptiles, all choristoderans might have retained oviparity, laying eggs in the manner of turtles, crocodiles, and dinosaurs. However, no clues had been found as to the reproductive pattern of the group until the relatively recent discovery of the second species of *Hyphalosaurus*, *Hyphalosaurus baitaiguoensis* from China.

H. baitaiguoensis is known from thousands of specimens. It was originally established on the basis of a skeleton with 11 associated eggs, some of which show embryos. Later others suggested possible viviparity in *H. baitaiguoensis* but had no firm evidence to support the view. In the summer of 2007, another skeleton of *H. baitaiguoensis* was collected from the Lower Cretaceous Jiufotang Formation in the same area where the holotype of the species was discovered. It is an exceptional specimen, not only due to its well-preserved nature but also that it carries up to 18 embryos arranged in pairs. Size comparison with small free-living individuals and the straight posture of the posterior-most pair suggest that those embryos were at term and had probably reached parturition. This remarkable specimen is very significant because: 1) it provides the first firm evidence to elucidate the reproductive pattern of the long-necked *Hyphalosaurus*; 2) it reveals a new fossil group of reptiles with viviparous capability; and 3) the new specimen represents the first reptilian group to have evolved viviparity within a freshwater ecosystem. Viviparity is a practical mode of reproduction, which may have facilitated the aquatic or semi-aquatic radiation of choristoderan reptiles.

Poster Session II, (Monday)

TAXONOMIC REVISION OF *FUKANGICHTHYS* (ACTINOPTERGYII: SCANILEPIFORMES) FROM THE MIDDLE TRIASSIC OF XINJIANG, CHINA

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Characterized by a long-based dorsal fin and other associated features, the Scanilepiformes are an extinct group of the Actinoptergyii confined in the Triassic. They mainly inhabited freshwater ecosystems of northern continents except a Late Triassic genus (*Scanilepis*) from the marine deposits of Scania, Sweden. Although relatively abundant, most of this group has not been well studied. *Fukangichthys* is the first scanilepiform described from the Middle Triassic of China, and it has remained a special problematic taxon with serious anatomical uncertainties since its original publication in 1978. The previous poor knowledge of this taxon led some researchers to question its assignment to the Scanilepiformes, but this assertion is not supported by our recent studies. A lot of anatomical characters that were undescribed or misidentified previously are revealed during our restudy of *Fukangichthys*. A new reconstruction is provided and its diagnosis is thoroughly revised. This study confirms that *Fukangichthys* is a scanilepiform rather than a perleidiform. Implicated from the form-function correlation of extant actinopterygians, the Scanilepiformes are supposed to have a good performance in precise maneuvering and low-speed stabilizing by a rhythmical undulation of their long-based dorsal fin which probably functions as a discrete thrust-generating propulsor independently from the body.

Poster Session III, (Tuesday)

RARE EARTH ELEMENTS AS AN INVESTIGATIVE TOOL INTO THE SOURCE, AGE AND ECOLOGY OF LATE MIOCENE TO LATE PLEISTOCENE FOSSILS FROM THE TUNICA HILLS, LOUISIANA

YANN, Lindsey, Louisiana State University, Baton Rouge, LA, USA; SCHIEBOUT, Judith, Louisiana State University, Baton Rouge, LA, USA

Rare earth elements were investigated for the potential to determine provenance and depositional environments of float vertebrate fossils from creeks in the Tunica Hills region of Louisiana. The rare earth element analysis was used to test the hypotheses that fossils span multiple time periods, from late Miocene to late Pleistocene and that elemental profiles can distinguish terrestrial depositional settings from possible estuarine deposits. The fossils present were used to test the hypothesis that the Tunica Hills had environmental conditions much like the modern Great Lake region in the late Pleistocene.Bone and tooth dentine replace calcium with similar-sized rare earth elements very quickly(10,000-30,000 years) and the signature is not altered by additional diagenetic effects. The change in source of sediment supply from the Tennessee River, a postulated source during the Miocene, to the average Midwest continental signature, during the late Pleistocene, would have affected the overall rare earth element compositions available during fossilization. The loess material may not have been in the ground long enough to complete the uptake of REE, which would have an influence on the profiles seen.The 38 fossils analyzed from the Pascagoula Formation, Peoria Loess and intermediate beds included horses, mastodons, ground sloths, a rhinoceros, a large felid, a giant armadillo, and a grouse. The first occurrence of *Synthetoceras* in Louisiana is represented in the analyzed fossil samples. Cluster analysis separated in situ fossils from loess deposits from the older Pascagoula Formation based on rare earth element profiles. The results on lithologically diverse and stratigraphically complex intermediate deposits, including reworked Citronelle Formation, are less clear, and shell material and nodules analyzed were not useful for stratigraphic control. In situ samples from the Pascagoula Formation support an estuarine depositional environment in the Tunica Hills during the late Miocene or early Pliocene. Rare earth element analysis shows promise, and needs be applied to more sites, and fossils, within the Gulf Coast region, to help unravel its history.

Poster Session IV, (Wednesday)

A NEW, POSSIBLY RELICTUAL, BASAL SAUROPODOMORPH DINOSAUR FROM THE EARLY JURASSIC OF SOUTH AFRICA

YATES, Adam, BPI, University of the Witwatersrand, Johannesburg, South Africa; BONNAN, Matthew, Western Illinois University, Macomb, IL, USA; NEVELING, Johann, Council for Geoscience, Tswane, South Africa

A new basal sauropodomorph dinosaur is described on the basis of a partial, disarticulated but associated skull and dispersed cranial and postcranial elements from at least two individuals. The new taxon is part of a distinctive local fauna from the upper Elliot Formation (Lower Jurassic) in the Senekal District, Free State, South Africa. It can be diagnosed by various details of the premaxilla, nasal, dentary and distal caudal vertebrae. The taxon displays an unusual mix of characteristics. It lacks several synapomorphies of Plateosauria (*Plateosaurus* + *Massospondylus* and all descendants of the most recent common ancestor) but does display other derived characteristics that are otherwise known only from less inclusive clades within Plateosauria. In a cladistic analysis a position outside the clade of *Efraasia* + more derived sauropodomorphs (including Plateosauria) is supported, however this position was not found to be a significantly better explanation of the data than a relatively derived position within Anchisauria. If the basal position for the new taxon is accepted then a divergence from other sauropodomorphs in the middle Norian and a ghost lineage up to 35 ma is implied. No other non-plateosaurian sauropodomorphs are known from the Jurassic, making the new taxon a potentially relictual taxon in the Early Jurassic.

Technical Session IV, Sunday 3:30

NEW MATERIALS OF *ESTESIA MONGOLIENSIS* (REPTILIA: SQUAMATA) FROM THE LATE CRETACEOUS OF MONGOLIA CAST DOUBT ON THE MONOPHYLY OF THE MONSTERSAURIA

YI, Hong-yu, American Museum of Natural History, New York, NY, USA; NORELL, Mark, American Museum of Natural History, New York, NY, USA

Estesia mongoliensis was the earliest Asian record of the Monstersauria, a lizard clade whose crown groups are the only living lizards with venom delivering apparatus (*Heloderma*). Fossil monstersaurs date back to the Early Cretaceous, and they were distributed in North America, Europe, and Asia. First discovered from the Late Cretaceous of Khulsan, Mongolia, *Estesia* was reported to be related to varanid lizards, but was later assigned to the Monstersauria. We report a new nearly-undistorted skull and a partial axial skeleton of *Estesia* from Ukhha Tolgod of Mongolia, which reveals three new diagnostic characters of the species: lateral projections at the base of the nasal process of the premaxilla, "venom groove" appearing at the posterior surface of marginal teeth instead of the anterior surface as in *Heloderma*, and the presence of longitudinal striation on the labial surface of dentary teeth forming a sharp cutting edge with the "venom groove". Phylogenetic analysis of *Estesia* in the Platynota was based on a matrix of all monstersaurs species and 27 other major platynotan taxa coded with 389 morphological characters. The strict consensus of 35 most parsimonious trees placed *Estesia* as the most basal varaniform (squamates sharing a more recent common ancestor with *Varanus varius* than with *H. suspectum* or *Mosasaurus hoffmanni*) based on the following synapomorphies: forking of the medial surface of postfrontal/postorbital, and the elongated nasal process of the premaxilla that is about two-thirds of the length of the nares. The new phylogeny rejects a monophyletic "Monstersauria" because of the polytomy between three species of *Heloderma* (Miocene – recent, North America), *Lowesaurus* (Oligocene – Miocene, North America), and *Eurheloderma* (Eocene/Oligocene of Europe), and varaniforms. The polytomy of "monstersaurs" are primarily due to a large amount of missing data in highly incomplete fossil taxa, which demands further analysis and future discovery of fossils. Consequently, we provisionally retain the definition of the "Monstersauria" as "squamates sharing a more recent common ancestor with *H. horridum* than with *Varanus varius*", but we exclude *Estesia* from the group.

Poster Session IV, (Wednesday)

FOSSIL PROCELARIDS (AVES: PROCELLARIIFORMES) FROM THE BAHIA INGLESA FORMATION BONEBED (LATE MIOCENE), ATACAMA DESERT, NORTHERN CHILE

YURY-YÁÑEZ, Roberto, Universidad de Chile, Santiago de Chile, Chile; GUTSTEIN, Carolina Simon, Universidad de Chile, Santiago de Chile, Chile; RUBILAR-ROGERS, David, Museo Nacional de Historia Natural, Santiago de Chile, Chile

The Bahía Inglesa Formation in the Atacama Desert is the most important geological unit with vertebrate Cenozoic fossils in Chile. The most studied locality of the formation is a phosphatic "bonebed" of marine origin no younger than Tortonian based in Sr/Sr dating and characterized by a high number of fragmentary remains of cetaceans, fishes (elasmobranchians and bony fishes), crocodiles and birds. Taphonomically this "bonebed" corresponds to a reworked layer of an older stratum (Messinian?). The most studied group of birds to date are penguins, also remains of sulids, cormorants, albatrosses and pseudo-toothed birds were described from the formation. We present here several isolated neurocrania mainly without rostrum of procelarids that shown a high diversity of this family in the Neogene of the southeast Pacific. The Procellariidae family is a group of pelagic birds with an extensive fossil record from insular environments from the Pleistocene. By direct comparison with recent species we recognized at least five different morphologies, based mainly in the configuration of the temporal region: medium size shearwaters related to the genus *Calonectris* (MPC 12001; SGO.PV 1065), gadfly petrels comparable to *Pterodroma*, (SGO.PV 1061) petrels related to *Pagodroma* (MPC 12003), prions as *Pachyptila* (SGO.PV 1019) and a procelarid of uncertain affinities, *Pterodroma*? (SGO.PV 1062). After Spheniscidae the Procellariidae, is the second more abundant family in the formation. This diversity shows that during the Neogene the Atacama Desert coast was a zone of high marine productivity with a higher taxonomic diversity than today representing a complex seabird community. The strict pelagic nature of these birds suggest that the fossils were deposited not in a near shore environment as early suggested by paleoenviromental reconstructions of the "bonebed" genesis, but in a deep sea environment as suggested by independent batrimetic data. It is also possible that the presence of reproductive colonies in the basement islands proposed in paleoenviromental reconstructions of the area could explain the high number of fossil procelarids.

Technical Session III, Sunday 4:00

CRANIUM OF A NEW OLIGOCENE PRIMATE FROM SAUDI ARABIA AND THE DIVERGENCE OF APES AND OLD WORLD MONKEYS

ZALMOUT, Iyad, University of Michigan, Museum of Paleontology, Ann Arbor, MI, USA; ALI, Mohammed, Saudi Geological Survey, Jeddah, Saudi Arabia; MACLATCHY, Laura , University of Michigan, Department of Anthropology, Ann Arbor, MI, USA; SANDERS, William , University of Michigan, Museum of Paleontology, Ann Arbor, MI, USA; GINGERICH, Philip, University of Michigan, Museum of Paleontology, Ann Arbor, MI, USA

A partial cranium of a new, medium-sized catarrhine was recently recovered by a Saudi Geological Survey-University of Michigan expedition, from the middle unit of the Shumaysi Formation at Harrat Al Ujayfa, Al Hijaz Province, western Saudi Arabia. Radiometric dating of intrusive volcanic dykes and basalts covering the top of the Shumaysi Formation indicates that the geological age of this new primate predates the Miocene. Biochronological correlation of associated terrestrial mammals (paenungulates and anthracotheres) refines the age of the middle Shumaysi Formation and the new primate to 29-28 Ma. The new specimen preserves substantial facial, palatal, and dental morphology, predominantly resembling male crania of the propliopithecoid *Aegyptopithecus*, with very broad molars, low hafting of the face on the neurocranium, snout-like midfacial projection, and a frontal trigon. It lacks obvious hominoid and cercopithecoid synapomorphies. However, it shares possession of a tubular ectotympanic with hominoids and cercopithecoids. Based on phylogenetic analysis, the new catarrhine is interpreted to be a more advanced stem catarrhine than propliopithecoids and pliopithecoids, close to the ancestry of hominoids and cercopithecoids. The age, morphology, and apparent phylogenetic position of the new catarrhine provide an opportunity to test competing hypotheses about the ancestral morphotype of cercopithecoids and hominoids, the phylogenetic connection between propliopithecoids and crown catarrhines (Old Work Monkeys and Hominoidea), and the timing of the cercopithecoid-hominoid divergence, and aids in identification of basal hominoid and cercopithecoid synapomorphies. Our results indicate that the last common ancestor of these catarrhines had a long, projecting *Aegyptopithecus*-like face, that propliopithecoids played an important role in the evolution of later catarrhines, and that the cercopithecoid-hominoid divergence happened between 29 and 24 Ma. This is the most complete catarrhine specimen from the mid to late Oligocene, further emphasizing Afro-Arabia as the locus of early catarrhine evolution.

Edwin H. and Margaret M. Colbert Poster Prize Competition (Monday)

ICHTHYOSAURS OF AUSTRALASIA: A REVIEW OF DIVERSITY AND DISTRIBUTION

ZAMMIT, Maria, University of Adelaide, Adelaide, Australia

Ichthyosaurs have a worldwide distribution, but the remains from Australasia are poorly known when compared to their European and North American counterparts. To date, most studies have reviewed ichthyosaur remains from individual countries only, rather than discussing the region as a whole, resulting in many specimens remaining largely unknown outside their country of origin. Four countries in Australasia have produced ichthyosaur fossils – Australia, New Caledonia, New Zealand, and Timor – with finds occurring throughout the known stratigraphical range of this marine reptile group. In New Zealand, ichthyosaurs have been recorded mainly from Triassic and Cretaceous deposits, although a new specimen is here reported from the Jurassic. In contrast, documented discoveries from Timor and New Caledonia are of Triassic age, and Australia has so far yielded only Cretaceous material. Several specimens exhibit diagnostic features that allow three genera to be identified: *Shonisaurus* from New Caledonia, *Mixosaurus* from Timor, and *Platypterygius* from Australia and New Zealand. All three genera have been recorded from deposits worldwide. The Australian fossils are the only ones specifically identifiable and represent a single apparently endemic species, *Platypterygius australis*.

Poster Session III, (Tuesday)

QUANTITATIVE ANALYSIS OF HERBIVOROUS ECOMORPHOLOGY IN THEROPOD DINOSAURS: PATTERNS OF CHARACTER CORRELATION AND PROGRESSION

ZANNO, Lindsay, The Field Museum, Chicago, IL, USA; MAKOVICKY, Peter, The Field Museum, Chicago, IL, USA

Trophic interpretations of extinct taxa are generally derived from observing suites of skeletal traits with analogues in living species. Whereas in some instances this approach is based on explicit comparisons, in others—particularly, fossil taxa spanning an inferred trophic shift, utilizing diverse dietary resources, and/or possessing ambiguous or novel features—such analogues are too indefinite to apply. One group for which diet is particularly problematic to interpret is Coelurosauria; an extraordinarily diverse clade of feathered theropods encompassing modern birds and several closely related lineages. Although a recent increase in the morphological disparity of the clade has sparked a renewed interest in their ecology, to date, interpretations of coelurosaurian herbivory are still founded on analogous models. Here we use three character correlation techniques within a phylogenetic framework to investigate whether skeletal traits purported to indicate an herbivorous diet in theropods based on analogous models (PHTs) correlate with extrinsic evidence of herbivory (EEH) such as stomach contents and gastroliths in clade members. Our results identify 21 craniodental, axial, and pelvic features that exhibit statistically significant correlation with EEH (p-value < 0.05) on multiple tree topologies. Such PHT clusters form the first quantitative, extrinsically founded proxy for identifying herbivorous ecomorphology in theropods and are robust despite uncertainty in phylogenetic relationships among major subclades. We further apply rank-based correspondence analyses to investigate whether herbivorous traits evolve with a common progression in coelurosaurian lineages. Our analyses detect a statistically significant pattern in the order of PHT accrual between Ornithomimosauria and Oviraptorosauria, marking a common pathway of increasing specialization to herbivory. Progressive ecomorphological trends of this kind may ultimately substantiate the presence of intrinsic constraints to the evolution of plant eating in theropods.

Poster Session II, (Monday)

INTERRELATIONSHIPS OF CRETACEOUS AND PALEOGENE NEOPLAGIAULACIDAE (MULTITUBERCULATA, MAMMALIA)

ZHANG, Yue, Ohio State University, Columbus, OH, USA; HUNTER, John, Ohio State University, Newark, OH, USA

Neoplagiaulacid multituberculates were a dominant group of small-bodied terrestrial omnivore-herbivores, analogous to muroid rodents, in the Cretaceous and Paleocene, and include the last-surviving multituberculates in the late Eocene. Interrelationships among neoplagiaulacids remain poorly known, impeding understanding of the evolution of this group. Two recently reported monospecific genera, *Nidimys* and *Parikimys*, both of "Edmontonian" age, need to be integrated into the neoplagiaulacid family tree. We conducted parsimony-based, Bayesian, and stratocladistic analyses of dental characters to meet the need for improved understanding of neoplagiaulacid phylogeny. Taxa included the two recently reported genera and relatively well-preserved neoplagiaulacids (*Mesodma formosa, M. thompsoni, Ectypodus elaphus, E. powelli, Parectypodus lunatus, Neoplagiaulax hunteri,* and *N. serrator*). We also included the primitive cimolodontans *Paracimexomys priscus*, *Dakotamys malcolmi*, *Cimexomys minor*, and *C. judithae*. The analysis used unordered characters and *Paracimexomys priscus* as the outgroup. Result from MrBayes using the Mk model and the most parsimonious trees from PAUP* show some identical relationships. *Dakotamys* is more basal than other taxa, and *Nidimys* consistently falls basal to other neoplagiaulacids. *Cimexomys minor* and *C. judithae* are consistently separated from each other, with *C. judithae* closer to the neoplagiaulacids, suggesting paraphyly within *Cimexomys*. All analyses support neoplagiaulacid monophyly, but they differ on the position of the newly reported *Parikimys*. Parsimony analysis suggests that *Parkimys* is the sister taxon of a clade comprising *Neoplagiaulax, Ectypodus,* and *Parectypodus*, and stratocladistic analysis supports *Parikimys* as ancestral to this group. Bayesian analysis, however, places *Parikimys* into a more basal position among neoplagiaulacids. Parsimony analyses support the view that *Ectypodus* is paraphyletic. Study of character evolution revealed homoplasy in key characters of the bladed premolars that are the hallmark of the group. Mapping results to the time scale reveals late Cretaceous splits between major neoplagiaulacid clades.

Technical Session X, Tuesday 8:45

A NEW TOOTHLESS ORNITHURINE BIRD FROM THE LOWER CRETACEOUS OF CHINA

ZHOU, Shuang, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHOU, Zhonghe, Institute of Vertebrate Paleontology and Paleoanthropology , Beijing, China; O'CONNOR, Jingmai , Institute of Vertebrate Paleontology and Paleoanthropology , Beijing, China

We report on a new species of basal ornithurine bird based on a well-preserved specimen from the Lower Cretaceous Jiufotang Formation in Jianchang, western Liaoning, China. The new specimen preserves a unique suite of characters that differentiate it from other known ornithurines, including several features previously unreported in Early Cretaceous ornithurines. The new species possesses a fairly V-shaped furcula with a short hypocleidium, the first definitively known among Early Cretaceous ornithurines, a rostrocaudally elongate unperforated sternum with deep caudal notches absent, a delto-pectoral crest that extends for half the length of the humerus, and an elongate manus with a reduced major ungual, previously unreported among Early Cretaceous ornithurines. The specimen preserves an excellent skull that indicates the species was toothless and preserves details of the skull anatomy such as the premaxilla-frontal articulation. Most notable of this specimen is the preservation of a tail morphology previously unknown among Mesozoic birds, and the second tail morphology known among early ornithurines, which have until now only preserved fan-shaped tails. The new specimen preserves a forked tail composed of elongate rectrices medially separated by a deep notch. This discovery reveals new diversity and specialization among Early Cretaceous ornithurines. This tail morphology in modern birds decreases aerodynamic efficiency relative to the fan-shaped tail, but increases chance of sexual reproduction. This discovery suggests that this tradeoff may have convergently evolved in basal members of Ornithurae, and is consistent with the wooded environment inferred for the Jehol.

Technical Session X, Tuesday 8:30

VERTEBRATE DIVERSITY OF THE EARLY CRETACEOUS JEHOL BIOTA

ZHOU, Zhonghe, Key Laboratory of Evolutionary Systematics, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; WANG, Yuan, Key Laboratory of Evolutionary Systematics, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Intensive collecting and study of the Early Cretaceous Jehol lagerstätte in the past twenty years have added significantly to our understanding of its biodiversity, and contributed greatly to reconstructing the Lower Cretaceous terrestrial ecosystem. An updated survey of valid taxa of Jehol vertebrates indicates that the Jehol vertebrate assemblage currently comprises, at the generic count, at least 33 birds, 30 dinosaurs, 16 pterosaurs, 13 mammals, 5 lizards, 5 choristoderes, 2 turtles, 8 amphibians, and 7 fishes as well as 1 agnathan, totaling 120 genera. All of them have been recognized as members of extinct genera and species, and only a few of them (e.g., some fishes and amphibians) can be referred to extant vertebrate families. Although 141 vertebrate species are currently regarded as valid, we estimate this number will increase with more detailed morphological and systematic study in the future. The recorded Jehol vertebrate diversity already exceeds that of such well-known contemporaneous lagerstätten as from Santana of Brazil and Las Hoyas of Spain. And to some degree, it is no less remarkable than that of the Late Jurassic Solnhofen lagerstätte in which more than half of the vertebrate species are fishes, or the Eocene Messel lagerstätte, of which only the bird diversity is greater than that of the Jehol Biota. In addition to its taxonomic diversity, the Jehol vertebrate assemblage also displays remarkable differentiation in diet, size, locomotion and habitat, all of which may account for evolution of the vertebrate diversity of the biota. A high percentage of arboreal or scansorial forms characterized the birds, pterosaurs, dinosaurs, mammals, and lizards of the biota. In particular, approximately 75% of the avian genera lived an arboreal life. Finally, against a complex geological, paleogeographical, and paleoenvironmental background, the interactions among various vertebrate groups as well as among the vertebrates, invertebrates, and plants had definitely played a key role in the succession of the Jehol ecosystem.

Technical Session VIII, Monday 3:30

PLACODERM JAW BONES FROM THE XIAOXIANG FAUNA (LUDLOW, SILURIAN) AND THE DENTITION OF EARLY GNATHOSTOMES

ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology (IVPP), Chinese Academy of Sciences, Beijing, China; ZHAO, Wen-jin, IVPP, Chinese Academy of Sciences, Beijing, China; JIA, Lian-tao, IVPP, Chinese Academy of Sciences, Beijing, China

The dermal jaw elements of placoderms were considered to comprise only the supragnathal and infragnathals (upper and lower toothplates), which form the inner dental arcade like other gnathostomes (acanthodians, chondrichthyans, and osteichthyans). However, whether placoderms have true teeth as in other gnathostomes has been a subject of controversy, partly due to the large morphological gap between dermal jaw bones of placoderms and

osteichthyans. Recently, we reported the Xiaoxiang Fauna from the Ludlow (Silurian) of China, which is characterized by the early diversification of gnathostomes. In addition to several osteichthyan forms exemplified by *Guiyu oneiros*, rich placoderm remains including disarticulated jaw bones were known from the Xiaoxiang Fauna. The anterior supragnathals are found in articulation with the endocranium at the level of orbits. One toothplate, bearing a denticulated biting portion anteriorly and a slender non-biting portion posteriorly, can be directly compared to the infragnathal of buchanosteid arthrodires. The rest of the jaw bones are equipped with clustered conical teeth along the jaw margin, and densely set tubercles on the external surface. They are very suggestive of the dentary or maxillary of primitive osteichthyans such as *Lophosteus* and *Andreolepis*, indicating the presence of the outer dental arcade in placoderms. The presence of the outer dermal jaw elements in placoderms, comparable to the dentary and infradentary bones of osteichthyans, is supported by an articulated placoderm specimen from the Xiaoxiang Fauna. All these novel data provide further morphological links between placoderms and other gnathostomes, and offer new insights into the dentitions among early gnathostomes.

Poster Session III, (Tuesday)

A NEW GLYPTODONTINAE (XENARTHRA, GLYPTODONTIDAE) FROM NORTHERN SOUTH AMERICA: ITS IMPLICATIONS IN THE GREAT AMERICAN BIOTIC INTERCHANGE

ZURITA, Alfredo, Centro de Ecología Aplicada del Litoral (CECOAL-CONICET) and Universidad Nacional del Nordeste, Argentina, Corrientes, Argentina; CARLINI, Alfredo, Paläontologisches Institut und Museum, Universität Zurich, and Departamento Científico Paleontología de Vertebrados, Museo de La Plata., LaPlata, Argentina; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ, USA

The population dynamics of the Glyptodontinae (Glyptodontidae) during the Great American Biotic Interchange (GABI) has been reinterpreted as a bidirectional process, with the reentry of some North American taxa in the latest Pleistocene into Venezuela. The first records of Glyptodontinae in North America are cf. *Glyptotherium* from the Pliocene of north-central Mexico. A new Glyptodontinae from the late Pliocene of northern Venezuela (San Gregorio Formation), prior the GABI, presents significant paleobiogeographical and phylogenetic implications. The material is represented by numerous osteoderms of the dorsal carapace. From a morphological perspective a comparison with the North American taxa (Pliocene-Late Pleistocene; *Glyptotherium* spp.) and with the southern South American taxa (Late Miocene-Early Holocene; *Glyptodontidium tuberifer, Paraglyptodon chapalmalensis, P. uquiensis*, and *Glyptodon*), reveals a closer relationship with *Glyptotherium* than to the southern South American forms. Some of these characters could be interpreted as primitive for the Glyptodontines. Shared characters include: 1) the sulci that delimit the central figure are shallower and narrower than observed in the southern South American taxa; 2) the dorso-ventral diameter of the osteoderms is less than in *Paraglyptodon, Glyptodontidium* and *Glyptodon; 3*) the exposed surface of the osteoderms is clearly rough and punctate; and 4) the central figure in the exposed surface is bigger. The available evidence suggests: 1) that this new late Pliocene Glyptodontine from northern South America is closely related to those that participated in the GABI and the ancestry of *Glyptotherium; 2*) in turn, that the southern South American taxa, especially the Miocene and Pliocene ones (i.e., G. *tuberifer* and *Paraglyptodon*) are clearly more closely related to the Pleistocene genus *Glyptodon*; and 3) finally, it is possible that the northern (*Boreostemma* spp. and the new Glyptodontinae presented here) and southern taxa (*Glyptodontidium, Paraglyptodon* and *Glyptodon*) of South America represent distinct lineages, separated from, at least, the Late Miocene-early Pliocene.

INDEX

INDEX

G

H

I

J

K

L

INDEX

M

N

O

P

Q

R

INDEX

S

T

U

V

W

INDEX

X

Y

Z


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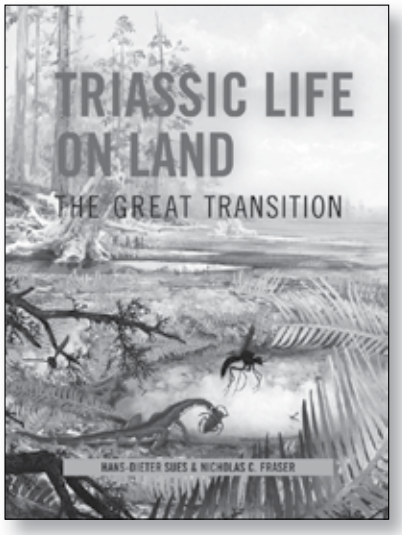

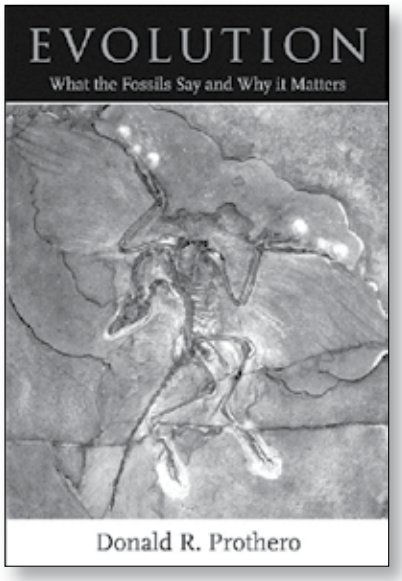

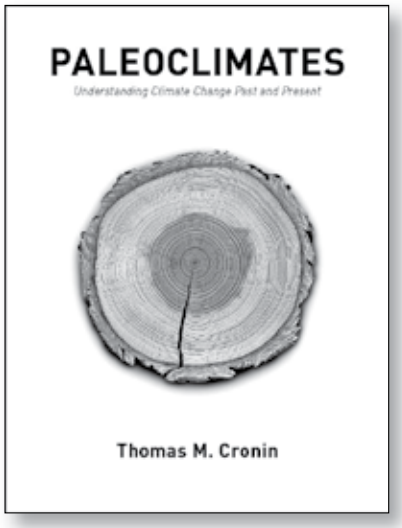

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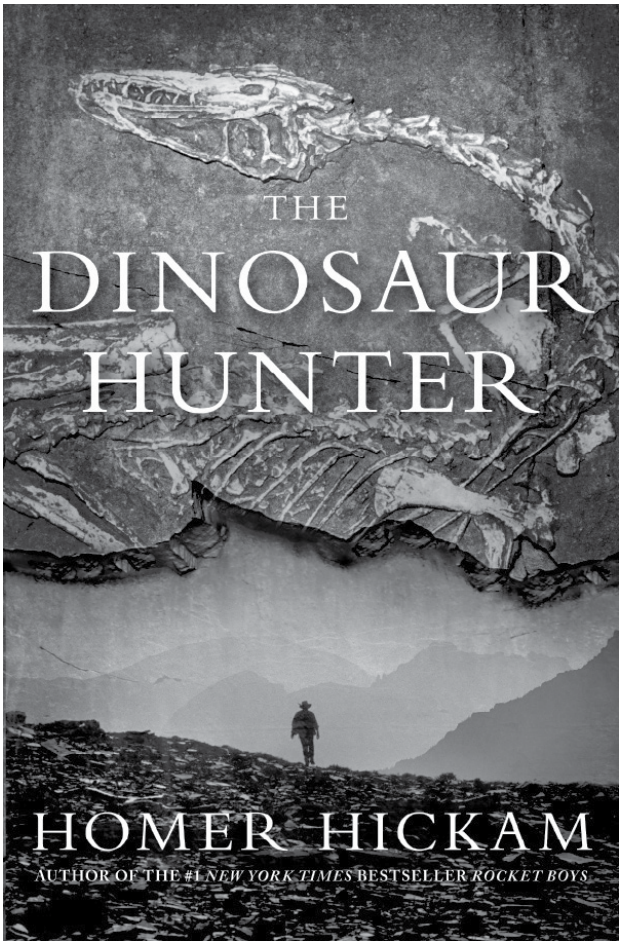

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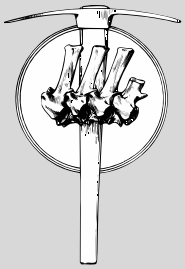

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