Society of Vertebrate Paleontology 77th Annual Meeting Program & Abstracts

SOCIETY OF VERTEBRATE PALEONTOLOGY

77th ANNUAL MEETING

MEETING PROGRAM AND ABSTRACTS

SVP
SOCIETY OF VERTEBRATE PALEONTOLOGY

August 23 - 26, 2017

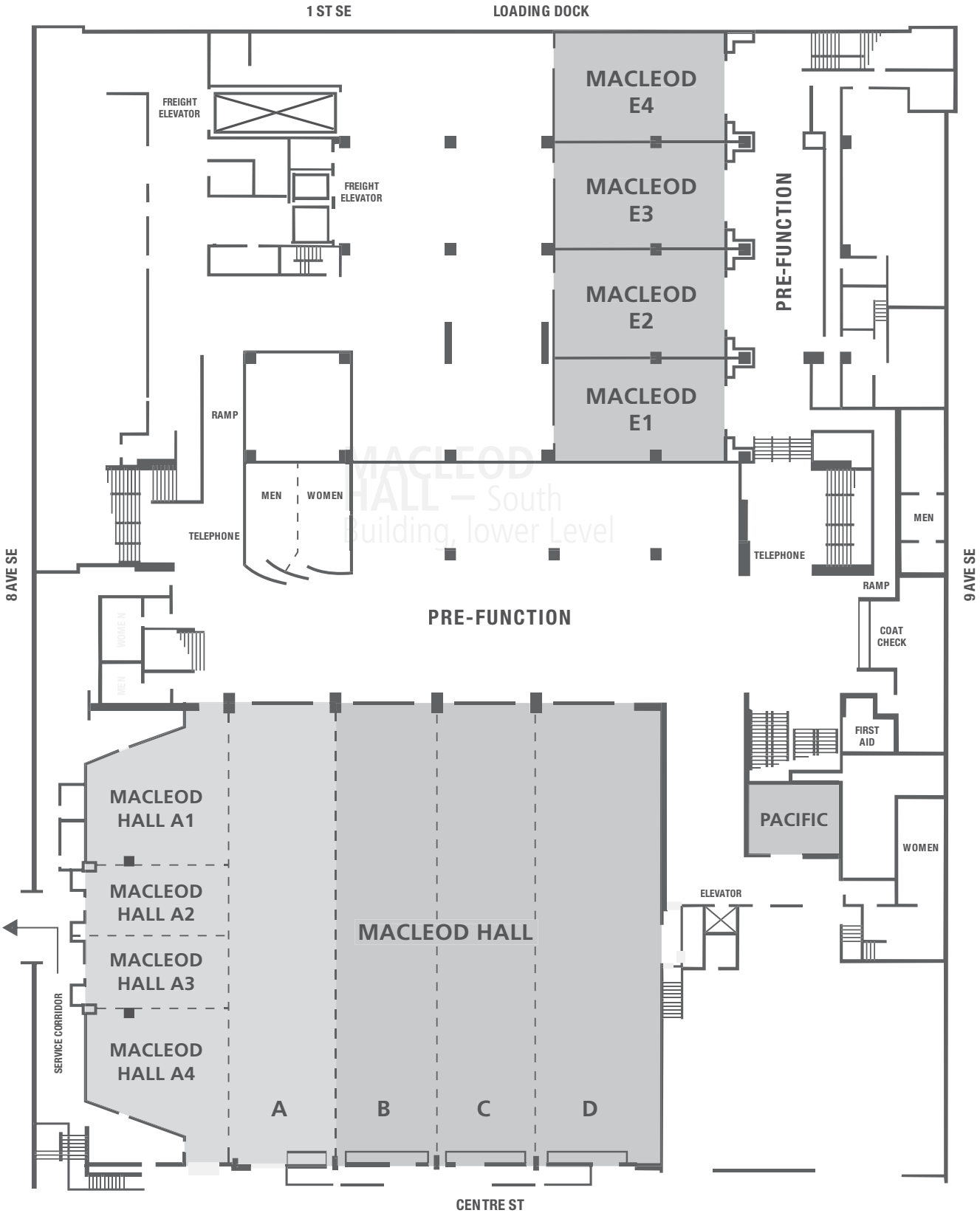
Calgary TELUS Convention Centre

Calgary, Canada

SOCIETY OF VERTEBRATE PALEONTOLOGY
AUGUST 2017
ABSTRACTS OF PAPERS
77th ANNUAL MEETING

TELUS Convention Centre
Calgary, AB, Canada
August 23–26, 2017

MACLEOD HALL – South Building, Lower Level



WELCOME TO CALGARY

Welcome to the Stampede City! Located where the prairies meet the mountains, Calgary has long been the starting point for expeditions into North America's natural history riches. With several UNESCO World Heritage sites nearby, including Dinosaur Provincial Park and the Burgess Shale, we are confident you will find appealing vertebrate fossils, no matter your interest.

There are numerous museums and sites of interest both within the city limits or a short drive from Calgary. The world renowned Royal Tyrrell Museum is an hour and a half drive away, and Head Smashed In Buffalo Jump, another UNESCO World Heritage site, is similarly nearby. Three hours away are the Walcott Quarry to the west in Yoho National Park (Field, BC) and Dinosaur Provincial Park to the east (Brooks, AB). Also 3 hours' drive away is the collection at the Laboratory of Vertebrate Paleontology at the University of Alberta in Edmonton. For the adventurous, consider visits to the Philip Currie Museum of Palaeontology in Grand Prairie, AB, and the Peace River Palaeontological Research Centre in Tumbler Ridge, BC. Between all of these points are some of the world's richest fossil deposits from Cretaceous and Cenozoic times.
We have located this year's Annual Meeting in the heart of downtown, and amenities for all tastes and budgets are available via a short stroll down the Stephen Ave. pedestrian mall. Please venture out and enjoy our famous hospitality!

Jessica Theodor, SVP 77th Annual Meeting Host Committee Co-Chair
Jason Alexander, SVP 77th Annual Meeting Host Committee Co-Chair

PRESENTATION POLICIES

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

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

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

Editorial policies for unpublished work: If you are planning to submit, or have submitted, your work to a journal that has embargo policies, be sure you are familiar with any restrictions they may impose on disseminating it before publication.

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

Citing an Abstract in the 2017 SVP Program and Abstracts Book

This Program and Abstracts Book is an official supplement to the online version of the *Journal of Vertebrate Paleontology.* The citation format for an abstract printed in this book is: *Journal of Vertebrate Paleontology*, Program and Abstracts, 2017, <insert page number here>.

CODE OF CONDUCT

The Society of Vertebrate Paleontology expects meeting attendees to behave in a courteous, collegial, and respectful fashion to each other, student volunteers, SVP staff, and convention center staff. Attendees should respect common sense rules for professional and personal interactions, public behavior (including behavior in public electronic communications), common courtesy, respect for private property, and respect for intellectual property of presenters. Demeaning, abusive, harassing, or threatening behavior towards other attendees or towards volunteers, SVP staff, convention center staff, or security staff is not permitted, either in personal or electronic interactions.

SOCIAL MEDIA GUIDELINES

Please Read Before You Tweet (Or Blog, Or Facebook, Or Instagram…)

The Society of Vertebrate Paleontology encourages open discussion on social media and other outlets at our annual meeting. In order to find a balance between embracing social media and protecting authors' work, we set forth the following guidelines:

- SVP has an embargo in place on discussing presentations until the beginning of the talk or poster session. Please do not discuss presentations until this time if you do not have the authors' permission to do so.

- This embargo exists to protect the authors. As an author, you have permission to break your own embargo or permit someone else to do the same. This includes discussing your own presentation online, posting slides or posters, etc. However, to protect yourself, make sure you are aware of any potential future publisher's policies about early dissemination of work.

- Do not photograph or video tape a talk or poster without the authors' express permission. Never post any images or video without the authors' permission.

- While the default assumption is to allow open discussion of SVP presentations on social media, please respect any request by an author to not disseminate the contents of their talk. The following icon may be downloaded from the SVP website for inclusion on slides or posters to clearly express when an author does not want their results posted:

We want to thank everyone for following these basic guidelines for online posts of all kinds. As a reminder, the official hashtag of the meeting is #2017SVP. We look forward to seeing your thoughts and discussion online!

2017 SVP Schedule of Events (subject to change)
All events are held at the TELUS Convention Centre unless otherwise noted with an **

Tuesday, August 22

3:00pm–7:00pm	**Registration Open**	Coat Check
7:00pm–9:00pm	**Special Lecture by Dr. Mary Schweitzer** Dinosaur molecules: the amazing potential of molecular paleontology	Eckhardt-Gramatté Hall, University of Calgary

Wednesday, August 23

7:00am–7:30pm	**Registration Open**	Coat Check
8:00am–12:15pm	**Podium Symposium**	Macleod C
	Technical Session I	Macleod D
	Technical Session II	Macleod A
9:30am–6:15 pm	**Exhibit and Poster Viewing Hours** **Colbert Prize Competition Posters** (B1–B21) **Colbert Prize posters will be on display Wednesday through Thursday.* **Regular Session Posters** (B22–B103)	Macleod Hall A1-A4 and Prefunction Areas
12:30pm-1:30pm	**Women in Paleo Luncheon**	Macleod Hall D
1:45pm–4:15pm	**Technical Session III**	Macleod C
	Technical Session IV	Macleod D
	Technical Session V	Macleod A
4:15pm–6:15pm	**Poster Session I (Regular Session Posters,** B22–B103**)** **Poster Session I authors will be present at their posters.*	Macleod Hall A1-A4 and Prefunction Areas
7:30pm–10:30pm	**Welcome Reception**	**TELUS Spark

Thursday, August 27

7:00am–6:15pm	**Registration Open**	Coat Check
8:00am–12:15pm	**Romer Prize Session**	Macleod C
	Preparators' Session	Macleod A
	Technical Session VI	Macleod D
9:30am–6:15pm	**Exhibit and Poster Viewing Hours** **Colbert Prize Competition Posters** **Colbert Prize posters (B1–B21) will be on display Wednesday through Thursday.* **Regular Session Posters** (B22–B92)	Macleod Hall A1-A4 and Prefunction Areas

	Posters associated with Preparators' Session (B93-B103)	
12:30pm–1:30pm	**SVP Business Meeting and Open Forum** An opportunity to bring your questions to SVP leadership!	Macleod Hall BC
1:45pm–4:15pm	**Technical Session VII**	Macleod C
	Technical Session VIII	Macleod D
	Technical Session IX	Macleod A
2:00pm–3:30pm	**Preparators' Meeting**	Glen 208-209
4:15pm–6:15pm	**Colbert Prize Competition Posters** (B1–B21) **Authors will be present at their posters.* **Poster Session II (Regular Session Posters,** B22–B92**)** **Poster Session II authors will be present at their posters.* **Posters associated with Preparators' Session** (B93–B103) **Authors will be present at their posters.*	Macleod Hall A1-A4 and Prefunction Areas
7:30pm–11:30pm	**Student and Postdoc Roundtable and Reprint Exchange**	Hyatt Hotel, Imperial Ballroom

Friday, August 28

7:00am–5:00pm	**Registration Open**	Coat Check
8:00am–12:15pm	**Technical Session X**	Macleod C
	Technical Session XI	Macleod D
	Technical Session XII	Macleod A
9:30am–6:15pm	**Exhibit and Poster Viewing Hours** **Regular Session Posters** (B1–B104)	Macleod Hall A1-A4 and Prefunction Areas
1:45pm–4:15pm	**Technical Session XIII**	Macleod C
	Technical Session XIV	Macleod D
	Technical Session XV	Macleod A
4:15pm–6:15pm	**Poster Session III (Regular Session Posters,** B1–B104**)** **Poster Session III authors will be present at their posters.*	Macleod Hall A1-A4 and Prefunction Areas
6:30pm–11:30pm	**Annual Benefit Auction and Social**	**Hyatt Hotel, Imperial Ballroom

Saturday, August 29

7:00am–4:00pm	**Registration Open**	Coat Check
8:00am–12:15pm	**Technical Session XVI**	Macleod C
	Technical Session XVII	Macleod D
	Technical Session XVIII	Macleod A
9:30am–6:15pm	**Exhibit and Poster Viewing Hours**	Macleod Hall A1-A4

	E&O Posters (B1–B20) **Regular Session Posters** (B21–B102**)**	and Prefunction Areas
1:45pm–4:15pm	**Technical Session XIX**	Macleod C
	Technical Session XX	Macleod D
	Technical Session XXI	Macleod A
4:15pm–6:15pm	**E&O Poster Session** (B1–B20**)** **Authors will be present at their posters.* **Poster Session IV (Regular Session Posters,** B21—B102**)** **Poster Session IV authors will be present at their posters.*	Macleod Hall A1-A4 and Prefunction Areas
7:30pm–10:00pm	**Awards Banquet** **Ticket required for admittance*	**Hyatt Hotel, Imperial Ballroom
10:30pm–1:00am	**After Hours Party**	**Hyatt Hotel, Imperial Ballroom

2017 SVP Workshops

**For Pre-registered Attendees*

TUE, August 22 10:00am–4:00pm	**Solutions for Supporting a Diverse SVP Membership**	TELUS Convention Centre, Macleod Hall A
TUE, August 22 9:00am–4:00pm	**Photography and Photoshop 101, Digital Imaging Techniques and Post Processing Basics for Specimen Data Capture**	TELUS Convention Centre, Macleod E3
TUE, August 22 1:00pm–4:30pm	**Paleontology Education: Staying on the Cutting Edge in Research, Pedagogy and Outreach**	TELUS Convention Centre, Macleod E4
TUE, August 22 11:00am–5:00pm	**Morphological Evolution in Deep Time: Calculating Disparity and Rates from Discrete Phenotypic Data**	TELUS Convention Centre, Macleod E2
TUE, August 22 1:00pm–4:30pm	**Thinking About Fossils: The Philosophy of Paleontology**	**Department of Philosophy, University of Calgary

2017 SVP Field Trips

**For Pre-registered Attendees*

**All Field Trips pick up and drop off locations are at or adjacent to the TELUS Convention Centre*

Day/Time	
MON, August 21 **Time:** 5:00am – 8:00pm	**Cambrian Vertebrates: The Walcott Quarry and the Burgess Shale**
MON, August 21 – TUE, August 22 **Time:** Begins Monday, August 21, at 8:00am. Ends Tuesday, August 22, at 9:00pm.	**Campanian-Maastrichtian Dinosaurs and Environments at Dinosaur Provincial Park and Drumheller**
TUE, August 22 **Time:** 8:00 am – 7:00pm	**Visit to the Royal Tyrrell Museum of Paleontology, Drumheller**
SUN, August 27 **Time:** 7:30am – 6:00pm.	**Urban Paleontology: Paleocene Mammal Localities of Calgary and Area**
SUN, August 27 – TUE, August 29 **Time:** Begins Sunday, August 27, at 6:45am. Ends Tuesday, August 29, at 7:00pm.	**The Late Cretaceous of Southeastern Alberta and Southwestern Saskatchewan –Milk River Formation and Belly River Group of Alberta through to the Oligocene (Cypress Hills Formation) of Saskatchewan**
MON, August 28 **Time:** 7:30am – 7:00pm	**Korite Ammolite Mine and Production Facility Tour: An Active Cretaceous Bearpaw Formation Mine-Site in Southern Alberta**
MON, August 28 **Time:** 7:30am – 6:00pm	**Late Cretaceous and Paleocene Mammal Localities from Near Red Deer, Alberta**

PROGRAM AT A GLANCE

	Macleod C	Macleod D	Macleod A	Macleod C	Macleod D	Macleod A
	Podium Symposium: The Tetrapod Limb: A Model System for the Anatomy of Evolutionary Radiation	**Technical Session I**	**Technical Session II**	**Romer Prize Session**	**Technical Session VI**	**Preparator's Session**
	WED	**WED**	**WED**	**THUR**	**THUR**	**THUR**
8:00 am	SEARS	DANTO	WHALEN	MYCHAJLIW	DUNNE	KOWALCHUK
8:15 am	SCHNEIDER	CURRY ROGERS	MIYASHITA	GORSCAK	MANN	DEMUTH
8:30 am	URBAN	SANDER	CHEN	LŽBE	GEE	CHAINEY
8:45 am	FROBISCH	CANOVILLE	VASKANINOVA	BISHOP	JANSEN	CARDENAS
9:00 am	O'KEEFE	CHINSAMY-TURAN	DEARDEN	MARTIN-SILVERSTONE	LOVELACE	KASKES
9:15 am	LARSSON	CHIBA	DENTON	LARSON	ATKINS	BROWNE
9:30 am	SUMIDA	CAMPIONE	COATES	SIMOES	MADDIN	CAPOBIANCO
9:45 am	HEERS	WITHDRAWN	MALTESE	CARRILLO	JIA	GRIECO
10:00 am	COFFEE					
10:15 am	HUTCHINSON	HARIDY	MAXWELL	LEBLANC	FLEAR	SIMPSON
10:30 am	DICKSON	STREET	OTOO	MATSUI	WITZMANN	RHUE
10:45 am	KILBOURNE	BRINK	SYME	VILLASEÑOR	MACDOUGALL	QVARNSTROM
11:00 am	LUNGMUS	BRAMBLE	VERNYGORA	HOERNER	CISNEROS	LISTON
11:15 am	MEACHEN	WANG	GROGAN	FAMOSO	JUNG	FANTI
11:30 am	CROFT	CARR	EHRET	HOFFMAN	ANDRADE	STEVENS
11:45 am	MARCOT	BUTTON	WYND	RANDAU	PEECOOK	LALLENSACK
12:00 pm	POLLY	BHULLAR	KRIWET	SAITTA	ELSLER	LIVELY
12:15 pm	**BREAK**					
1:30 pm						
	Macleod C	**Macleod D**	**Macleod A**	**Macleod C**	**Macleod D**	**Macleod A**
	Technical Session III	**Technical Session IV**	**Technical Session V**	**Technical Session VII**	**Technical Session VIII**	**Technical Session IX**
1:45 pm	TOMLINSON	MARCÉ-NOGUÉ	GILBERT	SULLIVAN	GHEERBRANT	WIEMANN
2:00 pm	WATANABE	FRASER	ORESKA	RASHID	SHELLEY	MCNAMARA
2:15 pm	STRUBLE	O'BRIEN	MOHR	WANG	SOLÉ	BABAROVIC
2:30 pm	HALL	TANIS	BAMFORTH	SERRANO	LÓPEZ-TORRES	PETEYA
2:45 pm	BAUMGART	YAMADA	THERRIEN	O'CONNOR	HONER	COLLEARY
3:00 pm	KSEPKA	KALTHOFF	CULLEN	HANSON	ATWATER	HEIJNE
3:15 pm	FAUX	HAUPT	LAWING	HELLERT	KEMP	ROGERS
3:30 pm	STIDHAM	NGUY	PINEDA-MUNOZ	FIELD	KAY	BEHRENSMEYER
3:45 pm	NAVALON	FERRUSQUIA VILLAFRANCA	BUTLER	BERV	MACLATCHY	LOUGHNEY
4:00 pm	MUSSER	SURAPRASIT	LLOYD	FELICE	TAKASHITA-BYNUM	MCGUIRE
4:15 pm	*Poster Session I*			*Poster Session II*		
6:15 pm						

PROGRAM AT A GLANCE

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4:00 pm	MUSSER	SURAPRASIT	LLOYD	FELICE	TAKASHITA-BYNUM	MCGUIRE
4:15 pm	*Poster Session I*			*Poster Session II*		
6:15 pm						

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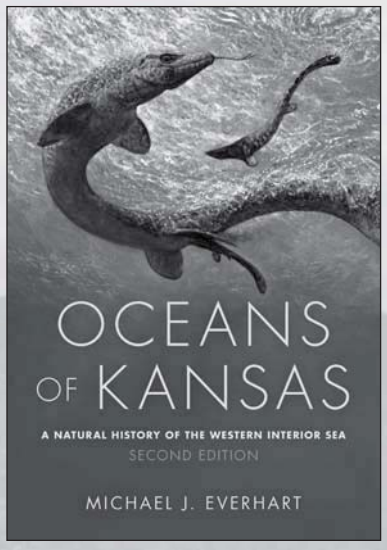

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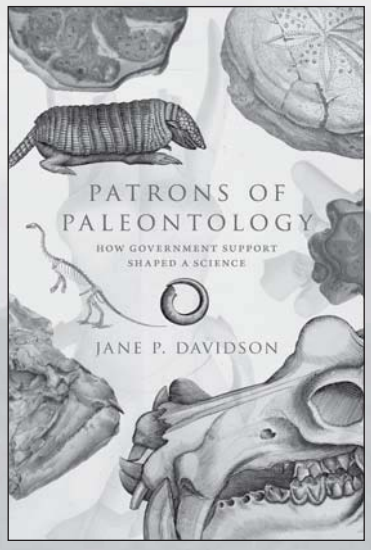
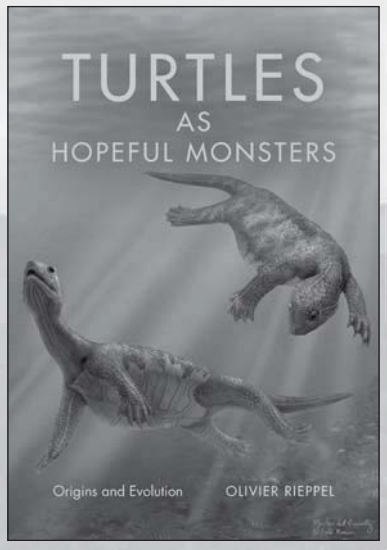


The history of paleontology is uniquely seen through the government patrons who generously funded the field expeditions and research of geologists and paleontologists.



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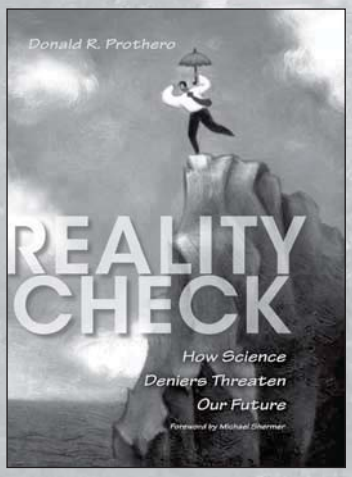

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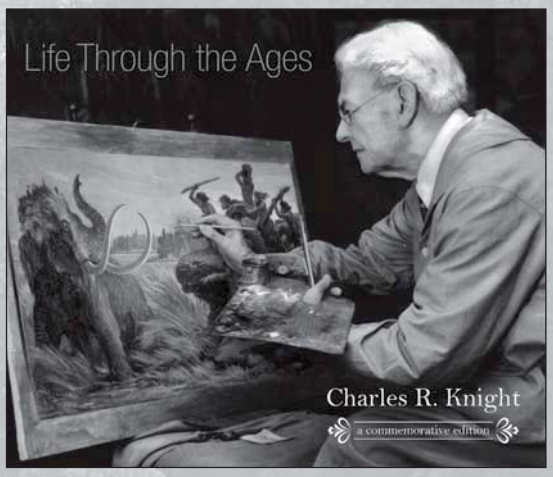

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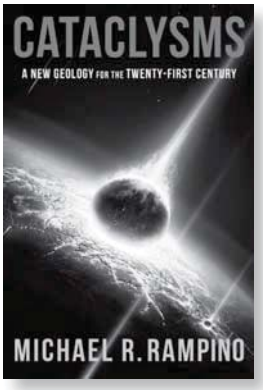

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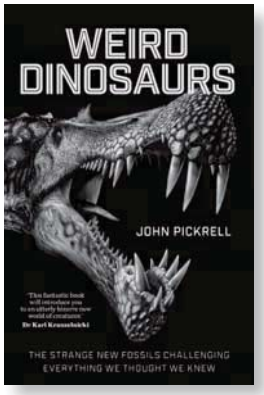

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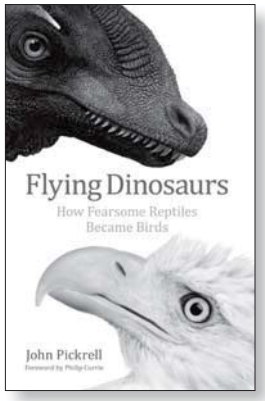

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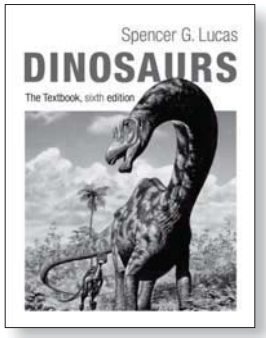

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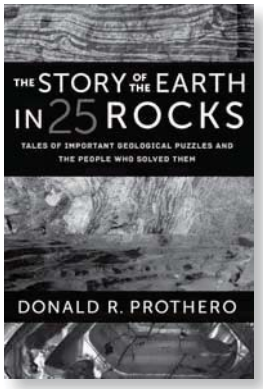

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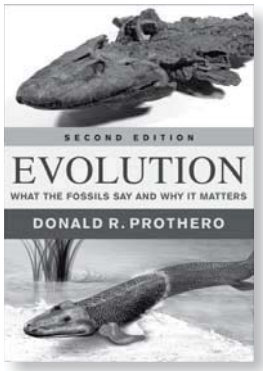

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WEDNESDAY MORNING, AUGUST 23, 2017

PODIUM SYMPOSIUM: THE TETRAPOD LIMB

TELUS CONVENTION CENTRE, MACLEOD C

MODERATORS: Karen Sears and Jonathan Marcot

8:00 **K. Sears, A. Cabrera, D. Ross, D. Urban, J. Maier, S. Zhong, R. Behringer, J. Rasweiler, Z. Rapti** TIMING THE DEVELOPMENTAL ORIGINS OF MAMMALIAN LIMB DIVERSITY

8:15 **I. Schneider, S. Darnet, I. Braasch, P. Schneider, M. Davis, N. B. Fröbisch** APPENDAGE REGENERATION IS AN ANCIENT TRAIT OF OSTEICHTHYES

8:30 **D. J. Urban, K. E. Sears** EVOLUTION AND DEVELOPMENT OF BAT WINGS

8:45 **N. B. Fröbisch, C. Bickelmann, G. Lima, S. Triepel, I. Schneider** PREAXIAL POLARITY IN TETRAPOD LIMB DEVELOPMENT AND EVOLUTION

9:00 **F. O'Keefe, S. Werning, D. J. Morgan** PALEOHISTOLOGY OF A HUMERAL GROWTH SERIES FROM THE CRETACEOUS PLESIOSAUR *DOLICHORHYNCHOPS*: NEW INSIGHTS ON PLESIOSAUR ONTOGENY

9:15 **H. C. Larsson, Y. Kherdjemil, M. Kmita** USE OF EXPERIMENTAL ATAVISMS TO ESTIMATE SOFT TISSUE RECONSTRUCTIONS OF THE EARLIEST TETRAPOD LIMBS

9:30 **S. S. Sumida, D. S. Berman, B. Jefcoat, A. Henrici, T. Martens, K. Devlin** STRUCTURE OF THE PECTORAL LIMB OF THE EARLY PERMIAN BOLOSAURID REPTILE *EUDIBAMUS CURSORIS*: FURTHER EVIDENCE SUPPORTING IT AS THE EARLIEST KNOWN FACULTATIVE BIPED

9:45 **A. Heers, R. Carney** BUILDING A BIRD: A MUSCULOSKELETAL MODEL OF THE *ARCHAEOPTERYX* FLIGHT APPARATUS

10:00 **BREAK**

10:15 **J. R. Hutchinson, S. Regnault, V. Allen** TEARS FOR GEARS: THE EVOLUTIONARY BIOMECHANICS AND DEVELOPMENT OF PATELLAR SESAMOID BONES

10:30 **B. V. Dickson, S. E. Pierce** QUANTITATIVE ASSESSMENT OF 3D HUMERUS MORPHOLOGY ACROSS THE TETRAPOD WATER-LAND TRANSITION

10:45 **B. M. Kilbourne** SELECTIVE REGIMES AND FUNCTIONAL ANATOMY IN THE MUSTELID FORELIMB: DIVERSIFICATION TOWARDS SPECIALIZATIONS FOR CLIMBING, DIGGING, AND SWIMMING

11:00 **J. K. Lungmus** INCREASED LIMB MORPHOLOGICAL DISPARITY COINCIDENT WITH THE EMERGENCE OF MAJOR SYNAPSID CLADES AND SHIFTS TO NEW MORPHOFUNCTIONAL TYPES

11:15 **J. Meachen, R. H. Dunn, C. Cooper, J. Lemert** WHAT CAN THE SCAPHOLUNAR BONE TELL US ABOUT THE LOCOMOTION AND HABITAT OF EXTINCT CARNIVORES?

11:30 **D. A. Croft** PATTERNS OF LIMB ELONGATION IN ENDEMIC SOUTH AMERICAN UNGULATES (NOTOUNGULATA AND LITOPTERNA) AS MEASURED BY METATARSAL/FEMUR RATIO

11:45 **J. D. Marcot** LIMB EVOLUTION OF NORTH AMERICAN UNGULATES IN RESPONSE TO CENOZOIC ENVIRONMENTAL CHANGE

12:00 **P. Polly, J. J. Head** MACROECOLOGY OF LIMBS: ECOMETRICS, COMMUNITY ASSEMBLY, AND CLADE SORTING IN LIMB TRAITS IN NEOGENE CARNIVORA

WEDNESDAY MORNING, AUGUST 23, 2017

TECHNICAL SESSION I

TELUS CONVENTION CENTRE, MACLEOD D

MODERATORS: Kirstin Brink and Kentaro Chiba

8:00 **M. Danto, F. Witzmann, S. E. Pierce, N. B. Fröbisch** DEVELOPMENT AND STRUCTURE OF EARLY TETRAPOD VERTEBRAL CENTRA: A PALEOHISTOLOGICAL APPROACH

8:15 **K. Curry Rogers, R. Martinez, O. Alcober, C. Colombi** COMPARATIVE BONE HISTOLOGY IN THE ISCHIGUALASTO FORMATION (UPPER TRIASSIC): SHEDDING LIGHT ON EARLY DINOSAUR GROWTH PATTERNS

8:30 **P. Sander** SYSTEMATIC VALUE OF LONG BONE HISTOLOGY OF MAJOR DINOSAUR CLADES

8:45 **A. Canoville, T. Yang, L. Zanno, W. Zheng, M. Schweitzer** PALEOHISTOLOGY OF A GRAVID OVIRAPTOROSAURIAN DINOSAUR FROM THE UPPER CRETACEOUS NANXIONG FORMATION, CHINA, WITH AN ENIGMATIC ENDOSTEAL TISSUE

9:00 **A. Chinsamy-Turan, I. Cerda, D. Pol, C. Apaldetti, Otero, J. Powell, R. N. Martínez** GROWTH DYNAMICS OF SAUROPODOMORPH DINOSAURS

9:15 **K. Chiba, N. E. Campione, D. C. Evans** EMPIRICAL TESTING OF DEVELOPMENTAL MASS EXTRAPOLATION FOR IMPROVED GROWTH CURVE RECONSTRUCTION

9:30 **N. Campione, D. C. Evans** COMPARING SCALING AND VOLUMETRIC METHODS FOR DINOSAUR BODY MASS ESTIMATION

9:45 **Withdrawn**

10:00 **BREAK**

10:15 **Y. Haridy, A. R. LeBlanc, R. R. Reisz** TOOTH REPLACEMENT, MIGRATION, AND LOSS IN THE EARLIEST ACRODONT REPTILE

10:30 **H. P. Street, A. R. LeBlanc, M. W. Caldwell** HISTOLOGIC ANALYSIS OF MOSASAUR TOOTH CROWN FEATURES AND THEIR DEVELOPMENTAL SIGNIFICANCE

10:45 **K. Brink, T. Grieco, J. Richman** MORPHOGENESIS OF THE EGG TOOTH IN THE LEOPARD GECKO AS A MODEL FOR THE DEVELOPMENT OF DENTAL SIZE VARIATION IN AMNIOTES

11:00 **K. K. Bramble, A. R. LeBlanc, M. Wosik, P. J. Currie** HISTOLOGY AND INTERNAL ANATOMY OF AN ENTIRE HADROSAURID DENTAL BATTERY WITH EVIDENCE OF TOOTH MIGRATION

11:15 **S. Wang, J. Stiegler, D. Hu, A. Balanoff, X. Xu** EVIDENCE FOR ONTOGENETIC TOOTH REDUCTION IN OVIRAPTOROSAURS AND BIRDS, AND THE MACROEVOLUTION OF EDENTULISM IN THEROPODA

11:30 **T. D. Carr, J. Sedlmayr, D. J. Varricchio, E. Roberts, J. Moore** NO LIPS FOR *T. REX*: THE CROCODILE-LIKE FACIAL INTEGUMENT AND SENSORY SYSTEM OF TYRANNOSAURS

11:45 **K. Button, L. Zanno** OSTEOLOGICAL CORRELATES OF RHAMPHOTHECA MORPHOLOGY IN BIRDS: RAMIFICATIONS FOR SOFT TISSUE RECONSTRUCTION IN THEROPODS

12:00 **B. S. Bhullar, M. Hanson, J. Botelho, D. Smith, M. Faunes, D. Field, M. Fabbri, D. A. Burnham, L. E. Wilson** ITERATIVE EVOLUTIONARY AND DEVELOPMENTAL APPEARANCE OF THE AVIAN BEAK REVEALED BY NEW FOSSIL AND EMBRYOLOGICAL DATA

WEDNESDAY MORNING, AUGUST 23, 2017

TECHNICAL SESSION II

TELUS CONVENTION CENTRE, MACLEOD A

MODERATORS: Erin Maxwell and Dana Ehret

8:00 **C. D. Whalen, D. E. Briggs** THE PALEOZOIC RISE OF EUNEKTIC VERTEBRATES

8:15 **T. Miyashita, S. A. Green, A. Oel, A. Palmer, W. Allison, M. E. Bronner** EVOLUTIONARY ORIGINS OF THE ENDOSKELETAL JOINT IN VERTEBRATES

8:30 **D. Chen, H. Blom, S. Sanchez, P. Tafforeau, P. Ahlberg** THE FIRST HARD EVIDENCE FOR THE"OUTSIDE-IN" THEORY OF THE ORIGIN OF TEETH: 3D SYNCHROTRON DENTAL HISTOLOGY OF THE SILURIAN STEM OSTEICHTHYAN *LOPHOSTEUS*

8:45 **V. Vaskaninova, P. E. Ahlberg** UNEXPECTED DENTITIONS DISCOVERED IN THREE GENERA OF EARLY DEVONIAN ACANTHOTHORACID PLACODERMS FROM THE PRAGUE BASIN (CZECH REPUBLIC)

9:00 **R. P. Dearden, M. D. Brazeau** THE EARLIEST THREE-DIMENSIONALLY PRESERVED CHONDRICHTHYAN BRANCHIAL SKELETON IN THE EARLY DEVONIAN ACANTHODIAN *PTOMACANTHUS ANGLICUS*

9:15 **J. S. Denton, A. Pradel, A. Bronson, R. Miller, C. Burrow, P. Janvier, J. Maisey** BASAL CHONDRICHTHYAN PHYLOGENY AND A NEW AFFINITY FOR *DOLIODUS PROBLEMATICUS* SUGGEST A COMPLEX PATTERN OF PECTORAL EVOLUTION SPANNING THE ACANTHODIAN-CHONDRICHTHYAN TRANSITION

9:30 **M. Coates, K. Tietjen** ARCHES AND ACTINOPTS: HYOID COMPOSITION AND RESOLVING THE BUSH AT THE BASE OF THE RAY-FIN TREE

9:45 **A. Maltese, J. Liston** PETTY TRIBALISM UNMASKED: OVEREMPHASIS ON DERMATOCRANIAL DATA IN PACHYCORMIDAE LEADS TO SKEWED INTRAFAMILIAL PATTERNS

10:00 **BREAK**

10:15 **E. E. Maxwell, T. Argyriou, R. Stockar, H. Furrer** RE-EVALUATION OF THE ONTOGENY AND REPRODUCTIVE BIOLOGY OF *SAURICHTHYS* (ACTINOPTERYGII)

10:30 **B. K. Otoo, J. A. Clack, T. R. Smithson, C. E. Bennett, T. I. Kearsey, M. I. Coates** A RASH OF RHIZODONTS: CHARACTERIZING A VERTEBRATE BIOTA IN THE IMMEDIATE POST-DEVONIAN WORLD

10:45 **C. Syme, S. Salisbury, K. Welsh, E. Roberts** LIVING BY THE EROMANGA SEA: EVIDENCE OF BRACKISH-WATER TOLERANT CROCODYLIFORMS AND OSTEICHTHYANS FROM THE LOWER CRETACEOUS WINTON FORMATION AT ISISFORD, QLD

11:00 **O. V. Vernygora, A. M. Murray** PHYLOGENETIC REASSESSMENT OF *ARMIGATUS ALTICORPUS* (TELEOSTEI, CLUPEOMORPHA, ELLIMMICHTHYIFORMES) AND NEW CLUPEOMORPH MATERIAL FROM THE LATE CRETACEOUS (CENOMANIAN) OF HAKEL, LEBANON

11:15 **E. D. Grogan, R. Lund** A NON-CONFORMIST: THE BEAR GULCH LIMESTONE CHONDRICHTHYAN LIONFISH

11:30 **D. J. Ehret, J. A. Ebersole** NEW LATE CRETACEOUS (SANTONIAN-CAMPANIAN) GENUS OF LAMNIFORM SHARK FROM THE MOOREVILLE CHALK OF ALABAMA, USA

WEDNESDAY MORNING, AUGUST 23, 2017
TECHNICAL SESSION II
(CONTINUED)

11:45 **B. M. Wynd, D. G. DeMar, G. P. Wilson** DIVERSITY OF CHONDRICHTHYANS THROUGH THE UPPERMOST CRETACEOUS (MAASTRICHTIAN) HELL CREEK FORMATION OF GARFIELD COUNTY, MONTANA, WITH IMPLICATIONS FOR THE CRETACEOUS-PALEOGENE MASS EXTINCTION

12:00 **J. Kriwet, T. Moers, M. A. Reguero, W. Kiessling, A. Engelbrecht** DIVERSITY DYNAMICS ARE LINKED TO CLIMATE CHANGE IN CARTILAGINOUS FISHES (CHONDRICHTHYES, HOLOCEPHALI ELASMOBRANCHII) FROM THE EOCENE OF ANTARCTICA

WEDNESDAY AFTERNOON, AUGUST 23, 2017
TECHNICAL SESSION III
TELUS CONVENTION CENTRE, MACLEOD C
MODERATORS: Stephanie Baumgart and Thomas Stidham

1:45 **C. A. Tomlinson, D. A. Burnham** ANIMATING PALEOGNATHOUS AND NEOGNATHOUS PALATAL FUNCTION TO PREDICT CRANIAL KINESIS IN THE UNKNOWN COMMON NEORNITHINE ANCESTOR

2:00 **J. Watanabe** COMPARATIVE ONTOGENY OF AVIAN LIMB SKELETON: IMPLICATIONS FOR ONTOGENETIC AGEING AND EVOLUTIONARY VARIABILITY

2:15 **M. K. Struble, J. Gardner, C. Organ** BIOMECHANICAL STRESSES OF PEDAL GRASPING BEHAVIOR WITHIN MODERN AVES: MORPHOLOGICAL ADAPTATIONS AND MESOZOIC IMPLICATIONS

2:30 **J. Hall** THE FUNCTIONAL SIGNIFICANCE OF PTILOPODY IN EXTANT AND EXTINCT BIRDS

2:45 **S. Baumgart** RELATING ECOLOGY TO STERNUM MORPHOLOGY IN"WATER BIRDS"

3:00 **D. Ksepka, F. Degrange, C. P. Tambussi** THE OLDEST CROWN CLADE PENGUIN: OSTEOLOGY, JAW MYOLOGY, AND NEUROANATOMY OF *MADRYNORNIS MIRANDUS*

3:15 **C. Faux, D. Field** DIFFERENTIAL GROWTH RATE IN THE WINGS OF RATITE EMBRYOS SUPPORT INDEPENDENT FLIGHT LOSS MECHANISMS

3:30 **T. A. Stidham, Z. Li, Z. Zhou, T. Deng** A LATE MIOCENE OSTRICH (STRUTHIONIDAE) POPULATION FROM HEZHENG, CHINA AND IMPLICATIONS FOR THE PALEOBIOLOGY, TAXONOMY, EVOLUTION, AND BIOGEOGRAPHY OF EURASIAN OSTRICHES

3:45 **G. Navalón, J. A. Bright, J. Marugán-Lobón, E. J. Rayfield** CRANIAL INTEGRATION PATTERNS IN LANDBIRDS AND IMPLICATIONS FOR THE DIVERSIFICATION OF PASSERINES

4:00 **G. M. Musser** RESOLVING THE RADIATION AND PHENOTYPIC EVOLUTION OF BASAL NEOAVES: BEGINNING CONSTRUCTION OF A NEW MORPHOLOGICAL DATASET AND A NOVEL SISTER TAXON FOR *APTORNIS*

WEDNESDAY AFTERNOON, AUGUST 23, 2017
TECHNICAL SESSION IV
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Daniela Kalthoff and Ryan Haupt

1:45 **J. Marcé-Nogué, J. P. Gailer, T. M. Kaiser** PRIMATE CHEWING BIOMECHANICS: THE PERSPECTIVE OF THE DAMAGE IN FOODS

WEDNESDAY AFTERNOON, AUGUST 23, 2017
TECHNICAL SESSION IV
(CONTINUED)

2:00 **D. L. Fraser, R. J. Haupt, W. Barr** TOOTH WEAR DIETARY PROXIES SHOW STRONG PHYLOGENETIC SIGNAL

2:15 **H. O'Brien, M. Belmaker** MESOWEAR METHOD COMPARISONS DEMONSTRATE NARROWER ORDINAL SCALES ARE MORE PREDICTIVE OF DIETARY AND ECOLOGICAL VARIABLES

2:30 **B. P. Tanis, L. R. DeSantis, R. C. Terry** LINKING MICROWEAR ACROSS THE DENTAL ARCADE: ARE CANID DIETARY SIGNALS FROM THE M1 TALONID COMPARABLE TO THE M2?

2:45 **E. Yamada, M. O. Kubo, T. Kubo, N. Kohno** THREE DIMENSIONAL MICROWEAR ANALYSIS WITH ISO SURFACE ROUGHNESS PARAMETERS FOR EXPLORING THE DOMESTICATED PIG IN THE PAST

3:00 **D. C. Kalthoff, J. L. Green** HARMONIOUS COLLABORATION OF DENTAL MICROWEAR ANALYSES BY STEREOMICROSCOPY AND SCANNING ELECTRON MICROSCOPY: THE CASE OF OLIGOCENE SLOTHS (MAMMALIA, XENARTHRA)

3:15 **R. J. Haupt, M. Clementz, R. N. Cliffe** ISOTOPIC OFFSETS BETWEEN DIET AND HAIR AND FECES IN EXTANT SLOTHS: IMPLICATIONS FOR PALEONTOLOGICAL INTERPRETATIONS

3:30 **W. Nguy, R. Secord** RECONSTRUCTING THE PALEOENVIRONMENT OF MIDDLE MIOCENE NEBRASKA, USA FROM STABLE ISOTOPES IN THE TEETH OF LARGE HERBIVORES

3:45 **I. Ferrusquia Villafranca, V. Pérez-Crespo, J. Ruiz-González, J. Torres-Hernández, P. Morales-Puente, E. Martinez-Hernandez, E. Cienfuegos-Alvarado** DIETARY PREFERENCES OF *PLIOHIPPUS POTOSINUS* PASO DEL AGUILA LOCAL FAUNA, CLARENDONIAN OF SAN LUIS POTOSI, CENTRAL-EASTERN MEXICO INFERRED FROM CARBON AND OXYGENE STABLE ISOTOPE RELATIONSHIPS

4:00 **K. Suraprasit, Y. Chaimanee, H. Bocherens, J. Jaeger** PALEOECOLOGICAL AND PALEOCLIMATIC RECONSTRUCTIONS OF THE PLEISTOCENE KHOK SUNG VERTEBRATE FAUNA (NAKHON RATCHASIMA PROVINCE, NORTHEASTERN THAILAND): STABLE CARBON AND OXYGEN ISOTOPE INVESTIGATIONS OF UNGULATE TOOTH ENAMEL

WEDNESDAY AFTERNOON, AUGUST 23, 2017
TECHNICAL SESSION V
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Emily Bamforth and Sidney Mohr

1:45 **M. M. Gilbert, E. L. Bamforth** PALEOECOLOGY OF A VERTEBRATE MICROFOSSIL ASSEMBLAGE FROM THE EASTERNMOST DINOSAUR PARK FORMATION (UPPER CAMPANIAN) SASKATCHEWAN, CANADA: RECONSTRUCTING DIVERSITY IN A COASTAL ECOSYSTEM

2:00 **M. P. Oreska, M. T. Carrano** A BAYESIAN APPROACH TO TERRESTRIAL PALEOECOLOGY: PALEOENVIRONMENTAL MIXING IN VERTEBRATE MICROFOSSIL ASSEMBLAGES FROM THE DINOSAUR PARK FORMATION (UPPER CRETACEOUS)

2:15 **S. R. Mohr, J. H. Acorn, P. J. Currie** ISOLATED"BIRD" TEETH FROM THE CRETACEOUS OF ALBERTA ARE FROM JUVENILE CROCODILIANS

2:30 **E. L. Bamforth, T. Tokaryk, H. C. Larsson** MARINE INFLUENCE AS A HIDDEN DRIVER OF PALEOBIODIVERSITY: AN EXAMPLE FROM THE LATEST CRETACEOUS (66 MA) OF SOUTHWEST SASKATCHEWAN, CANADA

WEDNESDAY AFTERNOON, AUGUST 23, 2017
TECHNICAL SESSION V
(CONTINUED)

2:45 **F. Therrien, D. K. Zelenitsky, D. B. Brinkman, A. Quinney, K. Tanaka, D. Eberth** THE END OF AN ERA: FAUNAL, PALEOENVIRONMENTAL, AND PALEOCLIMATIC CHANGES IN THE UPPERMOST CAMPANIAN-LOWERMOST PALEOCENE EDMONTON GROUP OF ALBERTA, CANADA

3:00 **T. M. Cullen, F. J. Longstaffe, U. G. Wortmann, M. B. Goodwin, L. Huang, D. C. Evans** STABLE ISOTOPE ANALYSIS OF AN EXTANT VERTEBRATE COMMUNITY USING PALEONTOLOGICAL SAMPLING CONSTRAINTS REVEALS LOW ECOLOGICAL RESOLUTION IN A C_3 FLOODPLAIN SYSTEM

3:15 **A. Lawing, J. L. McGuire, K. Maguire, S. Goring, J. Blois** OCCUPANCY MODELING IN PALEOECOLOGY

3:30 **S. Pineda-Munoz** NEW METHOD FOR PALEOECOLOGICAL RECONSTRUCTION AND ECOMORPHOSPACE ANALYSIS: SAMPLING THE SPATIAL DISTRIBUTION OF DATA ACROSS MORPHOSPACES

3:45 **R. J. Butler, R. A. Close, R. B. Benson, E. M. Dunne, J. Benito** PATTERNS OF ALPHA DIVERSITY FOR PHANEROZOIC TERRESTRIAL VERTEBRATES

4:00 **G. T. Lloyd** WHAT THE VERTEBRATE FOSSIL RECORD CONTRIBUTES TO CONSERVATION BIOLOGY PRIORITIES

WEDNESDAY - THURSDAY, AUGUST 23-24, 2017
SVP 2017 EDWIN H. AND MARGARET M. COLBERT PRIZE COMPETITION POSTER
TELUS CONVENTION CENTRE, MACLEOD A1-A4 AND PREFUNCTION
Authors must be present from 4:15 - 6:15 p.m. Thursday, August 24

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

B1 **L. S. Lassiter, D. K. Elliott** A PHYLOGENETIC REVIEW OF THE HETEROSTRACAN FAMILY CYATHASPIDIDAE

B2 **J. Chen** NEW CRANIAL FEATURES OF THE OLIGOCENE FOSSIL FROG *MACROPELOBATES OSBORNI* (ANURA: PELOBATOIDEA) RECONSTRUCTED USING X-RAY CT SCANNING, AND A RE-ASSESSMENT OF THE BIOGEOGRAPHIC HISTORY OF SPADEFOOT TOADS

B3 **K. L. Koeller, M. R. Stocker, S. J. Nesbitt** A LARGE ARCHOSAURIFORM (?ERYTHROSUCHIDAE) MAXILLA FROM THE MIDDLE TRIASSIC MOENKOPI FORMATION SHEDS LIGHT ON THE BIOGEOGRAPHY OF LARGE BODY SIZE EVOLUTION DURING THE POST-PERMIAN ARCHOSAURIFORM RADIATION

B4 **K. K. Formoso, S. J. Nesbitt, M. R. Stocker, A. C. Pritchard, W. Parker** A LONG-NECKED TANYSTROPHEID FROM THE MIDDLE TRIASSIC MOENKOPI FORMATION GIVES INSIGHTS INTO THE BIOGEOGRAPHY AND ECOLOGY OF TANYSTROPHEIDS

B5 **M. Yamashita, T. Tsuihiji** THE RELATIONSHIP BETWEEN HARD AND SOFT TISSUE OF THE EYE IN EXTANT LIZARDS: TOWARD RECONSTRUCTION OF THE VISUAL SENSITIVITY AND DIVING BEHAVIOR IN FOSSIL REPTILES

*Numbers beginning with "B" represent the poster board number in Exhibit Hall.

B6 **R. C. Garbin, M. Böhme, W. G. Joyce** NEW GEOEMYDID MATERIAL FROM THE EOCENE OF VIETNAM AND ITS IMPLICATION FOR GEOEMYDID SYSTEMATICS

B7 **C. T. Griffin, K. D. Angielczyk** THE EVOLUTION OF THE DICYNODONT SACRUM, WITH IMPLICATIONS FOR EVOLUTIONARY CONSTRAINT IN THE VERTEBRAL COLUMN OF MAMMALIA

B8 **P. Lai, A. Biewener, S. E. Pierce** RANGE OF MOTION AND MUSCLE ATTACHMENTS IN A CYNODONT PECTORAL GIRDLE AND FORELIMB

B9 **J. V. Proffitt, C. R. Torres, J. A. Clarke, M. A. Norell** AN EXCEPTIONALLY PRESERVED FULMARINE PROCELLARIIFORM FROM THE MIOCENE OF CALIFORNIA

B10 **A. C. Cincotta, V. Debaille, A. Gerdes, S. Sinitsa, S. Reshetova, K. Pestchevitskaya, M. McNamara, J. Yans, P. Godefroit** AGE, SEDIMENTOLOGY AND PALEOECOLOGY OF KULINDA, AN EXCEPTIONAL MIDDLE JURASSIC DINOSAUR LOCALITY FROM SIBERIA

B11 **M. Wosik, K. Chiba, D. C. Evans** LIFE HISTORY OF *EDMONTOSAURUS* FROM THE LATE CRETACEOUS (MAASTRICHTIAN) RUTH MASON DINOSAUR QUARRY, SOUTH DAKOTA, UNITED STATES

B12 **K. Schroeder, T. E. Williamson, S. Brusatte, M. Espy, C. Gautier, J. Hunter, A. Losko, R. Nelson, S. Vogel** NEUTRON COMPUTED TOMOGRAPHY OF CRETACEOUS TYRANNOSAUROID *BISTAHIEVERSOR SEALEYI* AND PALEOCENE PHENACODONTID *TETRACLAENODON PUERCENSIS* SKULLS SHOWS DETAIL NOT EASILY VISIBLE WITH X-RAY CT

B13 **K. Jäger, R. Cifelli, T. Martin** TOOTH ERUPTION AND POSSIBLE DIMORPHISM IN *TRICONODON MORDAX*

B14 **T. Plogschties, T. Martin** THE MASTICATORY CYCLE IN ACUTE ANGLED SYMMETRODONTS

B15 **R. C. Hielscher, R. Schellhorn, T. Martin** STATISTICAL ANALYSES OF MOLAR CROWN RELIEF OF BATS WITH LINKS TO FOOD PREFERENCES

B16 **T. Engler, R. C. Hielscher, T. Martin** INFERRING DIETARY ADAPTATIONS OF PALEOCENE SMALL MAMMALS FROM WALBECK (GERMANY) BY MOLAR RELIEF INDEX

B17 **K. A. Prufrock, J. M. Perry** CRESTS, CUSPS, AND DIET OF ASIADAPIDS (ADAPOIDEA, EUPRIMATES) FROM VASTAN MINE (GUJARAT, INDIA)

B18 **N. S. Vitek, S. G. Strait, D. M. Boyer, J. I. Bloch** MORPHOLOGICAL RESPONSE OF THREE CLOSELY RELATED SMALL-BODIED MAMMALS (EULIPOTYPHLA, ERINACEOMORPHA) TO CLIMATE CHANGE ACROSS THE PALEOCENE-EOCENE THERMAL MAXIMUM

B19 **J. E. Grimes, D. S. Taylor, R. C. Terry** MORPHOLOGICAL AND ISOTOPIC ASSESSMENT OF DIETARY FLEXIBILITY: DIFFERENT STRATEGIES ALLOWING FOR PERSISTENCE IN THE FACE OF NATURAL AND ANTHROPOGENIC ENVIRONMENTAL CHANGE

B20 **D. M. Reuter, S. S. Hopkins, N. A. Famoso** MAMMALIAN COMMUNITY STRUCTURE THROUGH TIME: OREGON MIOCENE COMMUNITY CHANGE IN RESPONSE TO SPREADING GRASSLANDS

B21 **B. McHorse, S. E. Pierce** DIVERSITY DYNAMICS AND DIGIT REDUCTION IN FOSSIL HORSES

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WEDNESDAY, AUGUST 23, 2017

POSTER SESSION I

TELUS CONVENTION CENTRE, MACLEOD A1-A4 AND PREFUNCTION

Authors must be present from 4:15 - 6:15 p.m. Wednesday, August 23

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

B22 **M. D. Karaus, J. L. Green** VARIATION IN ORTHODENTIN MICROWEAR ALONG THE TOOTH ROW IN THE CARNIVORE-OMNIVORE *EUPHRACTUS SEXCINCTUS* (XENARTHRA, CINGULATA)

B23 **T. J. Gaudin** AN ISOLATED PETROSAL OF THE PAMPATHERE *HOLMESINA FLORIDANUS* FROM THE BLANCAN NALMA OF FLORIDA

B24 **S. M. Beery, R. K. McAfee** EXPLORATION OF INTERSPECIFIC VARIATION IN *PAROCNUS* (MAMMALIA: PILOSA: MEGALONYCHIDAE) FROM HISPANIOLA: PRELIMINARY IMPLICATIONS FOR TAXONOMIC REVISION AND DIVERSITY

B25 **E. A. Buchholtz, A. Feldman, H. McDonald, T. J. Gaudin** IS THE MAMMALIAN PRESTERNUM COMPOSITE? EVIDENCE FROM *PARAMYLODON HARLANI*

B26 **J. Brinkkötter, A. H. Schwermann, T. Martin** MOLAR FUNCTION OF JURASSIC PSEUDOTRIBOSPHENIC DOCODONTS (MAMMALIAFORMES) AND TRIBOSPHENIC *MONODELPHIS* (DIDELPHIDAE) IS SIMILAR IN CRUSHING AND GRINDING EFFICIENCY

B27 **E. Panciroli, J. A. Schultz, Z. Luo** MORPHOLOGY OF THE PETROSAL AND STAPES OF *BOREALESTES SERENDIPITUS* (MAMMALIAFORMES, DOCODONTA) FROM THE JURASSIC OF SKYE, SCOTLAND

B28 **N. Ikegami, Y. Tomida** FIRST METATHERIAN MAMMAL FROM JAPAN: PALEOBIOGEOGRAPHIC IMPLICATIONS

B29 **T. Harper, G. Rougier** SYSTEMATIC AND FUNCTIONAL IMPLICATIONS OF NEW MATERIAL FROM THE LATE CRETACEOUS MAMMAL *REIGITHERIUM*

B30 **N. A. Brand, A. B. Heckert, J. R. Foster, R. K. Hunt-Foster** THE MICROVERTEBRATE FOSSIL ASSEMBLAGE OF THE UPPER CRETACEOUS (CAMPANIAN – MAASTRICHTIAN) WILLIAMS FORK FORMATION, WESTERN COLORADO

B31 **J. J. Eberle, W. A. Clemens, P. S. Druckenmiller, G. M. Erickson, A. R. Fiorillo** NEW INSIGHTS INTO A MAASTRICHTIAN MAMMALIAN FAUNA FROM THE NORTH SLOPE OF ALASKA

B32 **F. Mao, X. Zheng, X. Wang, Y. Wang, S. Bi, J. Meng** POSSIBLE DIPHYODONTY AS EVIDENCE OF MAMMALNESS FOR HARAMIYIDANS

B33 **D. W. Krause, S. Hoffmann, S. Werning** FIRST POSTCRANIAL REMAINS OF MULTITUBERCULATES (ALLOTHERIA, MAMMALIA) FROM GONDWANA

B34 **M. Chen, M. T. Carrano** REVISITING THE FEEDING ECOLOGY OF *PTILODUS MONTANUS* (MAMMALIA: MUTITUBERCULATA) USING 3D MODELING

B35 **T. Templeman, J. J. Eberle, D. L. Lofgren, D. W. Krause** NEW EARLIEST PALEOCENE (PUERCAN) MULTITUBERCULATES FROM THE CHINA BUTTE MEMBER OF THE FORT UNION FORMATION, GREAT DIVIDE BASIN, WYOMING

B36 **T. E. Williamson, B. Standhardt, C. Leslie** THERIAN MAMMALS FROM THE LOWER BLACK PEAKS FORMATION, BIG BEND NATIONAL PARK, TEXAS ARE TORREJONIAN, NOT PUERCAN, IN AGE

B37 **J. P. Hunter, N. H. Honer, D. W. Krause, J. H. Hartman** A MID PALEOCENE MAMMALIAN FAUNA FROM EASTERN MONTANA

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WEDNESDAY, AUGUST 23, 2017
POSTER SESSION I
(CONTINUED)

B38 **R. A. Ridder, K. Beard** MAMMAL COMMUNITY COMPOSITION AT A NEWLY-DISCOVERED LATE TIFFANIAN (TI-5) SITE IN SOUTHWESTERN WYOMING

B39 **G. Metais, E. De Bast** A NEW PLEURASPIDOTHERIID MAMMAL FROM THE LATEST PALEOCENE OF FRANCE AND ITS PHYLOGENETIC IMPLICATIONS

B40 **S. P. Zack, K. D. Rose, K. Kumar, R. Rana, T. Smith** AN ENIGMATIC NEW UNGULATE FROM THE EARLY EOCENE OF INDIA

B41 **K. Miyata, Y. Okazaki, H. Sakai, Y. Tomida** TAXONOMIC EVALUATION OF A CORYPHODONTID PANTODONTAN (MAMMALIA, PANTODONTA) FROM THE MIDDLE EOCENE OYAKE FORMATION, FUKUOKA PREFECTURE, JAPAN

B42 **S. V. Robson, E. B. Davis, N. A. Famoso, S. S. Hopkins** FIRST MESONYCHID KNOWN FROM THE CLARNO FORMATION (EOCENE) OF OREGON

B43 **D. Lofgren, D. Hanneman, J. Bibbens , B. Kong, A. Tarakji** MAMMALIAN BIOSTRATIGRAPHY OF HIGH ELEVATION TERTIARY STRATA IN THE GRAVELLY RANGE, SOUTHWESTERN MONTANA

B44 **J. W. Westgate** A MECO RAIN FOREST COMMUNITY FROM THE MIDDLE EOCENE LAREDO FORMATION

B45 **S. Mallick** DISSECTING THE EVOLUTIONARY HISTORY OF ELEPHANTS

B46 **B. Sun, S. Wang, T. Deng** MIOCENE MAMMALIAN FAUNAS FROM THE WUSHAN, CHINA, AND THEIR SIGNIFICANCE FOR EVOLUTION, BIOCHRONOLOGY, AND BIOGEOGRAPHY

B47 **S. R. Johnston, W. J. Sanders** AGE, AFFINITY, AND SUCCESSION OF STEGODONTID PROBOSCIDEANS FROM MIDDLE MIOCENE-LATE PLIOCENE FORMATIONS OF THE SIWALIK SEQUENCE IN SOUTH ASIA

B48 **P. A. Groenewald, D. D. Stynder, J. C. Sealy, K. M. Smith** RESOURCE PARTITIONING AMONG THREE FOSSIL PROBOSCIDEAN SPECIES FROM THE SOUTH AFRICAN MIOCENE/PLIOCENE FOSSIL LOCALITY OF LANGEBAANWEG 'E' QUARRY

B49 **B. S. Alves, L. A. Silva, T. R. Pansani, M. A. Dantas, A. V. Araújo, H. Bocherens** ISOTOPIC PALAEOECOLOGY ($\delta^{13}C$) OF THE LATE PLEISTOCENE MEGAMAMMALS OF AMERICA (FLORIDA, MEXICO AND BRAZIL): FINDING THE KEY SPECIES IN THE STRUCTURATION OF THESE COMMUNITIES

B50 **V. A. Pérez-Crespo, E. Corona-M, J. Arroyo-Cabrales, P. Morales-Puente, E. Cienfuegos-Alvarado, F. J. Otero** ISOTOPIC INFORMATION ON PLEISTOCENE MAMMALS FROM THE STATE OF MORELOS, MÉXICO

B51 **D. A. Esker** TRACKING THE LAST MEALS AND MOVEMENTS OF AN ADOLESCENT *MAMMUTHUS COLUMBI* WITH STABLE ISOTOPE ANALYSIS OF ENAMEL AND VEGETATION

B52 **K. M. Smith, A. C. Dooley** TUSK MORPHOLOGY IN THE VALLEY OF THE MASTODONS (CALIFORNIA, USA): ARE WESTERN MASTODON TUSKS DISTINCTIVE LIKE WESTERN MASTODON MOLARS?

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B53 **A. Grass, J. E. Morrow** THE ARKANSAS KING MASTODON SITE AND ASSOCIATED MASTODON TUSK ALVEOLAR PATHOLOGIES

B54 **Y. A. Mufarreh, D. C. Fisher, A. M. Memesh, S. A. Soubhi, A. J. Abdulshakoor, A. M. Masary, A. H. Matari, A. A. Bahameem, M. A. Haptari, I. S. Zalmout** SKELETAL CHARACTERISTICS OF A PLEISTOCENE ELEPHANT FROM THE NAFUD DESERT, NORTHWESTERN SAUDI ARABIA

B55 **J. Liu, F. Abdala** NEW PERMIAN THEROCEPHALIANS FROM CHINA

B56 **R. W. Blob, J. A. Wilson, C. A. Marsicano, L. J. Panko, R. M. Smith** LOCOMOTOR KINEMATICS OF THE MANUS AND PES IN DINOCEPHALIAN THERAPSIDS RECONSTRUCTED FROM THREE-DIMENSIONAL MORPHOLOGY OF FOOTPRINTS FROM GANSFONTEIN, SOUTH AFRICA

B57 **M. Romano, N. Brocklehurst, J. Fröbisch** REDESCRIPTION OF THE POSTCRANIAL SKELETON OF *ENNATOSAURUS TECTON* (SYNAPSIDA, CASEASAURIA, CASEIDAE) AND ITS FIRST *IN VIVO* RESTORATION

B58 **N. Brocklehurst, J. Fröbisch** A RE-EXAMINATION OF *MILOSAURUS MCCORDI*, AND THE EVOLUTION OF LARGE BODY SIZE IN CARBONIFEROUS SYNAPSIDS

B59 **Y. Tse, M. R. Whitney, R. H. Smith, C. A. Sidor** UNUSUAL DENTIN DEPOSITION IN THE TUSK OF *LYSTROSAURUS* (SYNAPSIDA: ANOMODONTIA) FROM THE EARLY TRIASSIC OF SOUTHERN PANGEA

B60 **J. Huang, R. Motani, Y. Hu, D. Jiang** TOOTH STRUCTURE FOUND IN THE BASAL ICHTHYOSAURIFORM *CARTORHYNCHUS LENTICARPUS*

B61 **W. Lin, D. Jiang, Z. Sun** A NEW PACHYPLEUROSAUR (REPTILIA: SAUROPTERYGIA) FROM THE MIDDLE TRIASSIC GUANLING FORMATION OF SOUTHWESTERN CHINA

B62 **Q. Shang, J. Liu, C. Li** NEW MATERIAL OF A SMALL SIZED EOSAUROPTERYGIAN FROM THE MIDDLE TRIASSIC OF LUOPING, YUNAN, CHINA

B63 **T. Sato, T. Hanai, S. Hayashi, T. Nishimura** A TURONIAN POLYCOTYLID PLESIOSAUR (REPTILIA; SAUROPTERYGIA) FROM HOKKAIDO, JAPAN, AND ITS BIOSTRATIGRAPHIC AND HISTOLOGICAL SIGNIFICANCE

B64 **P. L. Holman** WHAT DOES THE CO-OSSIFICATION OF THE VERTEBRAL AND PECTORAL GIRDLE ELEMENTS SHOW ABOUT THE SKELETAL MATURITY OF DOLICHORHYNCHOPS?

B65 **R. S. Nagesan, J. S. Anderson** NECK MOBILITY OF THE PLESIOSAUR *NICHOLLSSAURA BOREALIS* (PLESIOSAURIA; LEPTOCLEIDIDAE)

B66 **J. A. Campbell, M. T. Mitchell, J. S. Anderson** A REMARKABLY WELL-PRESERVED ELASMOSAURID (SAUROPTERYGIA: PLESIOSAURIA) SPECIMEN FROM THE UPPER CRETACEOUS (CAMPANIAN) DINOSAUR PARK FORMATION OF SOUTHERN ALBERTA

B67 **R. L. Nydam, M. W. Caldwell, A. Palci, T. R. Simões, B. M. Davis** THE DEVIL IS IN THE DETAILS: NEW EVIDENCE OF THE PRIMITIVE SNAKE *DIABLOPHIS* FROM THE JURASSIC OF UTAH, U.S.A.

B68 **K. M. Jenkins, E. Stelling, J. D. Daza** THE APPENDICULAR SKELETON OF A MID-CRETACEOUS LIZARD (SQUAMATA: SCINCOIDEA?)

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B69 **T. Ikeda, D. K. Zelenitsky, H. Ota, K. Tanaka, F. Therrien** FRAGMENTARY MANDIBLES OF FOSSIL LIZARDS FROM THE UPPER CRETACEOUS OLDMAN FORMATION, DEVIL'S COULEE, SOUTHERN ALBERTA, CANADA

B70 **K. G. Zumach, P. C. Sereno** DIGITAL CRANIAL RECONSTRUCTION: DOCUMENTING VISUALIZATION METHODOLOGY AND DECISION-MAKING IN THREE-DIMENSIONAL COMPUTED TOMOGRAPHIC RECONSTRUCTION OF FOSSIL SKULLS, AS EXEMPLIFIED USING THE EARLY CRETACEOUS BASAL SQUAMATE *NORELLIUS NYCTISAUROPS*

B71 **R. Allemand, M. J. Polcyn, P. Vincent, A. Houssaye, N. Bardet** THE BRAINCASE AND THE ENDOCRANIAL ANATOMY OF *TETHYSAURUS NOPCSAI*, A PRIMITIVE MOSASAUROID (REPTILIA, SQUAMATA) FROM THE LOWER TURONIAN (LATE CRETACEOUS) OF GOULMIMA (SOUTHERN MOROCCO)

B72 **B. R. Chapman, J. R. Lively** A NEW MOSASAURINE FROM THE UPPER CRETACEOUS (LOWER CONIACIAN) OF NORTH TEXAS DEMONSTRATES MOSAIC EVOLUTION IN EARLY MOSASAURS

B73 **P. Jiménez-Huidobro, M. W. Caldwell** THE STATUS OF *TYLOSAURUS NEUMILLERI* FROM SOUTH DAKOTA AND A REASSESSMENT OF TYLOSAURINE MOSASAURS FROM THE MIDDLE-LATE CAMPANIAN OF NORTH AMERICA

B74 **C. C. Green, L. Wilson** PRELIMINARY RESULTS OF LONG BONE HISTOLOGY IN AN ONTOGENETIC SERIES OF *CLIDASTES* (SQUAMATA: MOSASAURINAE)

B75 **S. Faude, M. Habib** IT TAKES NERVE: PERIPHERAL NERVE CONDUCTION TIME WAS A POTENTIAL LIMIT ON DYNAMIC FLIGHT CONTROL IN GIANT PTEROSAURS

B76 **B. H. Breithaupt, N. A. Matthews** PRECISE 3D PHOTOGRAMMETRY REVEALS NEW INFORMATION ON PTEROSAUR ICHNOTAXONOMY AND TERRESTRIAL LOCOMOTION: REVISITING THE ICHNOHOLOTYPE OF *PTERAICHNUS SALTWASHENSIS*

B77 **H. Kim, I. Paik** PRELIMINARY STUDY ON THE NEW PTEROSAUR FOOTPRINTS FROM THE EARLY CRETACEOUS HASANDONG FORMATION OF HADONG-GUN, GYEONGSANGNAM-DO, SOUTH KOREA

B78 **K. L. Rosenbach, J. A. Wilson, I. Zalmout** NEW AZHDARCHID PTEROSAUR REMAINS FROM THE LATE CRETACEOUS (MAASTRICHTIAN) OF JORDAN

B79 **A. C. Sharp, K. Siu, T. H. Rich** REVEALING THE SKELETON OF THE POLAR DINOSAUR *LEAELLYNASAURA AMICAGRAPHICA* USING SYNCHROTRON COMPUTED TOMOGRAPHY

B80 **K. Andrzejewski, D. Winkler, L. Jacobs** SYSTEMATICS AND DESCRIPTION OF THE"PROCTOR LAKE ORNITHOPOD"

B81 **D. E. Barta, M. A. Norell** ONTOGENETIC CHANGES IN THE OSTEOHISTOLOGY OF *HAYA GRIVA*, A BASAL NEORNITHISCHIAN DINOSAUR FROM THE UPPER CRETACEOUS JAVKHLANT FORMATION OF MONGOLIA

B82 **G. Garcia, P. Godefroit, B. Gomez, K. Stein, A. C. Cincotta, U. Lefèvre, X. Valentin** EXTREME TOOTH ENLARGEMENT IN A NEW LATE CRETACEOUS RHABDODONTID DINOSAUR FROM SOUTHERN FRANCE

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WEDNESDAY, AUGUST 23, 2017
POSTER SESSION I
(CONTINUED)

B83 **T. C. Hunt, J. E. Peterson, J. A. Frederickson, J. E. Cohen, J. L. Berry** NEW INSIGHTS INTO *TENONTOSAURUS TILLETTI* (DINOSAURIA; ORNITHOPODA) FROM AN EXCEPTIONALLY PRESERVED SPECIMEN

B84 **K. H. Stein, T. Hübner, C. Snoeck, F. Bertozzo, P. Godefroit, P. Claeys** HISTOLOGY AND GROWTH OF *IGUANODON BERNISSARTENSIS*

B85 **J. Driebergen, R. Cifelli, L. Zanno, A. Prieto-Marquez, P. Makovicky** COMPARATIVE TAPHONOMY OF TWO JUVENILE *EOLAMBIA CAROLJONESA* (HADROSAURIA) BONEBEDS FROM THE CEDAR MOUNTAIN FORMATION OF UTAH

B86 **M. G. Thompson, M. J. Ryan, C. J. Schröder-Adams, F. Bedek, D. C. Evans** HADROSAUR FAUNAL DIVERSITY DURING THE CLAGGETT MARINE REGRESSION OF CAMPANIAN NORTHERN LARAMIDIA

B87 **F. Bertozzo, K. Stein, P. Godefroit, P. Claeys** THE MUMMY RETURNS:"LAURA", AN EXCEPTIONALLY PRESERVED HADROSAURID MUMMY FROM MONTANA (USA), WITH REMARKS ON THE FOSSILIZED INTEGUMENT

B88 **E. T. Drysdale, F. Therrien, D. K. Zelenitsky, D. B. Weishampel** HISTOLOGY REVEALS TIMING OF CREST DEVELOPMENT IN *PROSAUROLOPHUS MAXIMUS* (HADROSAURIDAE: SAUROLOPHINAE): IMPLICATIONS FOR SEXUAL DISPLAY AND MATURITY

B89 **J. Slowiak, L. Fostowicz-Frelik, M. S. Ginter** ONTOGENETIC CHANGES IN BONE TISSUE OF *SAUROLOPHUS ANGUSTIROSTRIS* (DINOSAURIA: ORNITHISCHIA) FROM THE LATE CRETACEOUS OF MONGOLIA

B90 **T. Gates, D. C. Evans, T. Birthisel, J. Bourke, L. Zanno** A NEW SPECIES OF *PARASAUROLOPHUS* FROM THE UPPER CRETACEOUS KAIPAROWITS FORMATION OF SOUTHERN UTAH BASED ON A SERIES OF SKULLS

B91 **J. Bourke, T. Gates, T. Birthisel, L. M. Witmer, L. Zanno** VISUALIZING POTENTIAL SOUND PRODUCTION FROM THE ORNATE CRANIAL CRESTS OF *PARASAUROLOPHUS* AND *HYPACROSAURUS* (DINOSAURIA: ORNITHOPODA: HADROSAURIDAE)

B92 **T. L. Stubbs, A. Prieto-Marquez, M. J. Benton** DISPARITY AND RATES OF EVOLUTION IN HADROSAURID DINOSAURS

B93 **B. M. Rothschild, B. Borkovic, D. Tanke** OCCURRENCE OF NON-INFECTIOUS SPONDYLOARTHROPATHY IN A LATE CRETACEOUS HADROSAUR FROM SOUTHERN ALBERTA, CANADA

B94 **J. C. Kosch, L. E. Zanno** A NEW PROTOCOL FOR THE STUDY OF POLYPHYODONT DENTITIONS WITH MULTIPLE REPLACEMENT TEETH

B95 **J. B. McHugh, J. R. Foster, R. Gay, C. Racay** A NEW DIPLODCID SKULL AND ASSOCIATED ANTERIOR CERVICAL VERTEBRAE FROM THE UPPER JURASSIC MYGATT-MOORE QUARRY (MORRISON FORMATION) IN RABBIT VALLEY, COLORADO

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WEDNESDAY, AUGUST 23, 2017
POSTER SESSION I
(CONTINUED)

B96 **S. Khansubha, C. Pothichaiya, M. Rugbumrung, A. Meesook** THE GIGANTIC TITANOSAURIFORM SAUROPOD FROM THE EARLY CRETACEOUS KHOK KRUAT FORMATION IN THE NORTHEASTERN OF THAILAND: A PRELIMINARY REPORT

B97 **I. Shimizu, P. Chanthasit, A. Sardsud, S. Khansubha, S. Agematsu, K. Sashida** JUVENILE SAUROPOD REMAINS FROM THE LOWER CRETACEOUS OF PHU PENG, KALASIN PROVINCE, THAILAND

B98 **D. Vidal, J. Sanz, P. Mocho, A. Páramo, F. Escaso, F. Marcos, F. Ortega** THE TITANOSAUR TAILS FROM LO HUECO (CUENCA, SPAIN): FOUR DIFFERENT WAYS TO SHAKE?

B99 **F. Knoll, S. Lautenschlager, X. Valentin, V. Díez Díaz, X. Pereda Suberbiola, G. Vilanova, G. Garcia** PALAEONEUROLOGY OF A TITANOSAURIAN SAUROPOD FROM THE LATE CRETACEOUS OF FOX-AMPHOUX-MÉTISSON (SOUTHERN FRANCE) AND ITS SYSTEMATIC SIGNIFICANCE

B100 **E. Gomani Chindebvu, K. Andrzejewski, M. J. Polcyn, D. Winkler, L. L. Jacobs** 3D RECONSTRUCTION OF THE BRAIN ENDOCAST AND INNER EAR OF *MALAWISAURUS DIXEYI* (SAUROPODA: TITANOSAURIA)

B101 **H. Bui, K. Curry Rogers** AN INVESTIGATION OF PATHOLOGICAL VERTEBRAE IN SAUROPOD DINOSAURS FROM THE UPPER CRETACEOUS MAEVARANO FORMATION OF MADAGASCAR

B102 **R. T. McCrea, L. Buckley, M. G. Lockley, L. Xing, N. Matthews** OCCURRENCES OF SAUROPODA FROM CANADA

B103 **J. A. Case** AGE OF THE ADAMANTINA FORMATION, UPPER BAURU GROUP, LATE CRETACEOUS, BRAZIL

THURSDAY MORNING, AUGUST 24, 2017
ROMER PRIZE SESSION
TELUS CONVENTION CENTRE, MACLEOD C
MODERATOR: Mark Uhen

8:00 **A. M. Mychajliw** FOSSILS, FECES, & THE FUTURE: A 20,000 YEAR EXPERIMENT OF MAMMALIAN EXTINCTIONS ON ISLANDS

8:15 **E. Gorscak** AN EMERGING MODEL ON THE PALEOBIOGEOGRAPHIC ROLE(S) OF LATE CRETACEOUS AFRICA: NEW TITANOSAURIAN SAUROPOD DINOSAURS SIGNAL DISTINCT NORTHERN AND SOUTHERN AFRICAN REGIONS

8:30 **S. Läbe** THE DINOSAUR SCALE – ICHNOLOGY MEETS SOIL MECHANICS FOR WEIGHT ESTIMATION OF SAUROPOD DINOSAURS BASED ON THEIR TRACKS

8:45 **P. J. Bishop** USING CANCELLOUS BONE ARCHITECTURE TO INFER THEROPOD DINOSAUR LOCOMOTOR BIOMECHANICS AND ITS EVOLUTION

9:00 **E. Martin-Silverstone** VARIATION IN PTEROSAUR WING BONE GEOMETRY AND IMPLICATIONS FOR PTEROSAUR ECOLOGY

9:15 **D. W. Larson** DIETARY INFERENCE AND EVOLUTION IN EXTINCT FAUNIVOROUS REPTILES USING AN ECOMORPHOLOGICAL MODEL OF VARIATION IN THE DENTAL APPARATUS OF VARANID LIZARDS

9:30 **T. R. Simões** THE ORIGIN AND EARLY EVOLUTION OF LEPIDOSAURIAN REPTILES

THURSDAY MORNING, AUGUST 24, 2017
ROMER PRIZE SESSION
(CONTINUED)

9:45 **J. D. Carrillo** SYSTEMATICS, BIOGEOGRAPHY, AND DIVERSITY OF SOUTH AMERICAN NATIVE UNGULATES: NEW RECORDS FROM THE NEOTROPICS AND THEIR IMPLICATIONS FOR THE GREAT AMERICAN BIOTIC INTERCHANGE

10:00 **BREAK**

10:15 **A. R. LeBlanc** HETEROCHRONY AND THE ORIGIN OF THE MAMMALIAN TOOTH ATTACHMENT SYSTEM

10:30 **K. Matsui** QUANTITATIVE ANALYSIS OF AQUATIC ADAPTATION IN DESMOSTYLIA (MAMMALIA: ?AFROTHERIA) BASED ON CRANIAL CHARACTERISTICS

10:45 **A. Villaseñor** INTEGRATING CLIMATE, VEGETATION, AND MAMMAL COMMUNITY DIVERSITY IN PLIOCENE EAST AFRICA: IMPLICATIONS FOR EARLY HOMININ EVOLUTION

11:00 **M. E. Hoerner** USURPERS AND INSINUATORS: THE ROLE OF COMPETITION IN THE DYNAMICS OF THE GREAT AMERICAN BIOTIC INTERCHANGE

11:15 **N. A. Famoso** LARGE VOLCANIC ERUPTIONS DRIVE LOCAL MAMMALIAN COMMUNITY CHANGE

11:30 **J. M. Hoffman** THE 'GRIT EFFECT' ON UNGULATE TOOTH WEAR: EVIDENCE FROM EXPERIMENTS AND NATURAL POPULATIONS

11:45 **M. Randau** DRIVERS AND CONSTRAINTS OF SHAPE EVOLUTION IN THE VERTEBRAL COLUMN OF FELIDAE (CARNIVORA, MAMMALIA)

12:00 **E. T. Saitta** CREATING FOSSILS IN THE LAB: REPLICATING FOSSILIZATION USING SEDIMENT-BASED MATURATION

THURSDAY MORNING, AUGUST 24, 2017
PREPARATORS' SESSION
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Don DeBlieux and Darren Tanke

8:00 **A. L. Kowalchuk, I. MacDonald, D. Brinkman** AT THE CUTTING EDGE OF PALEONTOLOGY: THE DIAMOND TIPPED CHAINSAW – ADVANTAGES AND DISADVANTAGES COMPARED TO THE CONCRETE CUT-OFF SAW

8:15 **O. E. Demuth, H. Mallison, S. Lautenschlager, E. Tschopp** RETRODEFORMATION AND RECONSTRUCTION OF A CERVICAL SERIES OF *GALEAMOPUS* (SAUROPODA: DIPLODOCIDAE)

8:30 **A. R. Chainey, W. N. McLaughlin, E. B. Davis, S. S. Hopkins** A TECHNICAL ANALYSIS OF METHODS OF DEFLESHING SMALL MAMMAL MODERN COMPARATIVE SPECIMENS

8:45 **M. Cárdenas, K. Moreno** THE MANY BENEFITS OF 3D XRAY IMAGING IN PALEONTOLOGY: PREPARATION OF A DELICATE FOSSIL CONTAINED INSIDE A PLASTER JACKET

9:00 **P. Kaskes, D. Bastiaans, V. Vanhecke, M. Van 'T Zelfde, E. Dullaart, K. De Jong, N. Den Ouden, M. Guliker, A. S. Schulp** COMBINING ALL DIMENSIONS: INTEGRATED 3D MODELS OF DINOSAUR BONEBEDS

9:15 **I. D. Browne** EIGHTY PERCENT FASTER AND GOOD ENOUGH? A MORE PRACTICAL PROCESS TO PRODUCE PHOTOGRAMMETRIC MODELS OF VERTEBRATE MICROFOSSILS IN THE 0.5-2 MM SIZE RANGE

THURSDAY MORNING, AUGUST 24, 2017
PREPARATORS' SESSION
(CONTINUED)

9:30 **C. Capobianco** ASSESSING AND REHOUSING THE DEPARTMENT OF VERTEBRATE PALEONTOLOGY'S TEACHING COLLECTION AT THE MUSEUM OF COMPARATIVE ZOOLOGY (MCZ), HARVARD UNIVERSITY: A CASE STUDY INTO THE IMPORTANCE OF PREPARATION RECORDS IN REMEDIAL CONSERVATION

9:45 **M. R. Grieco, M. Fracasso** LEVERAGING GIS AS A COLLABORATIVE PLATFORM: ESTABLISHING A PALEONTOLOGY RESOURCE DATABASE FOR PUBLIC LANDS

10:00 **BREAK**

10:15 **W. F. Simpson** THE NULLARBOR SWAT TEAM PROJECT: ADDRESSING COLLECTIONS BACKLOGS

10:30 **V. R. Rhue** HOW TO STRUCTURE AN EFFECTIVE VOLUNTEER TASK FORCE IN THE LAB AND COLLECTIONS: A CASE STUDY ON ESTABLISHING CRITERIA FOR RECRUITMENT, SELECTION, AND TRAINING

10:45 **M. Qvarnström, G. Niedźwiedzki, P. Tafforeau, Ž. Žigaitė, P. E. Ahlberg** 3D-VISUALIZATION OF VERTEBRATE COPROLITES THROUGH PHASE-CONTRAST SYNCHROTRON IMAGING UNRAVEL NEW ASPECTS OF PALEOECOLOGICAL RELATIONS

11:00 **J. Liston** PALEONTOLOGICAL RESEARCH IN CHINA IN THE CONTEXT OF THE NEW SVP ETHICS STATEMENT

11:15 **F. Fanti, M. Tighe, P. R. Bell, L. Milan, E. Dinelli** GEOCHEMICAL 'FINGERPRINTING' OF GOBI DINOSAURS; A TOOL FOR REPATRIATING POACHED DINOSAUR FOSSILS IN MONGOLIA

11:30 **K. A. Stevens, S. Ernst, D. Marty** THE IMPORTANCE OF BEING UNCERTAIN: PROBABILISTIC COMPUTATION OF TRACKMAKER SIZE, GAIT, AND GAUGE

11:45 **J. N. Lallensack, H. Barthel, J. N. Lallensack** TRIDACTYL DINOSAUR FOOTPRINTS: SHAPE AS A FUNCTION OF SIZE

12:00 **J. R. Lively, C. J. Bell, C. B. Withnell** MOSASAURS AND MICROTINES: TAXONOMIC PRACTICE SHAPES COGNITIVE BIASES IN PALEONTOLOGY

THURSDAY MORNING, AUGUST 24, 2017
TECHNICAL SESSION VI
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Brandon Peecock and Jade Atkins

8:00 **E. M. Dunne, R. A. Close, N. Brocklehurst, D. J. Button, R. J. Butler** TERRESTRIAL TETRAPOD DIVERSITY AND BIOGEOGRAPHY ACROSS THE CARBONIFEROUS/PERMIAN BOUNDARY

8:15 **A. Mann, H. C. Maddin** A NEW MICROSAUR (LEPOSPONDYLI: TETRAPODA) FROM THE CARBONIFEROUS FRANCIS CREEK SHALE, MAZON CREEK, ILLINOIS, AND IMPLICATIONS FOR AN ECOLOGICALLY DIVERSE MICROSAURIAN FAUNA.

8:30 **B. M. Gee, R. R. Reisz, J. J. Bevitt** NEW MATERIAL OF *LLISTROFUS PRICEI* FROM THE CAVE DEPOSITS OF RICHARDS SPUR, OKLAHOMA AND THE PALEOECOLOGY OF THE HAPSIDOPAREIONTIDAE

8:45 **M. Jansen, D. Marjanovic** THE PERMIAN"MICROSAUR" *BATROPETES* AS A MODEL FOR THE ORIGIN OF FROGS

THURSDAY MORNING, AUGUST 24, 2017
TECHNICAL SESSION VI
(CONTINUED)

9:00 **D. Lovelace, A. K. Huttenlocker, J. D. Pardo, A. M. Kufner, G. Chen, K. Li** THE FIRST LATE TRIASSIC TEMNOSPONDYL MASS-MORTALITY LOCALITIES FROM THE POPO AGIE FORMATION, FREMONT COUNTY, WY

9:15 **J. Atkins, R. R. Reisz, H. C. Maddin** BRAINCASE EVOLUTION IN DISSOROPHOIDEA

9:30 **H. C. Maddin** IMPLICATIONS OF THE EVOLUTION OF SOMITIC CONTRIBUTIONS TO THE HEAD ON THE EVOLUTION OF CRANIAL MUSCLES IN TETRAPODS

9:45 **J. Jia, K. Gao, N. Shubin** PATTERNS OF CHONDRIFICATION AND OSSIFICATION IN THE HYOBRANCHIAL APPARATUS OF CRYPTOBRANCHOID SALAMANDERS

10:00 **BREAK**

10:15 **V. J. Flear, S. P. Modesto, R. R. Reisz** NEW DIADECTOMORPH COTYLOSAUR MATERIAL FROM THE MIDDLE CLEAR FORK FORMATION, LOWER PERMIAN OF TEXAS

10:30 **F. Witzmann, R. R. Schoch** NEW DATA ON SKULL AND POSTCRANIUM OF BYSTROWIANID CHRONIOSUCHIANS, AND THE POSITION OF CHRONIOSUCHIANS WITHIN EARLY TETRAPODS

10:45 **M. J. MacDougall, R. R. Reisz** THE RICHARDS SPUR LOCALITY (289 MA), OKLAHOMA, A UNIQUE UPLAND EARLY PERMIAN LOCALITY WITH A DISTINCT PALEOECOLOGY

11:00 **J. C. Cisneros, C. F. Kammerer, K. D. Angielczyk, J. Fröbisch, C. A. Marsicano, R. M. Smith, M. Richter** A PARAREPTILE FROM THE LOWER PERMIAN OF THE PARNAÍBA BASIN, NORTHEASTERN BRAZIL

11:15 **J. Jung, S. S. Sumida, G. Albright** REASSESSMENT OF EARLY PERMIAN REPTILE"*CAPTORHINIKOS PARVUS*" SUGGESTS HERETOFORE UNKNOWN DENTAL AND BIOGEOGRAPHIC COMPLEXITY IN THE BASAL EUREPTILIAN FAMILY CAPTORHINIDAE

11:30 **M. B. Andrade, N. Galvez** A QUESTION OF TIME IN TEMNOSPONDYL EVOLUTION AND THE SURVIVAL OF CAPITOSAURIA THROUGH THE PERMO-TRIASSIC EXTINCTION EVENT

11:45 **B. Peecook** EVIDENCE FOR REGIONAL VARIABILITY IN RECOVERY OF TETRAPOD ASSEMBLAGES FROM THE END-PERMIAN MASS EXTINCTION: SETTING THE STAGE FOR THE AGE OF DINOSAURS IN SOUTHERN PANGEA

12:00 **A. Elsler, M. J. Benton, M. Ruta, A. M. Dunhill** HETEROGENEOUS EVOLUTIONARY RATES IN LATE PALAEOZOIC-EARLY MESOZOIC AMNIOTES

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION VII
TELUS CONVENTION CENTRE, MACLEOD C
MODERATORS: Daniel Field and Jingmai O'Connor

1:45 **C. Sullivan, J. O'Connor** EXPANDED STERNAL RIBS INDICATE AN UNUSUAL ACCESSORY RESPIRATORY MECHANISM IN THE LONG BONY-TAILED CRETACEOUS BIRD *JEHOLORNIS*

2:00 **D. J. Rashid, K. Surya, S. C. Chapman, L. M. Chiappe, A. Bailleul, J. R. Horner** PYGOSTYLE DEVELOPMENT AND ITS IMPLICATIONS FOR THE CRETACEOUS LONG- TO SHORT-TAILED AVIAN TRANSITION

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION VII
(CONTINUED)

2:15 **M. Wang, J. K.O'Connor, Y. Pan, Z. Zhou** A NEW ENANTIORNITHINE BIRD WITH A PLOUGH-SHAPED PYGOSTYLE AND UNIQUE TIBIOTARSAL FEATHERS

2:30 **F. J. Serrano, L. M. Chiappe** FLIGHT PROPERTIES OF THE EARLY ENANTIORNITHINE BIRD *PROTOPTERYX FENGNINGENSIS*

2:45 **J. O'Connor** THE TROPHIC HABITS OF EARLY BIRDS

3:00 **M. Hanson, A. C. Pritchard, D. A. Burnham, B. S. Bhullar** RECONSTRUCTING THE FEEDING APPARATUS OF A STEM BIRD: A COMPARATIVE STUDY IDENTIFYING OSTEOLOGICAL CORRELATES TO MUSCLES IN THE SKULLS LIVING ARCHOSAURS AND APPLYING THEM TO A FOSSIL TAXON

3:15 **S. Hellert** UNDERSTANDING THE CAUSES OF PHENOTYPIC INTEGRATION PATTERNS IN THE EVOLUTION OF FLIGHTLESS BIRDS

3:30 **D. J. Field, A. Bercovici, R. Dunn, D. E. Fastovsky, J. Berv, J. A. Gauthier** ANCESTRAL ECOLOGICAL RECONSTRUCTIONS AND EVIDENCE OF CANOPY DESTRUCTION REVEAL STRONG ECOLOGICAL SELECTIVITY AMONG BIRDS ACROSS THE K-PG MASS EXTINCTION

3:45 **J. S. Berv, D. Field** GENOMIC SIGNATURE OF AN AVIAN LILLIPUT EFFECT ACROSS THE K-PG EXTINCTION

4:00 **R. N. Felice, A. Goswami** BIRDS OF A FEATHER EVOLVE WITH HETEROGENEOUS TEMPO AND MODE BIRDS OF A FEATHER EVOLVE WITH HETEROGENEOUS TEMPO AND MODE

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION VIII
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Laura MacLatchy and Sergi López Torres

1:45 **E. Gheerbrant** FIRST EVIDENCE FROM THE PALEOCENE OF MOROCCO OF THE CONVERGENCE OF THE QUADRITUBERCULAR-BILOPHODONT PATTERN IN AFROTHERIAN AND LAURASIATHERIAN UNGULATE-LIKE MAMMALS

2:00 **S. L. Shelley, T. E. Williamson, S. Brusatte** 'ARCHAIC' PALEOGENE MAMMALS POSSESSED UNIQUE LOCOMOTOR STYLES DISTINCT FROM MODERN FORMS: INSIGHTS FROM MULTIVARIATE ANALYSES

2:15 **F. Solé, K. Le Verger, A. Phélizon, T. Smith** NEW FOSSILS OF PAROXYCLAENIDS (PLACENTALIA, MAMMALIA) FROM THE EARLY EOCENE OF FRANCE SHED LIGHT ON THE ORIGIN AND EVOLUTION OF THESE ENDEMIC EUROPEAN MAMMALS

2:30 **S. López-Torres, M. T. Silcox** THE PHYLOGENETIC RELATIONSHIPS OF THE PAROMOMYIDAE (PRIMATES, MAMMALIA)

2:45 **N. H. Honer, M. Hubbe, J. P. Hunter** MODULES AND MOSAICS IN THE EVOLUTION OF THE *TETONIUS - PSEUDOTETONIUS* DENTITION

3:00 **A. L. Atwater, E. C. Kirk** NEW MIDDLE EOCENE OMOMYINES (PRIMATES, HAPLORHINI) FROM THE FRIARS FORMATION OF SAN DIEGO COUNTY, SOUTHERN CALIFORNIA

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION VIII
(CONTINUED)

3:15 **A. Kemp, E. Kirk** MAMMALIAN EYE ORIENTATION: COMPARISONS OF BONY ORBIT CONVERGENCE AND SOFT TISSUE MEASURES FROM DICE-CT SCANS

3:30 **R. F. Kay, L. A. Gonzales, W. Salenbien, J. Martinez, M. Ortega Villar, L. Valdivia Coveñas, G. Béjar, C. Rigsby, E. Cadena Ruida, P. A. Baker** A NEW PRIMATE FROM THE EARLY MIOCENE OF THE AMAZON BASIN, PERU

3:45 **L. MacLatchy, S. Cote** MIXING AND MATCHING "ENDEMIC" PRIMATE TAXA: A DISTINCT COMBINATION OF CATARRHINE PRIMATES FROM AN EARLY MIOCENE SITE AT BUKWA, UGANDA

4:00 **K. K. Takashita-Bynum, C. M. Liutkus-Pierce, F. M. Kirera, A. Grossman** THE PALEOENVIRONMENT OF LOPEROT, AN EARLY MIOCENE CATARRHINE LOCALITY IN WEST TURKANA, KENYA: EVIDENCE FROM STRATIGRAPHY, SEDIMENTOLOGY, AND GEOCHEMISTRY

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION IX
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Jenny McGuire and Jasmina Wiemann

1:45 **J. Wiemann, D. Briggs** TRACKING DOWN CELLS, NERVES, AND VASCULARITY FOSSILIZED IN VERTEBRATE HARD TISSUES: A FIELD GUIDE

2:00 **M. E. McNamara, P. Godefroit, D. Dhouailly, M. J. Benton, S. Sinitsa, Y. Bolotsky, A. Sizov, P. Spagna** ULTRASTRUCTURE AND CHEMISTRY OF INTEGUMENTARY STRUCTURES IN AN ORNITHISCHIAN DINOSAUR

2:15 **F. Babarovic, G. Mayr, J. Vinther** NON-IRIDESCENT STRUCTURAL COLORS (NISC) IN BIRD PLUMAGE AND THEIR DETECTION IN THE FOSSIL RECORD

2:30 **J. A. Peteya, K. Gao, Q. Li, J. A. Clarke, L. D'Alba, M. Shawkey** MELANOSOME EVOLUTION IN VERTEBRATES

2:45 **C. Colleary, A. Dolocan, H. Lamadrid, S. O'Reilly, S. J. Nesbitt** BIOMOLECULE PRESERVATION IN VERTEBRATE FOSSILS FROM DIFFERENT BURIAL ENVIRONMENTS

3:00 **J. Heijne, N. Klein, P. Sander** UNRAVELING THE UNUSUAL TAPHONOMY OF THE LOWER MUSCHELKALK (MIDDLE TRIASSIC) LOCALITY OF WINTERSWIJK, THE NETHERLANDS: THE INFLUENCE OF MICROBIAL MATS AND CURRENTS ON THE DISARTICULATION PATTERNS OF MARINE REPTILES

3:15 **R. Rogers, D. W. Krause, K. Curry Rogers, J. R. Groenke, P. M. O'Connor, J. Sertich** TWENTY YEARS OF TAPHONOMIC OBSERVATIONS AND INSIGHTS IN THE UPPER CRETACEOUS MAEVARANO FORMATION, MADAGASCAR

3:30 **A. K. Behrensmeyer, R. R. Rogers** THE TYRANNY OF TRANSPORT IN TAPHONOMY – HOW FAR DO BONES REALLY MOVE AND HOW MUCH DOES IT MATTER?

3:45 **K. M. Loughney** TAPHONOMY OF MAMMAL FOSSILS IN THE BARSTOW FORMATION, SOUTHERN CALIFORNIA, IN RELATION TO FACIES AND ENVIRONMENTS

THURSDAY AFTERNOON, AUGUST 24, 2017
TECHNICAL SESSION IX
(CONTINUED)

4:00 **J. L. McGuire, A. Woodruff, J. Iacono, A. L. Meadows, C. M. Redman, J. Meachen** MICROFAUNA OF NATURAL TRAP CAVE: TAPHONOMIC ANALYSES INDICATE A MIXED PREDATOR ASSEMBLAGE LIKELY RESULTING FROM *NEOTOMA* (WOODRAT) GATHERING

THURSDAY, AUGUST 24, 2017
POSTER SESSION II
TELUS CONVENTION CENTRE, MACLEOD A1-A4 AND PREFUNCTION
Authors must be present from 4:15 - 6:15 p.m. Thursday, August 24

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

B22 **J. J. Jacisin, A. Lawing** EXPLORING ECOMETRIC RELATIONSHIPS IN THE VERTEBRAE OF NORTH AMERICA SNAKES.

B23 **J. Rio, P. Mannion** NEW DATA ON THE GIANT SNAKE *GIGANTOPHIS GARSTINI* FROM THE UPPER EOCENE OF NORTH AFRICA AND ITS BEARING ON THE PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF MADTSOIIDAE

B24 **E. Handyside, M. Tapscott, G. Narbonne, H. C. Larsson, R. Tahara, T. Dececchi** AMBER AND AMBIGUITY: A LIZARD'S TALE

B25 **S. Y. Onary, A. S. Hsiou** THE SYSTEMATIC REVISION OF THE EARLY MIOCENE *PSEUDOEPICRATES* (SERPENTES, BOIDAE) SHEDS LIGHT ON THE EVOLUTIONARY AND HISTORICAL BIOGEOGRAPHY OF THE WEST INDIAN BOID SNAKES (*CHILABOTHRUS*)

B26 **A. B. Quadros, P. Chafrat, H. Zaher** A NEW LIZARD OF THE GENUS *CALLOPISTES* GRAVENHORST 1838 (SQUAMATA; TEIIDAE) FROM THE LOWER MIOCENE OF ARGENTINA, AND THE FOSSIL RECORD OF TEIIDS IN SOUTH AMERICA

B27 **A. Čerňanský, J. Klembara** PARTLY ARTICULATED SKELETON OF *OPHISAURUS* (SQUAMATA: ANGUIMORPHA) FROM THE MIDDLE MIOCENE OF EUROPE, WITH COMMENTS ON THE HISTORY OF ANGUID LIMB REDUCTION BASED ON THE ANATOMY OF THE PELVIC GIRDLE

B28 **M. Riegler, M. R. Stocker, R. L. Anemone, B. Nachman** EARLY EOCENE HERPETOFAUNA FROM THE WASATCH FORMATION, WYOMING: DIVERSITY AND BIOGEOGRAPHY SURROUNDING THE PALEOCENE-EOCENE THERMAL MAXIMUM

B29 **R. C. Ely, J. A. Case** FIRST FOSSIL OCCURENCES OF THE *SPHENOMORPHUS* SPECIES GROUP (SQUAMATA; SCINCIDAE; LYGOSOMINAE) FROM THE LATE OLIGOCENE NAMBA AND ETADUNNA FORMATIONS OF SOUTH AUSTRALIA

B30 **S. G. Scarpetta** LATEST OLIGOCENE GLYPTOSAURINE LIZARDS FROM THE SHARPS AND MONROE CREEK FORMATIONS, SOUTH DAKOTA, AND PHYLOGENETIC AND BIOCHRONOLOGIC IMPLICATIONS

B31 **N. J. Czaplewski, K. S. Smith** GONE FROM THE SOUTHERN PLAINS: A PLEISTOCENE *HELODERMA* IN A NEW LOCAL FAUNA FROM A KARSTIC FILLING IN SOUTHWESTERN OKLAHOMA

B32 **W. J. Wilkins, J. I. Mead, S. Swift, P. Collins, M. M. Bugbee** NEW FOSSIL HERPETOFAUNA FROM THE LATE PLEISTOCENE OF THE NORTHERN CALIFORNIA CHANNEL ISLANDS, CHANNEL ISLANDS NATIONAL PARK

*Numbers beginning with "B" represent the poster board number in Exhibit Hall.

THURSDAY, AUGUST 24, 2017
POSTER SESSION II
(CONTINUED)

B33 **J. Rej, J. I. Mead, B. W. Schubert** LATE QUATERNARY DRAGON LIZARDS (AGAMIDAE: SQUAMATA) FROM WESTERN AUSTRALIA

B34 **L. A. Rooney, J. X. Samuels** POSTCRANIAL MORPHOLOGY AND THE LOCOMOTOR ADAPTATIONS OF EXTANT AND EXTINCT CROCODYLOMORPHS AND LEPIDOSAURS

B35 **J. D. Gardner, Y. Zaim, Y. Rizal, A. Aswan, J. Zonneveld, J. I. Bloch, R. L. Ciochon, D. M. Boyer, G. F. Gunnell** ANURAN MAXILLAE FROM THE PALEOGENE (LATE EOCENE–EARLY OLIGOCENE) OF SUMATRA, INDONESIA

B36 **H. Blain, I. Lozano-Fernández, T. Prikryl, O. Oms, P. Anadón, P. Rodríguez-Salgado, J. Agustí, G. Campeny, B. Gómez De Soler** WATER FROGS (ANURA, RANIDAE) FROM THE PLIOCENE CAMP DELS NINOTS KONSERVAT-LAGERSTÄTTE (CALDES DE MALAVELLA, NE SPAIN)

B37 **C. Zhou, S. Shao** THE FIRST JUVENILE SPECIMEN OF *MANCHUROCHELYS MANCHOUKUOENSIS* FROM THE EARLY CRETACEOUS JEHOL BIOTA

B38 **G. Abuelkheir, M. K. Abdelgawad** DISCOVERY OF TESTUDINES MATERIALS FROM THE EARLY CENOMANIAN MAGHRABI FORMATION, SOUTH WESTERN DESERT, EGYPT

B39 **D. Lawver, E. A. Freedman Fowler** A NEW LARGE-BODIED TURTLE FROM THE LATE CRETACEOUS JUDITH RIVER FORMATION OF MONTANA

B40 **R. Hirayama, Y. Nakajima, A. Folie** *PLATYCHELONE EMARGINATA*, GIGANTIC CRETACEOUS MARINE TURTLE FROM BELGIUM

B41 **M. K. Abdelgawad, M. F. Aly, A. El-Ghareeb, A. Sileem, M. Shahata** LATE EOCENE-EARLY OLIGOCENE TURTLE DIVERSIFICATION FROM EGYPT

B42 **Y. Yu, C. Sullivan, X. Xu, K. Wang, S. Cheng, P. Wang** A NEW CAENAGNATHID (THEROPODA: OVIRAPTOROSAURIA) FROM THE UPPER CRETACEOUS WANGSHI GROUP OF SHANDONG, CHINA

B43 **R. D. Wilkinson, G. F. Funston, P. J. Currie** ONTOGENETIC VARIATION IN THE BONE HISTOLOGY OF CAENAGNATHID MANDIBULAR SYMPHYSES

B44 **W. Ma, M. Pittman, Q. Tan, X. Xu** FUNCTIONAL ANATOMY OF A GIANT DINOSAUR BEAK: *GIGANTORAPTOR* AND THE EVOLUTION OF THE OVIRAPTOROSAURIAN JAW

B45 **H. Avrahami, T. Gates, R. Cifelli, P. Makovicky, L. Zanno** QUANTIFYING SHAPE VARIATION AMONG THEROPOD TEETH FROM THE UPPER CRETACEOUS (CENOMANIAN) MUSSENTUCHIT MEMBER OF THE CEDAR MOUNTAIN FORMATION, UTAH

B46 **T. Trapman, F. M. Holwerda, O. Rauhut, J. Reumer, M. Joachimski** STABLE ISOTOPES IN NEOTHEROPOD TEETH FROM THE KEM KEM BEDS, NORTH AFRICA: INSIGHTS IN THE PALAEOENVIRONMENT AND PALAEOBIOLOGY OF LARGE PREDATORY DINOSAURS

B47 **J. A. Frederickson, R. Cifelli, M. H. Engel** THEROPOD ECOLOGY OF THE MIDDLE CRETACEOUS: DIET AND HABITAT PREFERENCE IN SMALL TO MEDIUM-SIZE PREDATORS FROM THE UPPERMOST CEDAR MOUNTAIN FORMATION OF UTAH, U.S.A.

B48 **R. Takasaki, T. Tanaka, Y. Kobayashi** RELATIONSHIPS OF DIET AND GASTROLITH SHAPE, USING LAYER CHICKS: IMPLICATION FOR *DEINOCHEIRUS* DIET

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THURSDAY, AUGUST 24, 2017
POSTER SESSION II
(CONTINUED)

B49 **T. Hanai, T. Tsuihiji** DESCRIPTION OF TOOTH REPLACEMENT PATTERNS IN A JUVENILE *TARBOSAURUS BATAAR* (THEROPODA, TYRANNOSAURIDAE) USING CT-SCAN DATA

B50 **M. J. Powers, P. J. Currie** A NEW INTERPRETATION OF THE PROATLAS ARTICULATION IN TYRANNOSAURID ATLAS-AXIS COMPLEXES

B51 **T. Chinzorig, Y. Kobayashi, M. Saneyoshi, K. Tsogtbaatar, Z. Badamkhatan, T. Ryuji** MULTITAXIC BONEBED OF TWO NEW ORNITHOMIMIDS (THEROPODA, ORNITHOMIMOSAURIA) FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF SOUTHEASTERN GOBI DESERT, MONGOLIA

B52 **R. E. Nottrodt, F. Therrien, D. K. Zelenitsky, Y. Kobayashi** ORNITHOMIMID MATERIAL FROM THE LOWER SCOLLARD FORMATION (UPPER MAASTRICHTIAN) OF ALBERTA, CANADA, CONFIRMS THE PRESENCE OF ORNITHOMIMIDS, INCLUDING ONE LARGE-BODIED TAXON, AT THE END OF THE CRETACEOUS PRIOR TO THE CRETACEOUS-PALEOGENE BOUNDARY

B53 **R. K. Hunt-Foster, J. I. Kirkland** EVALUATING THE ENIGMATIC EARLY CRETACEOUS ORNITHOMIMOSAUR RECORD IN NORTH AMERICA

B54 **K. Kubo, Y. Kobayashi** KINEMATIC FUNCTION OF ARCTOMETATARSUS OF ORNITHOMIMOSAURS AND THEIR CURSORIAL ADAPTATION

B55 **M. M. Rhodes, P. J. Currie, G. F. Funston** THEROPOD PELVIC MUSCULATURE AND THE TRANSITION TO KNEE-DRIVEN LOCOMOTION

B56 **U. Lefèvre, A. Cau, D. Hu, P. Godefroit** PRIMITIVE FEATHER ARRANGEMENT ALONG THE HINDWING OF A NEW JURASSIC PARAVIAN FROM CHINA

B57 **S. E. Jasinski, R. M. Sullivan, P. Dodson** THE LAST OF THE NORTH AMERICAN DROMAEOSAURIDS (THEROPODA: DROMAEOSAURIDAE), BASED ON A NEW MAASTRICHTIAN SPECIMEN FROM NEW MEXICO

B58 **R. Pei, S. Brusatte, M. Pittman, A. H. Turner, M. A. Norell** BAYESIAN INFERENCE OF PARAVIAN PHYLOGENY WITH THE THEROPOD WORKING GROUP DATASET

B59 **S. Peters, K. Sheppard, D. Rival, M. Habib, T. Dececchi** IT'S ALL IN THE WRIST.... OR IS IT: THE USE OF AERODYNAMIC MODELLING TO UNRAVEL THE ORIGINS OF AVIAN FLIGHT

B60 **S. Ascari** CLAW FUNCTIONAL MORPHOLOGY OF *DEINONYCHUS ANTIRRHOPUS* AND OTHER THEROPODS

B61 **T. Dececchi, L. Jackson, P. Mabee** GENES FROM A STONE: USING BIOINFORMATICS TO UNCOVER THE GENETIC DRIVERS FOR LIMB DIVERSITY AMONG NON-AVIAN THEROPOD DINOSAURS

B62 **S. Gage, S. H. Burch** ANALYSIS OF ROBUSTICITY IN THEROPOD FORLIMBS USING GEOMETRIC MORPHOMETRICS TO INDICATE PREY SIZE PREFERENCE

B63 **O. B. Afanassieva** HISTOLOGICAL STRUCTURE OF THE EXOSKELETON OF *ATELEASPIS, RETICULASPIS* AND *ESCUMINASPIS* (OSTEOSTRACI, AGNATHA): PRELIMINARY ANALYSIS OF DATA

B64 **B. Choo, J. Long, B. King, G. Young** NEW MATERIAL OF AN UNUSUAL TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF CENTRAL AUSTRALIA

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THURSDAY, AUGUST 24, 2017
POSTER SESSION II
(CONTINUED)

B65 **L. E. Hall, A. R. McGee, M. J. Ryan** CRUISIN' THE DEVONIAN HIGHWAY: THE 50TH ANNIVERSARY OF THE I-71 DIG

B66 **M. Richter, E. Bosetti** PIONEERING DISCOVERY OF FISH-BEARING ROCKS OF EARLY DEVONIAN (EARLY LATE EMSIAN) AGE IN THE PARANÁ BASIN, SOUTHERN BRAZIL

B67 **R. A. Carr, J. Scannella** PRESERVATIONAL AND MORPHOLOGICAL VARIATION IN THE HALECOSTOM FISH *HULETTIA AMERICANA* FROM THE JURASSIC ELLIS GROUP OF SOUTHERN MONTANA

B68 **A. E. Jacob, R. Lund, E. D. Grogan** AN ENIGMATIC SCALE-LESS ACTINOPTERYGIAN FROM THE UPPER MISSISSIPPIAN BEAR GULCH LIMESTONE OF MONTANA, USA

B69 **K. Mickle** DESCRIPTION OF A NEW LOWER ACTINOPTERYGIAN TAXON FROM THE LATE MISSISSIPPIAN BLUEFIELD FORMATION OF WEST VIRGINIA, U. S. A.

B70 **A. N. Michels, L. E. Wilson** PRELIMINARY APPROACH TOWARD DETERMINING TROPHIC RELATIONSHIPS AMONG ACTINOPTERYGIAN CLADES FROM THE WESTERN INTERIOR SEAWAY

B71 **M. A. Bair, M. G. Newbrey** FURTHER DESCRIPTION OF *APATEODUS BUSSENI,* A LIZARDFISH (TELEOSTEI, AULOPIFORMES) FROM THE LATE CRETACEOUS, SMOKY HILL MEMBER, NIOBRARA CHALK (EARLY CAMPANIAN), KANSAS, USA

B72 **C. Fielitz, K. J. Super, M. Everhart** A DESCRIPTION OF A SECOND SPECIMEN OF *URENCHELYS ABDITUS* FROM THE SMOKY HILL CHALK MEMBER OF THE NIOBRARA FORMATION (UPPER CRETACEOUS: SANTONIAN) OF KANSAS WITH NEW CHARACTERS FOR THE SPECIES

B73 **K. Shimada** A NEW SPECIES AND BODY FORM OF THE LATE CRETACEOUS 'BLUNT-SNOUTED' BONY FISH, *THRYPTODUS* (ACTINOPTERYGII: TSELFATIIFORMES)

B74 **K. J. Super, J. L. King** NEW ONTOGENETIC AND BIOMETRIC DATA FOR ICHTHYODECTIDAE: SMALLEST RECORDED INSTANCE OF *XIPHACTINUS AUDAX* (TELEOSTEI: ICHTHYODECTIFORMES)

B75 **M. V. Wilson, A. M. Murray, T. C. Grande** NEW GENERA AND SPECIES OF FOSSIL MARINE AMIOID FISHES (ACTINOPTERYGII, HOLOSTEI) FROM THE LATE CRETACEOUS AGOULT LOCALITY IN SOUTHEASTERN MOROCCO

B76 **A. M. Murray, D. Zelenitsky, D. B. Brinkman, A. G. Neuman** A NEW SPECIES OF THE PALAEOCENE *JOFFRICHTHYS* (OSTEOGLOSSOMORPHA) FROM CALGARY, ALBERTA AND A REASSESSMENT OF THE RELATIONSHIPS OF THE GENUS

B77 **J. Gardner, M. V. Wilson** A MOSTLY COMPLETE BOWFIN (AMIIDAE: *AMIA* SP.) FROM THE COAL CREEK MEMBER OF THE EOCENE KISHENEHN FORMATION, NORTHWESTERN MONTANA

B78 **T. Smith, K. E. Bemis, J. C. Tyler, W. E. Bemis, K. Kumar, R. S. Rana** A PECULIAR FISH JAW WITH MOLARIFORM TEETH FROM THE EARLY EOCENE OF TADKESHWAR MINE, INDIA HIGHLIGHTS DIVERSITY AND EVOLUTION OF EARLY GYMNODONT TETRAODONTIFORMS

B79 **S. E. El-Sayed, A. M. Murray, H. M. Sallam, G. F. Gunnell, E. R. Seiffert** --NEW CATFISH (SILURIFORMES) REMAINS FROM THE UPPER EOCENE BIRKET QARUN FORMATION, IN THE JEBEL QATRANI AREA, FAYUM DEPRESSION, EGYPT

*Numbers beginning with “B” represent the poster board number in Exhibit Hall.

THURSDAY, AUGUST 24, 2017
POSTER SESSION II
(CONTINUED)

B80 **T. Prikryl, G. Carnevale** THE EARLIEST SKELETAL RECORD FOR THE ORDER BATRACHOIDIFORMES (TELEOSTEI, PERCOMORPHA) - AN OLIGOCENE TOADFISH FROM PARATETHYS SEDIMENTS OF MORAVIA, CZECH REPUBLIC

B81 **G. Chen, M. Chang** A NEW GENUS AND SPECIES OF ELLIMMICHTHYIFORMES (CLUPEOMORPHA) FROM THE OLIGOCENE OF SOUTH CHINA

B82 **M. K. Macias, M. A. Roeder** AN EARLY MIOCENE MOBULID LOCALITY FROM THE FRANK R. BOWERMAN LANDFILL, IRVINE, CALIFORNIA: THE IMPORTANCE OF MITIGATION PALEONTOLOGY AND ITS IMPLICATIONS FOR MOBUILD PALEOBIOGEOGRAPHY

B83 **J. R. Pérez-Marín, K. Moreno, S. N. Nielsen** A SERRANID FISH (ACTINOPTERYGII, PERCIFORMES) FROM THE EARLY MIOCENE OF THE PROVINCE OF ARAUCO, CHILE

B84 **H. M. Maisch Iv, M. A. Becker, J. A. Chamberlain Jr.** OCCURRENCE OF LAMNIFORM AND CARCHARHINIFORM SHARKS FROM THE PUNGO RIVER AND YORKTOWN FORMATIONS (MIOCENE-PLIOCENE) OF THE SUBMERGED CONTINENTAL SHELF, ONSLOW BAY, NORTH CAROLINA, U.S.A.

B85 **J. Van Dijk, M. Bazzi, Ž. Žigaite, N. E. Campione** ENVIRONMENTAL DRIVERS OF LAMNIFORM SHARK EVOLUTION FROM THE LATE CRETACEOUS TO EARLY PALEOGENE

B86 **B. P. Kear, M. Bazzi, L. Wretman, N. E. Campione** GIANT LAMNIFORM SHARKS FROM THE LATE APTIAN AUSTRALIAN TETHYS

B87 **M. Bazzi, E. Einarsson, M. Newbrey, N. E. Campione, B. P. Kear, M. Siversson** A LARGE *SQUALICORAX* (CHONDRICHTHYES: LAMNIFORMES) FROM THE LATE CRETACEOUS OF SWEDEN AND THE ASSOCIATION OF SHARKS AND MOSASAURS

B88 **A. M. Deans, A. L. Hendrix, C. Lewis, S. G. Lucas, A. A. Harrison, A. B. Heckert** NEW LATE CRETACEOUS (EARLY CAMPANIAN) MICROFOSSIL FISH ASSEMBLAGE FROM THE UPPER CRETACEOUS ALLISON MEMBER OF THE MENEFEE FORMATION OF NEW MEXICO

B89 **J. Lilja, M. Bazzi, N. E. Campione, B. Kear, H. Blom, P. E. Ahlberg** DENTAL MORPHOLOGY AND TAXONOMY OF MEGATOOTHED SHARKS: A MORPHOMETRIC APPROACH

B90 **J. I. Kirkland, D. D. DeBlieux, R. Hunt-Foster, M. C. Hayden** MEDIAL MESOZOIC PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING OF BUREAU OF LAND MANAGEMENT (BLM) LANDS IN THE BLUE HILLS AREA, EASTERN UTAH: DOCUMENTING PALEONTOLOGICAL RESOURSES THAT HAVE BEEN LOVED TO DEATH

B91 **A. Millhouse, H. Little** DEVELOPING GUIDELINES TO INCREASE DATA ACCESSIBILITY AND INTEROPERABILITY FOR VERTEBRATE FOSSILS

B92 **J. E. Peterson, M. L. Krippner, S. R. Clawson** COMPARISONS OF FIDELITY IN THE DIGITIZATION AND 3D PRINTING OF VERTEBRATE FOSSILS FOR OUTREACH, EDUCATION, AND RESEARCH

*Numbers beginning with "B" represent the poster board number in Exhibit Hall.

THURSDAY, AUGUST 24, 2017
POSTER SESSION II
(CONTINUED)

MACLEOD A1-A4 AND PREFUNCTION

Preparators' Poster Session

B93 **T. Sato, F. Xu, B. Hu, D. Jiang** ULTRALIGHT POLYESTER RESIN CASTS FOR MUSEUM EXHIBITS IN SOUTHWEST CHINA

B94 **C. A. Hoffmann, M. B. Andrade, M. B. Soares, J. Marques** CT SCAN DATA COLLECTION THROUGH LOW KV PROTOCOLS PROVIDES ACCURATE DATA ON NON-MAMMALIAN CYNODONT FROM THE SANTA MARIA FORMATION, BRAZIL

B95 **B. Borkovic, R. S. Nagesan, J. Sanchez** 3D PHOTOGRAMMETRY MODELLING - THREE CASE STUDIES IN VERTEBRATE PALEONTOLOGY

B96 **J. Sanchez, B. Borkovic, C. Scott** RIVERS AND RECOVERY - MITIGATIVE PALEONTOLOGY AS A RESULT OF FLOODING IN SOUTHERN ALBERTA

B97 **T. J. Kerr, K. Patrick, M. T. Clementz, L. Vietti** NO FOSSILS WERE HARMED DURING THE TRAINING OF THIS PREPARATOR: USING 3D MODELS TO TEACH PROPER PREPARATION TECHNIQUES

B98 **A. A. Kilmury, C. M. Brown, C. Carbone, M. Mitchell** COLLECTION AND PREPARATION OF A SUB-ADULT *PROSAUROLOPHUS* (ORNITHISCHIA: HADROSAURIDAE) FROM THE BEARPAW FORMATION (LATE CAMPANIAN) NEAR LETHBRIDGE, ALBERTA, AN EXAMPLE OF EXPEDITED LARGE-SCALE EXCAVATION IN AN INDUSTRIAL SITE

B99 **E. K. Frampton, D. N. Spivak, D. B. Brinkman** CONSULTING PALAEONTOLOGY IN ALBERTA: PROCESS, METHODS AND RESULTS OF HISTORICAL RESOURCE IMPACT ASSESSMENTS FOR INDUSTRY.

B100 **A. C. Henrici, L. J. Church, N. Wuerthele, J. Leacock, G. E. Anderson** A METHOD FOR MAKING FOSSIL VERTEBRATE SUPPORT CRADLES FROM AN EPOXY CLAY COMPOUND

B101 **L. T. Yann** COMPARISON OF DIFFERENT STORE BOUGHT AND HOMEMADE CONTACT PAPERS USED TO STABILIZE JACKETED FOSSILS WITH POTENTIAL BIOLOGICAL MATERIAL

B102 **M. Foy, B. L. Beatty, M. C. Mihlbachler** MOLD AND CAST FIDELITY AND DATA LOSS IN DENTAL MICROWEAR TEXTURE ANALYSIS

B103 **R. Anemone, J. Crowell** THREE DIMENSIONAL VIRTUAL RECONSTRUCTION OF A *CORYPHODON* MAXILLA FROM THE EOCENE OF WYOMING

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION X
TELUS CONVENTION CENTRE, MACLEOD C
MODERATORS: Adam Pritchard and Michael Habib

8:00 **S. J. Nesbitt, M. R. Stocker, M. Ezcurra, N. C. Fraser, A. B. Heckert, A. Marsh, W. Parker, B. Mueller, A. C. Pritchard** THE 'STRANGE REPTILES' OF THE TRIASSIC: THE MORPHOLOGY, ECOLOGY, AND TAXONOMIC DIVERSITY OF THE CLADE ALLOKOTOSAURIA ILLUMINATED BY THE DISCOVERY OF AN EARLY DIVERGING MEMBER

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION X
(CONTINUED)

8:15 **R. Irmis, R. Schoch** A NEW SMALL-BODIED REPTILE FROM THE MIDDLE TRIASSIC OF GERMANY DOCUMENTS THE CURSORIAL TO AQUATIC EVOLUTIONARY TRANSITION IN A CLADE OF EARLY ARCHOSAURIFORMS

8:30 **A. C. Pritchard, B. S. Bhullar, J. A. Gauthier** A TINY, EARLY PAN-ARCHOSAUR FROM THE UPPER TRIASSIC OF CONNECTICUT AND THE DIVERSITY OF THE EARLY SAURIAN FEEDING APPARATUS

8:45 **S. Singh, A. Elsler, T. Stubbs, M. J. Benton** RED IN TOOTH AND JAW: MANDIBULAR MORPHOLOGY REVEALS POSSIBLE INTRINSIC PRESSURES ON ARCHOSAUROMORPH TROPHIC EVOLUTION THROUGH THE EARLY MESOZOIC

9:00 **M. C. Langer, J. Ramezani, S. Dias-Da-Silva, S. Cabreira, F. Pretto, M. Bronzati, J. Marsola, R. Müller, C. Pacheco, L. Roberto-Da-Silva** NEW DINOSAUROMORPHS AND RADIOISOTOPIC AGES FROM THE LATE TRIASSIC SANTA MARIA AND CATURRITA FORMATIONS, SOUTH BRAZIL

9:15 **B. T. Breeden, R. Irmis, S. J. Nesbitt, N. D. Smith, A. H. Turner** NEW SILESAURID (ARCHOSAURIA: DINOSAURIFORMES) SPECIMENS FROM THE UPPER TRIASSIC CHINLE FORMATION OF NEW MEXICO AND THE PHYLOGENETIC RELATIONSHIPS OF *EUCOELOPHYSIS BALDWINI*

9:30 **M. Habib, D. Hone, F. Therrien** EVALUATION OF FLIGHT CHARACTERISTICS OF CANADIAN AZHDARCHID PTEROSAUR MATERIAL REVEALS UNIQUE FUNCTIONAL MORPHOLOGY AND HINTS AT HIDDEN AZHDARCHID TAXONOMIC AND ECOLOGICAL DIVERSITY

9:45 **N. Carroll, A. A. Farke, S. Chai, A. Oei** A NEW AZHDARCHID PTEROSAUR FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH, USA

10:00 **BREAK**

10:15 **P. D. Mannion, A. A. Chiarenza, P. L. Godoy, J. P. Tennant, Y. Cheah** THE QUALITY OF THE 230 MILLION YEAR FOSSIL RECORD OF TERRESTRIAL CROCODYLOMORPHS AND ITS IMPACT ON DIVERSITY

10:30 **S. Drymala, S. J. Nesbitt, R. Irmis, L. Zanno** NEW CARNIAN TAXON FROM NORTH CAROLINA (USA) CLARIFIES EARLY CROCODYLOMORPH ANATOMY AND ALLOWS FOR EXPANDED CHARACTER SAMPLING IN THE CLADE

10:45 **D. Foffa, M. T. Young, S. Brusatte, L. Steel** A NEW MIDDLE JURASSIC METRIORHYNCHID AND ITS IMPLICATIONS FOR MACROPREDATORY ORIGINS AND EVOLUTION

11:00 **D. Driscoll, T. L. Stubbs, A. M. Dunhill, M. J. Benton** HOW MANY SKULLS DOES IT TAKE TO MAKE A CROC? THE FOSSIL RECORD OF MESOZOIC MARINE CROCODILES IS BIASED BY FOSSIL COMPLETENESS.

11:15 **K. Voegele, P. Ullmann, Z. M. Boles, E. Schroeter, M. Schweitzer, K. J. Lacovara** PRESERVATION OF ENDOGENOUS COLLAGEN I IN A MARINE CROCODILE, *THORACOSAURUS NEOCESARIENSIS*

11:30 **O. Mateus, P. M. Callapez, E. Puértolas-Pascual** THE OLDEST CROCODYLIA? A NEW EUSUCHIAN FROM THE LATE CRETACEOUS (CENOMANIAN) OF PORTUGAL

11:45 **G. Cidade, A. S. Hsiou** A NEW COMPREHENSIVE PHYLOGENETIC ANALYSIS OF ALLIGATOROIDEA (CROCODYLOMORPHA, CROCODYLIA) AND ITS BIOGEOGRAPHIC AND PALEOECOLOGIC IMPLICATIONS

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION X
(CONTINUED)

12:00 **X. Wu, T. Sato, H. Shan, Y. Cheng** NEW INFORMATION ON *TOMISTOMA PETROLICA* YEH, 1958

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION XI
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Eric Scott and Mark Clementz

8:00 **B. Bai** EOCENE PACHYNOLOPHINAE (PERISSODACTYLA, PALAEOTHERIIDAE) FROM CHINA AND ITS PALEOBIOGEOGRAPHIC IMPLICATIONS

8:15 **P. A. Holroyd** EVIDENCE FOR ROSTRAL ELONGATION IN LATE MIDDLE EOCENE BOTHRIODONTINES (ANTHRACOTHERIIDAE: ARTIODACTYLA) IN NORTH AMERICA

8:30 **D. R. Green, A. S. Colman** BOVID TOOTH MINERALIZATION AND BAYESIAN METHODS FOR RECONSTRUCTING PALEOSEASONALITY

8:45 **E. Scott, K. Springer** *BISON* FROM THE TULE SPRINGS LOCAL FAUNA, SOUTHERN NEVADA: IMPLICATIONS FOR THE DIVERSITY AND BIOGEOGRAPHY OF LATE PLEISTOCENE BISON IN SOUTHWESTERN NORTH AMERICA

9:00 **E. M. Doughty, J. D. Marcot** THE ECOLOGY AND EVOLUTION OF BODY MASS OF NORTH AMERICAN UNGULATES IN RELATION TO ENVIRONMENTAL CHANGE

9:15 **E. B. Davis, S. S. Hopkins, N. A. Famoso, E. M. Biedron, S. Robson, K. Walters** ASSESSING THE PALEO-SPECIES-AREA RELATIONSHIP WITH NEOGENE FOSSIL MAMMALS FROM NORTH AMERICA

9:30 **Z. Calamari** ARE BONES ENOUGH? USING GENOMIC EVIDENCE TO ASSESS HOOFED MAMMAL CRANIAL APPENDAGE HOMOLOGY

9:45 **J. A. MacLaren, R. C. Hulbert, S. C. Wallace, S. Nauwelaerts** CHALLENGING THE TAPIR *STATUS QUO* – FORELIMB VARIATION INDEPENDENT OF BODY MASS ACROSS TIME AND SPACE IN THE GENUS *TAPIRUS* (PERISSODACTYLA: TAPIRIDAE)

10:00 **BREAK**

10:15 **M. D. Uhen** LATITUDINAL EFFECTS ON THE DISTRIBUTION AND DIVERSITY OF FOSSIL MARINE MAMMALS

10:30 **M. Clementz, M. D. Uhen** MORPHOLOGIC AND ISOTOPIC EVIDENCE OF THE DEVELOPMENTAL HISTORY OF AUDITORY BULLAE IN *DORUDON ATROX* AND *ZYGORHIZA KOCHII* (ORDER CETACEA, FAMILY BASILOSAURIDAE)

10:45 **A. Lanzetti, A. Berta, E. G. Ekdale** HOW TO MAKE A WHALE: FIRST COMPLETE DEVELOPMENTAL SEQUENCE OF THE SKULL OF THE HUMPBACK WHALE AND ITS IMPLICATIONS FOR THE EVOLUTION OF MYSTICETES

11:00 **R. W. Boessenecker, M. Churchill, D. L. Fraser, J. H. Geisler** NEW DISCOVERIES OF XENOROPHIDAE FROM THE OLIGOCENE OF THE CAROLINAS: INSIGHTS INTO THE EVOLUTION OF FEEDING MORPHOLOGY, ENCEPHALIZATION, AND LOCOMOTION OF THE EARLIEST DOLPHINS (ODONTOCETI)

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION XI
(CONTINUED)

11:15 **C. M. Peredo, M. D. Uhen, M. D. Nelson** A NEW KENTRIODONTID (ODONTOCETI) FROM THE PACIFIC NORTHWEST SHEDS NEW LIGHT ON THE TEMPORAL AND GEOGRAPHIC RANGE OF THE ENIGMATIC DOLPHIN FAMILY

11:30 **C. S. Gutstein, C. P. Figueroa-Bravo, J. Mpodozis** TOWARDS A BETTER RESOLUTION ON THE PHYLOGENY OF PANDELPHINA (CETACEA: ODONTOCETI): DEFINITION OF NEW MORPHOLOGICAL CHARACTERS

11:45 **R. S. Paterson, N. Rybczynski, H. C. Maddin, N. Kohno** THE EVOLUTION OF PINNIPEDS FROM A TERRESTRIAL ANCESTOR: THE POSSIBILITY OF PARALLEL EVOLUTION WITHIN A MONOPHYLETIC FRAMEWORK

12:00 **L. Dewaele, O. Lambert, C. De Muizon, S. Louwye** NEW MATERIAL OF *AUSTRALOPHOCA* (CARNIVORA, PHOCIDAE) FROM THE LATE MIOCENE OF PERU SUGGESTS SEXUAL DIMORPHISM IN THE SMALLEST, EARLY-BRANCHING MONACHINE SEAL

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION XII
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Ilaria Paparella and Alexander Hastings

8:00 **J. A. Herrera-Flores, M. J. Benton, T. L. Stubbs** EARLY EVOLUTION AND MORPHOLOGICAL DIVERSIFICATION OF MESOZOIC SQUAMATES

8:15 **M. Campbell Mekarski, M. W. Caldwell** THE POLYPHYLY OF MOSASAURS: RESULTS FROM AN EXPANSIVE PYTHONOMORPH PHYLOGENY AND IMPLICATIONS FOR MULTIPLE MARINE RADIATIONS AMONG CRETACEOUS SQUAMATES

8:30 **B. G. Augusta, M. Polcyn, H. Zaher, A. R. Fiorillo, L. L. Jacobs** A NEW SPECIES OF *CONIASAURUS* (SQUAMATA: MOSASAURIA) FROM THE MIDDLE CENOMANIAN OF TEXAS (USA) AND REASSESSMENT OF THE COMPOSITION OF DOLICHOSAURIDAE

8:45 **I. Paparella, T. Konishi, M. W. Caldwell** HOMOLOGIES OF THE ILIAC PROCESSES IN MOSASAUROIDS AND NEW INSIGHTS IN THE PLESIOPELVIC–HYDROPELVIC TRANSITION

9:00 **M. W. Caldwell, R. L. Nydam, A. Palci, T. R. Simões, F. Garberoglio, S. Apesteguia** EMERGING HEAD FIRST: THE EARLY FOSSIL RECORD OF SNAKE CRANIAL EVOLUTION

9:15 **F. F. Garberoglio, R. O. Gómez, T. R. Simões, M. W. Caldwell, S. Apesteguía** THE CAUDAL INTERCENTRUM SYSTEM (CIS) OF FOSSIL AND LIVING SNAKES REVEALED BY A NEW SPECIMEN OF *DINILYSIA PATAGONICA*

9:30 **H. Yi** ESTIMATING AGILITY OF THE FOSSIL SNAKE *DINILYSIA PATAGONICA* (REPTILIA: SQUAMATA), USING THE SEMICIRCULAR CANALS AS AN ECOMORPHIC PROXY IN SQUAMATES

9:45 **H. Zaher, J. A. Wilson, D. Mohabey** A NEW SPECIMEN OF THE NEST PREDATOR *SANAJEH INDICUS* (SERPENTES) SUGGESTS A MORE BASAL POSITION WITHIN SNAKE PHYLOGENY

10:00 **BREAK**

FRIDAY MORNING, AUGUST 25, 2017
TECHNICAL SESSION XII
(CONTINUED)

10:15 **A. Palci, M. S. Lee, M. Hutchinson, M. W. Caldwell, J. Scanlon** PALEOECOLOGICAL IMPLICATIONS OF THE INNER EAR MORPHOLOGY OF THE AUSTRALIAN FOSSIL SNAKES *YURLUNGGUR* AND *WONAMBI* (SQUAMATA, SERPENTES, MADTSOIIDAE)

10:30 **N. Mongiardino Koch, J. A. Gauthier** MOLECULAR PHYLOGENETIC SIGNAL IS INSUFFICIENT TO CONFIDENTLY RESOLVE THE SQUAMATE BACKBONE TOPOLOGY

10:45 **A. Watanabe, J. A. Maisano, J. Müller, A. Herrel, A. Goswami** LARGE-SCALE MORPHOMETRIC ANALYSIS REVEALS PATTERNS OF CRANIAL SHAPE EVOLUTION ACROSS SQUAMATES

11:00 **K. M. Thorn, M. S. Lee, M. Hutchinson, M. Archer** PHYLOGENY OF THE *EGERNIA* GROUP SKINKS: COMBINING MORPHOLOGICAL AND MOLECULAR DATA TO DECIPHER THE ORIGINS OF AUSTRALIA'S BLUETONGUED LIZARDS

11:15 **S. J. ElShafie** EARLIEST EVIDENCE OF TAIL REGENERATION IN A FOSSIL SQUAMATE

11:30 **A. Hastings, A. C. Dooley** CENOZOIC MARINE REPTILES OF CENTRAL VIRGINIA: EVIDENCE FROM THE EARLY EOCENE AND MIDDLE MIOCENE AT THE CARMEL CHURCH QUARRY FOSSIL LOCALITY

11:45 **A. J. Lichtig, S. G. Lucas, H. Klein, D. Lovelace** TRIASSIC TURTLE TRACKS AND THE ORIGIN OF TURTLES

12:00 **M. Rabi, D. B. Brinkman** SOFTSHELL TURTLES BREAK DOLLO'S LAW: PHYLOGENETIC EVIDENCE FOR THE REVERSAL OF PERIPHERAL ELEMENTS IN THE SHELL OF THE INDIAN FLAPSHELL TURTLE

FRIDAY AFTERNOON, AUGUST 25, 2017
TECHNICAL SESSION XIII
TELUS CONVENTION CENTRE, MACLEOD C
MODERATORS: Angelica Torices and Michael Pittman

1:45 **F. M. Smithwick, R. Nicholls, I. Cuthill, J. Vinther** COUNTERSHADING AND STRIPES IN *SINOSAUROPTERYX* REVEAL HETEROGENEOUS HABITATS IN THE JEHOL BIOTA

2:00 **P. J. Makovicky, S. Apesteguía, F. Gianechini** A NEW, ALMOST COMPLETE SPECIMEN OF *ALNASHETRI CERROPOLICIENSIS* IMPACTS OUR UNDERSTANDING OF ALVAREZSAUROID EVOLUTION

2:15 **M. Kundrát, J. Lü, L. Xu, H. Pu, C. Shen, H. Chang** FIRST ASSEMBLAGE OF EGGSHELLS AND SKELETAL REMAINS OF THE ALVAREZSAURID DINOSAUR FROM LAURASIA (UPPER CRETACEOUS, CHINA)

2:30 **G. F. Funston, P. J. Currie, C. Tsogtbaatar** A NEW OVIRAPTORID (DINOSAURIA: THEROPODA) PROVIDES A RARE GLIMPSE INTO SOCIAL BEHAVIOUR IN DINOSAURS

2:45 **J. Lü, M. Kundrát, Y. Kobayashi, Y. Lee, C. Shen, F. Teng** A CASSOWARY-LIKE CRESTED OVIRAPTORID DINOSAUR (DINOSAURIA: OVIRAPTOROSAURIA) FROM SOUTHERN CHINA

FRIDAY AFTERNOON, AUGUST 25, 2017
TECHNICAL SESSION XIII
(CONTINUED)

3:00 **W. L. Parsons, K. M. Parsons** A PARTIAL EGG OF *DEINONYCHUS ANTIRRHOPUS* CONTAINING EMBRYONIC BONES, FROM THE UNIT VI CHANNEL STRATUM OF THE EARLY CRETACEOUS CLOVERLY FORMATION OF CENTRAL MONTANA

3:15 **A. Torices, R. D. Wilkinson, V. Arbour, J. I. Ruiz-Omeñaca, P. J. Currie** MICROWEAR AND FINITE ELEMENT ANALYSES OF THEROPOD DENTICLES HIGHLIGHT SHARED FEEDING STRATEGIES AMONG THEROPOD DINOSAURS, BUT DIVERGENT PREY SELECTION BETWEEN DROMAEOSAURIDS AND TROODONTIDS

3:30 **S. Hartman, M. Mortimer, W. Wahl, D. Lomax, D. Lovelace** NEW INFORMATION ON A PARAVIAN THEROPOD FROM THE MORRISON FORMATION

3:45 **X. Xu** SKELETAL OSSIFICATION AND FUSION PATTERNS IN JEHOL DROMEOSAURID THEROPODS, AND IMPLICATIONS FOR IDENTIFICATION OF POSTNATAL ONTOGENETIC STAGES AND GROWTH STRATEGIES

4:00 **M. Pittman, X. Xu, P. J. Currie, L. Xing, Q. Meng, J. Lü, D. Hu, C. Yu** MOSAIC EVOLUTION IN AN ASYMMETRICALLY FEATHERED TROODONTID DINOSAUR WITH TRANSITIONAL FEATURES

FRIDAY AFTERNOON, AUGUST 25, 2017
TECHNICAL SESSION XIV
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Ashley Reynolds and Ashley Poust

1:45 **A. W. Poust** OSTEOHISTOLOGY OF PALEOGENE CARNIVORES REVEALS EXTENDED TIME TO MATURITY IN BOTH CARNIVORAMORPHA AND"CREODONTIA"

2:00 **K. Veitschegger** LIFE HISTORY EVOLUTION IN CAVE BEARS – ELUCIDATING THE BIOLOGY OF AN EXTINCT MEGAFAUNAL ELEMENT

2:15 **K. L. Long, D. R. Prothero** DID SABER-TOOTH KITTENS GROW UP MUSCLEBOUND? A STUDY OF POSTNATAL LIMB BONE ALLOMETRY IN FELIDS FROM THE PLEISTOCENE OF RANCHO LA BREA

2:30 **A. R. Reynolds, K. L. Seymour** SABRE-TOOTHED CAT (*SMILODON FATALIS*) SUBADULTS FROM CORALITO, ECUADOR INTERPRETED AS MEMBERS OF THE SAME AGE COHORT

2:45 **K. L. Seymour, A. R. Reynolds, C. Churcher** THE SABRE CAT *SMILODON FATALIS* FROM TALARA PERU: AGE, SEX, MASS AND SOCIALITY

3:00 **B. Figueirido, A. Pérez-Ramos, B. Van Valkenburgh** CORTICAL VS TRABECULAR BONE AND THE SPECIALIZED KILLING BITE OF SABER-TOOTHS

3:15 **L. R. DeSantis, P. L. Koch** DIETARY ECOLOGY OF THE SCIMITAR-TOOTHED CAT *HOMOTHERIUM SERUM* FROM FRIESENHAHN CAVE AS INFERRED FROM STABLE ISOTOPES AND DENTAL MICROWEAR: A CHEETAH-LIKE PREDATOR

3:30 **J. Biewer, J. Parham, J. Velez Juarbe** ELEVEN NEW SKULLS FROM THE LOS ANGELES BASIN, SOUTHERN CALIFORNIA, SHED LIGHT ON THE TIMING OF MAJOR WALRUS RADIATIONS

FRIDAY AFTERNOON, AUGUST 25, 2017
TECHNICAL SESSION XIV
(CONTINUED)

3:45 **A. Houssaye** INNER BONE ADAPTATION IN SEMI-AQUATIC AMNIOTES - QUANTITATIVE 3D ANALYSIS OF LONG BONE SHAFT MICROANATOMICAL AND GEOMETRICAL FEATURES IN MUSTELIDS AND PINNIPEDS AND COMPARISONS WITH FOSSIL SEMI-AQUATIC AND AQUATIC AMNIOTES

4:00 **L. M. Lynch** SKELETAL LIMB MORPHOLOGY OF *MARTES AMERICANA*, A SMALL MUSTELID CARNIVORAN, VARIES PREDICTABLY BY BIOME BUT NOT IN CORRELATION WITH BODY SIZE

FRIDAY AFTERNOON, AUGUST 25, 2017
TECHNICAL SESSION XV
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Lucas Weaver and Alexandria Brannick

1:45 **J. A. Miyamae, B. S. Bhullar** COMPARATIVE MORPHOLOGY OF THE TRIGEMINAL CANAL AND A SCENARIO FOR THE EVOLUTION OF FACIAL MUSCULATURE IN MAMMALS

2:00 **J. K. Spear, E. Hoffman, B. S. Bhullar** THE RECONSTRUCTED BRAINCASE OF *ADELOBASILEUS* AND IMPLICATIONS FOR EARLY MAMMALIAFORM DIVERSITY

2:15 **D. Grossnickle, M. Chen, J. Wauer, Q. Meng, D. Liu, Y. Zhang, G. P. Wilson, Z. Luo** GLIDING AND ROOSTING BEHAVIOR IN ELEUTHERODONTID STEM MAMMALIAFORMS FROM THE JURASSIC OF CHINA

2:30 **D. T. Polet, J. M. Theodor, J. E. Bertram** RECONSTRUCTING EXTINCT MAMMAL LOCOMOTION THROUGH OPTIMAL CONTROL THEORY

2:45 **L. N. Weaver, M. Whitney, G. P. Wilson** OSTEOHISTOLOGY OF THREE MULTITUBERCULATE FEMORA FROM NORTHEASTERN MONTANA SUGGESTS VARIATION IN GROWTH RATE NEAR THE K-PG BOUNDARY

3:00 **A. L. Brannick, G. P. Wilson** EXPLORING THE EVOLUTION OF DUROPHAGY IN STAGODONTID METATHERIANS USING RELATIVE MANDIBULAR BENDING STRENGTH

3:15 **R. K. Engelman, J. J. Flynn, A. R. Wyss, D. A. Croft** A NEW, EARLY RELATIVE OF SABER-TOOTHED SPARASSODONTS (METATHERIA: SPARASSODONTA: THYLACOSMILIDAE) FROM THE EARLY OLIGOCENE CACHAPOAL FAUNA, ANDEAN MAIN RANGE, CENTRAL CHILE

3:30 **R. M. Beck, M. L. Taglioretti** THE IMPACT OF INCORPORATING TEMPORAL INFORMATION INTO PHYLOGENETIC ANALYSES: RESOLVING THE EVOLUTIONARY AFFINITIES OF"SPARASSOCYNIDS" (DIDELPHIMORPHIA; MARSUPIALIA)

3:45 **T. J. Halliday, G. V. Prasad, A. Goswami** THE GLOBAL AFFINITIES OF CRETACEOUS INDIAN FAUNAS

4:00 **J. D. Yeakel, C. P. Kempes, S. Redner** THE DYNAMICS OF STARVATION AND RECOVERY: A MECHANISTIC MODEL FOR A WITHIN-LINEAGE DRIVER OF COPE'S RULE

FRIDAY, AUGUST 25, 2017

POSTER SESSION III

TELUS CONVENTION CENTRE, MACLEOD A1-A4 AND PREFUNCTION

Authors must be present from 4:15 - 6:15 p.m. Friday, August 25

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

B1 **D. Broussard, T. Daeschler, J. Trop** THE PALEOBIOGEOGRAPHICAL AND PALEOENVIRONMENTAL IMPLICATIONS OF A WHATCHEERIID-LIKE TETRAPOD FEMUR FROM THE UPPER DEVONIAN CATSKILL FORMATION IN NORTHCENTRAL PENNSYLVANIA

B2 **B. J. Small, J. D. Pardo, J. K. Lungmus, R. J. Douglass, T. Schlotterbeck, A. K. Huttenlocker** THE FIRST VERTEBRATE BODY FOSSILS FROM THE CARBONIFEROUS-PERMIAN MAROON FORMATION, COLORADO, USA

B3 **A. K. Huttenlocker, J. D. Pardo, D. S. Berman, A. C. Henrici** NEW DISSOROPHOIDS FROM THE CARBONIFEROUS-PERMIAN OF COLORADO, USA

B4 **J. Fröbisch, C. F. Kammerer, H. Sues** FIRST RECORD OF THE CHINESE CAPTORHINID *GANSURHINUS* IN THE LATE PERMIAN OF GERMANY

B5 **M. L. Perez, E. G. Chindebvu, H. Simfukwe, D. P. Vineyard, M. J. Polcyn, D. Winkler, L. L. Jacobs** *EUNOTOSAURUS* (PARAREPTILIA) FROM THE MIDDLE PERMIAN OF THE REPUBLIC OF MALAWI

B6 **A. Bradley, S. J. Nesbitt** A POSSIBLE NEW SPECIMEN OF THE OWENETIID *RUHUHUARIA REISZI* FROM THE MANDA BEDS OF SOUTHERN TANZANIA (MIDDLE TRIASSIC) AND ITS IMPLICATIONS FOR SMALL REPTILES DURING THE TRIASSIC PERIOD RECOVERY

B7 **L. McCormack, W. Parker** A NEW OCCURRENCE OF THE PHYTOSAUR (ARCHOSAURIFORMES, PHYTOSAURIA) *PRAVUSUCHUS HORTUS* FROM THE MONITOR BUTTE MEMBER (UPPER TRIASSIC; CHINLE FORMATION) OF UTAH

B8 **W. L. Holloway** A COMPARATIVE ANALYSIS OF RECONSTRUCTED CRANIAL MYOLOGY OF PHYTOSAURIA

B9 **A. B. Heckert, Y. Delgado, D. K. Hoffman, V. Schneider** TINY SKELETON OF AN ARCHOSAUR FROM THE UPPER TRIASSIC (CARNIAN) PEKIN FORMATION OF NORTH CAROLINA, U.S.A.: A GLIMPSE OF A HATCHLING AETOSAUR?

B10 **Y. Delgado, A. B. Heckert, J. R. Foster** NEW OCCURRENCES OF UPPER TRIASSIC (ADAMANIAN—REVUELTIAN?) FOSSILS FROM THE LOWER CHINLE GROUP NEAR WINGATE MESA, SOUTHEASTERN UTAH: EXPANDING UTAH'S LATE TRIASSIC FOSSIL RECORD

B11 **D. K. Hoffman, A. B. Heckert, Y. Delgado, L. E. Zanno** DERMAL ARMOR AND LIMB BONE HISTOLOGY OF THE AETOSAUR *COAHOMASUCHUS* (ARCHOSAURIA: STAGONOLEPIDIDAE) FROM THE UPPER TRIASSIC PEKIN FORMATION, DEEP RIVER BASIN, NORTH CAROLINA

B12 **M. R. Stocker, H. Sues, S. E. Jasinski** UNITING THE UPPER TRIASSIC DEPOSITS OF CENTRAL AND NORTH PANGEA: THE FIRST RECORD OF *PARASUCHUS* FROM THE NEWARK SUPERGROUP AND ITS IMPLICATIONS FOR BIOCHRONOLOGY

B13 **A. M. Laing, A. H. Turner, C. Kernan, S. Werning, N. Smith, R. Irmis, S. J. Nesbitt** A NEW SHUVOSAURID TAXON (ARCHOSAURIA, PSEUDOSUCHIA) FROM THE LATE TRIASSIC HAYDEN QUARRY OF NEW MEXICO, USA

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FRIDAY, AUGUST 25, 2017
POSTER SESSION III
(CONTINUED)

B14 **E. J. Lessner, W. Parker, S. J. Nesbitt, A. Marsh, R. Irmis, B. Mueller** RECONSTRUCTING LATE TRIASSIC VERTEBRATE FAUNAS FROM THE UPPER TRIASSIC DOCKUM GROUP OF TEXAS USING APOMORPHY-BASED IDENTIFICATIONS

B15 **A. R. Milner, R. J. Gay, R. Irmis, F. Overkamp, M. Santella** NEW SOUTHWESTERN UTAH PALEONTOLOGICAL LOCALITY FROM THE LOWER JURASSIC KAYENTA FORMATION REVEALS A DIVERSE VERTEBRATE FAUNA BASED ON TEETH AND TRACKS

B16 **S. C. Maidment, T. J. Raven** A NEW PHYLOGENY OF STEGOSAURIA (DINOSAURIA: ORNITHISCHIA)

B17 **T. J. Raven, S. C. Maidment** THE ANATOMY, TAXONOMY AND SYSTEMATIC POSITION OF THE ENIGMATIC THYREOPHORAN DINOSAUR *PARANTHODON AFRICANUS*

B18 **H. E. Rivera-Sylva, E. Frey, W. Stinnesbeck** THE ANKYLOSAURIA FROM MEXICO

B19 **M. Clemens, D. Winkler, M. Polcyn, L. L. Jacobs** A NODOSAURID (ORNITHISCHIA, ANKYLOSAURIA) FROM THE LOWER EAGLE FORD GROUP OF NORTH CENTRAL TEXAS

B20 **J. C. Mallon, D. M. Henderson, C. M. McDonough, W. J. Loughrey** THE RIDDLE OF THE UPSIDE-DOWN ANKYLOSAURS

B21 **D. M. Henderson, C. M. Brown** TAPHONOMY OF THE FORT MCMURRAY NODOSAUR – A THREE-DIMENSIONALLY PRESERVED ARMOURED DINOSAUR WITH *IN-SITU* SKIN, SCALES AND OSTEODERMS

B22 **J. Vinther, C. M. Brown, D. Henderson, I. Fletcher, R. Summons** 3D CAMOUFLAGE IN A LARGE-BODIED, HEAVILY ARMORED ANKYLOSAUR REVEALS NON-UNIFORMITARIAN MESOZOIC PREDATOR-PREY DYNAMICS

B23 **L. Jia, H. You, R. Wang, J. Yi, S. Xu** A NEW ANKYLOSAURID DINOSAUR FROM THE EARLY LATE CRETACEOUS OF ZUOYUN, SHANXI PROVINCE, CHINA

B24 **C. T. Freer, V. Arbour, N. E. Campione** ON THE POTENTIAL COEVOLUTION OF ANKYLOSAURS AND THEROPODS

B25 **K. Tanoue, T. Ohashi, R. Matsumoto, S. Fujiwara, S. Kawabe, Y. Urano, Q. Zhao, H. You** DISTRIBUTION OF KERATIONOUS BEAKS IN BASAL CERATOPSIANS FROM THE LOWER CRETACEOUS IN CHINA

B26 **D. Anduza** TOWARD DISCOVERING THE ADAPTIVE FUNCTIONS OF CERATOPSIAN ROSTRALS

B27 **E. M. Morschhauser, F. Varriale** THE LABIAL (HORIZONTAL) SHELF IS A SYNAPOMORPHY OF NEOCERATOPSIA (DINOSAURIA: ORNITHISCHIA)

B28 **C. Bullar, M. J. Benton, Q. Zhao, M. J. Ryan** CERATOPSIAN BRAINCASE MORPHOLOGY AND PALAEONEUROLOGY THROUGH ONTOGENY

B29 **M. J. Ryan, D. C. Evans** A NEW CENTROSAURIN CERATOPSID FROM THE UPPER UNIT OF THE OLDMAN FORMATION (LATE CRETACEOUS: CAMPANIAN) OF SOUTHERN ALBERTA, CANADA

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FRIDAY, AUGUST 25, 2017
POSTER SESSION III
(CONTINUED)

B30 **A. Prieto-Marquez, P. J. Makovicky, S. H. Joshi** ONTOGENY AND EVOLUTION OF THE FRILL OF NEOCERATOPSIAN DINOSAURS

B31 **A. J. Brown, N. Smith** OSTEOHISTOLOGICAL EVALUATION OF THE SQUAMOSAL IN *TRICERATOPS HORRIDUS*

B32 **A. Knapp, R. Knell, A. A. Farke, D. Hone** SPECIES RECOGNITION IN THE MESOZOIC? TESTING HYPOTHESES OF ELABORATE STRUCTURES IN CERATOPSIAN DINOSAURS

B33 **J. R. Burgo, D. J. Varricchio** SEM AND THIN SECTION ANALYSIS OF PREVIOUSLY UNIDENTIFIED EGGSHELL FROM EGG MOUNTAIN

B34 **E. Przybyszewski, P. D. Germano, D. J. Varricchio, D. Trexler** FILLING A DATA GAP WITH ANALYSIS OF FOSSIL EGGSHELL FROM THE LATE CRETACEOUS UPPER TWO MEDICINE FORMATION OF MONTANA

B35 **D. K. Zelenitsky, K. Tanaka, J. T. Voris, F. Therrien** TAXONOMIC TRENDS IN FOSSIL EGG REMAINS DURING THE LATE CRETACEOUS OF ALBERTA, CANADA

B36 **J. T. Voris, D. K. Zelenitsky, K. Tanaka, F. Therrien** DINOSAUR EGGSHELL ASSEMBLAGE FROM THE UPPERMOST CAMPANIAN—LOWER MAASTRICHTIAN ST. MARY RIVER FORMATION OF SOUTHERN ALBERTA, CANADA

B37 **H. Lee, Y. Lee, Y. Kobayashi, K. Tsogtbaatar** A PRELIMINARY REPORT OF UNUSUAL DINOSAUR NESTING GROUND, EASTERN GOBI, MONGOLIA

B38 **A. Pérez-García, F. Gascó, F. Ortega** A SINGULAR UPPERMOST CRETACEOUS DINOSAUR NESTING AREA IN THE VILLALBA DE LA SIERRA FORMATION (GUADALAJARA, CENTRAL SPAIN)

B39 **D. J. Varricchio, M. Kundrát, J. Hogan** A TIME TO BROOD: INCUBATION PERIOD IN THE THEROPOD DINOSAUR *TROODON FORMOSUS*

B40 **M. J. Vavrek** CONTINENTAL BREAKUP AND THE EVOLUTION OF BODY SIZE IN DINOSAURS

B41 **A. A. Chiarenza, P. Mannion, P. A. Allison, D. J. Lunt, P. J. Markwick** ABSENCE OF EVIDENCE IS NOT EVIDENCE OF ABSENCE: THE EFFECT OF SPATIAL FOSSIL BIAS IN PALEODIVERSITY ESTIMATES IN THE LATEST CRETACEOUS OF NORTH AMERICA

B42 **D. E. Malinzak, M. C. Lamanna** NEW TERMINAL CRETACEOUS (LATE MAASTRICHTIAN) NON-AVIAN DINOSAUR DISCOVERIES FROM SOUTH DAKOTA: IMPLICATIONS FOR LARAMIDIAN PALEOECOLOGY AND PALEOBIOGEOGRAPHY

B43 **M. C. Lamanna, P. M. O'Connor, S. W. Salisbury, E. Gorscak, J. A. Clarke, R. D. MacPhee, E. M. Roberts, D. E. Malinzak, R. C. Ely, J. A. Case** NEW MATERIAL OF NON-AVIAN DINOSAURS FROM THE LATE CRETACEOUS OF JAMES ROSS ISLAND, ANTARCTICA

B44 **D. A. Eberth, F. Fanti** COMPOSITE STRATIGRAPHY AND SEDIMENTOLOGIC EVOLUTION OF THE DINOSAUR-RICH BARUUNGOYOT-NEMEGT SUCCESSION (UPPER CRETACEOUS), NEMEGT BASIN, SOUTHERN MONGOLIA

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FRIDAY, AUGUST 25, 2017
POSTER SESSION III
(CONTINUED)

B45 **D. DeBlieux, J. I. Kirkland, M. Hayden, R. Hunt-Foster** SIGNIFICANT MESOZOIC VERTEBRATE FOSSIL LOCALITIES DISCOVERED DURING PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING ON BUREAU OF LAND MANAGEMENT LAND IN THE WESTERN BLANDING BASIN, SOUTHEASTERN UTAH

B46 **E. A. Smith, E. U. Petersen, M. A. Loewen, J. I. Kirkland** MANGANESE OXIDE PERMINERALIZATION IN DINOSAUR BONE AT THE JURASSIC-CRETACEOUS BOUNDARY OF CENTRAL UTAH

B47 **S. K. Swenson, K. Chin, K. Curry Rogers, R. R. Rogers** TAPHONOMY OF DINOSAUR COPROLITES FROM THE UPPER CRETACEOUS (CAMPANIAN) TWO MEDICINE FORMATION, NORTHWESTERN MONTANA

B48 **M. L. Winitch, P. E. Olsen** IMPLICATIONS OF AN ANALYSIS OF DEEP PES TRACES AND MANUS IMPRESSIONS FOR THE SUPPOSED *ATREIPUS-GRALLATOR* ICHNOGENERIC PLEXUS*:* AN APOMORPHY-BASED APPROACH

B49 **P. E. dePolo, S. Brusatte, T. Challands, D. Foffa, M. Wilkinson, D. Ross** NEW TRACK SITES ON ISLE OF SKYE (SCOTLAND, UK) INDICATE POSSIBLE ENVIRONMENTAL PARTITIONING AMONG DINOSAURS

B50 **S. Kozu, A. Sardsud, D. Saesaengseerung, C. Pothichaiya, S. Agematsu, K. Sashida** DINOSAUR FOOTPRINT ASSEMBLAGE AND ITS GREGARIOUS BEHAVIOR FROM THE LOWER CRETACEOUS KHOK KRUAT FORMATION, KHORAT GROUP, NORTHEASTERN THAILAND

B51 **P. Citton, M. Romano, M. Avanzini** THE AXONY CONCEPT IN TETRAPOD ICHNOLOGY

B52 **M. F. Jones, N. A. Thurber, K. Beard** NEW SPECIMENS OF *CHIROMYOIDES* (MAMMALIA: PLESIADAPIDAE) FROM THE LATE PALEOCENE OF WYOMING ILLUMINATE RELATIONSHIPS AMONG NORTH AMERICAN AND EUROPEAN SPECIES OF THE GENUS

B53 **B. W. Rodwell, K. A. Nichols, T. M. Bown** USING A HIGH RESOLUTION 3-D PROFILOMETER TO EXAMINE DIETARY NICHE SPACE OCCUPATION AMONG THE EARLY EOCENE PRIMATES *CANTIUS*, *TEILHARDINA*, AND *TETONIUS*

B54 **J. Femenias-Gual, R. Minwer-Barakat, J. Marigó, S. Moyà-Solà** A NEW SPECIES OF *AGERINIA* (ADAPIFORMES, PRIMATES) FROM THE EARLY EOCENE OF THE PYRENEES (NE IBERIAN PENINSULA)

B55 **K. E. Samonds, L. R. Godfrey, J. W. Baldwin, M. R. Sutherland, J. Kamilar, K. Allfisher** MID-TERTIARY CLIMATE CHANGE, EXTINCTION AND SPECIATION IN MADAGASCAR, AND THEIR BEARING ON THE EVOLUTION OF MADAGASCAR'S LEMURS

B56 **N. J. Stevens, K. Whitman, E. M. Roberts, M. R. Borths, P. M. O'Connor** MAMMALIAN FAUNAL COMPOSITION ACROSS LOCALITIES IN THE LATE OLIGOCENE NSUNGWE FORMATION, RUKWA RIFT BASIN, TANZANIA

B57 **S. Mattingly, K. Beard, P. Coster, M. Salem, Y. Chaimanee, J. Jaeger** A NEW PARAPITHECINE (PRIMATES: ANTHROPOIDEA) FROM THE EARLY OLIGOCENE OF CENTRAL LIBYA

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FRIDAY, AUGUST 25, 2017
POSTER SESSION III
(CONTINUED)

B58 **E. R. Miller, G. F. Gunnell, H. Sallam, J. Habersetzer, E. Seiffert** TOWARDS RESOLVING THE MORPHOLOGY AND TAXONOMY OF *PARAPITHECUS FRAASI* (PARAPITHECIDAE, ANTHROPOIDEA) FROM THE FAYUM DEPRESSION, EGYPT

B59 **I. Arney, S. Cote, D. L. Fox, J. Kingston, L. MacLatchy, F. Manthi, E. Mbua, K. McNulty, I. Nengo** STABLE ISOTOPIC EVIDENCE OF PALEOENVIRONMENTS AT EARLY MIOCENE LOCALITIES FROM TINDERET, KENYA

B60 **D. Hock** VERTEBRATE SPECIES RICHNESS CHANGE FROM THE LATE MIOCENE TO EARLY PLIOCENE OF LOTHAGAM, TURKANA BASIN, KENYA

B61 **C. C. Gilbert, K. D. Pugh, B. A. Patel, C. J. Campisano, N. P. Singh, J. G. Fleagle, R. Patnaik** NEW SMALL-BODIED HOMINOID FROM LOWER SIWALIK DEPOSITS SURROUNDING RAMNAGAR (JAMMU AND KASHMIR), INDIA

B62 **I. Tanaka, A. Markó, B. Bradák, M. Hyodo, E. C. Strickson, P. L. Falkingham** A RE-ANALYSIS OF ~350 KA HOMININ-LIKE FOOTPRINTS FROM VÉRTESSZOLOS, HUNGARY, EMPLOYING PHOTOGRAMMETRY AND 3D ANALYSIS.

B63 **J. P. Wiersma, H. L. Hilbert-Wolf, C. J. Placzek, P. H. Dirks, E. M. Roberts** INVESTIGATING $^{234}U/^{238}U$ ACTIVITY RATIOS AND U UPTAKE IN VERTEBRATE MICROFOSSIL TEETH FROM THE RISING STAR CAVE (CRADLE OF HUMANKIND, SOUTH AFRICA) TO RECONSTRUCT PHREATIC WATER TABLE FLUCTUATIONS ASSOCIATED WITH PLEISTOCENE CLIMATE CHANGE IN SOUTHERN AFRICA

B64 **L. Fostowicz-Frelik, J. Slowiak, J. Meng** ENAMEL MICROSTRUCTURE IN LAGOMORPHA (MAMMALIA: GLIRES): IN THE SEARCH OF FUNCTIONAL AND PHYLOGENETIC IMPLICATIONS

B65 **M. Lang, O. C. Bertrand, M. T. Silcox** SCALING PATTERN IN RODENT PARAFLOCCULI: IMPACTS OF LOCOMOTION AND ACTIVITY PATTERN

B66 **R. Bhagat, O. C. Bertrand, M. T. Silcox** LOCOMOTOR BEHAVIOUR RECONSTRUCTION FROM THE SEMICIRCULAR CANALS OF EARLY FOSSIL RODENTS: INSIGHTS INTO MAJOR EVOLUTIONARY TRANSITIONS FROM THE INNER EAR

B67 **D. K. Anderson** NEW GENUS OF SCIURAVID (SCIURAVIDAE, RODENTIA) FROM THE LATEST EARLY EOCENE (EARLIEST BRIDGERIAN) OF RAVEN RIDGE, UTAH AND THE EARLY MIDDLE EOCENE (MIDDLE BRIDGERIAN) OF GREEN RIVER BASIN, WYOMING

B68 **S. S. Hopkins** EVOLUTIONARY HISTORY OF RARE MIOCENE APLODONTIID RODENTS FROM ASIA AND THE HISTORY OF BIOGEOGRAPHY IN THE APLODONTIIDAE

B69 **Y. Kimura, Y. Tomida, I. Casanovas-Vilar, T. Amemiya, R. Sawaura, T. Yasuno** ONE TINY JAW, A BIG DEAL: A NEW EOMYID GENUS FROM THE MIOCENE MIZUNAMI GROUP OF GIFU, CENTRAL JAPAN

B70 **Y. Tanabe, M. Nakatsukasa, Y. Kunimatsu, H. Nakaya** MORPHOLOGICAL CHANGES OF THE MOLAR OCCLUSAL SURFACE THROUGH DENTAL WEAR IN *NAKALIMYS LAVOCATI* (RHIZOMYIDAE, RODENTIA) FROM THE NAKALI FORMATION (EARLY LATE MIOCENE) OF NORTHERN KENYA

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POSTER SESSION III
(CONTINUED)

B71 **F. Rusnack, M. C. Mihlbachler, B. L. Beatty** EXPERIMENTAL APPROACHES TO ASSESS THE EFFECT OF FOOD TEXTURE AND GRAIN COMPOSITION OF ABRASIVES IN THE CAUSE OF DENTAL MICROWEAR

B72 **R. López-Antoñanzas, S. Renaud, P. Peláez-Campomanes, D. Azar, F. Knoll** FIRST *PROGONOMYS* FROM THE LATE MIOCENE OF THE ARABIAN PLATE

B73 **C. Crowe, J. X. Samuels** IDENTIFICATION OF SCIURIDS (RODENTIA:SCIURIDAE) FROM TWO LATE CENOZOIC LOCALITIES IN THE EASTERN U.S.

B74 **G. C. Argyros, G. Bresowar, C. Fielitz** HISTORICAL BIOGEOGRAPHY OF INSULAR WHITE-FOOTED MICE (*PEROMYSCUS LEUCOPUS*) IN NORTHEASTERN NORTH AMERICA

B75 **J. B. Henry, C. B. Withnell, C. J. Bell** PATTERNS OF DENTAL VARIATION WITHIN VOLES OF THE GENUS *ARBORIMUS*

B76 **K. Xie, Y. Li, Y. Liu** MIDDLE PLEISTOCENE "LARGER SIZED" HAMSTER FOSSILS FROM LOCALITY 2 OF SHANYANGZHAI IN QINHUANGDAO AREA, CHINA, AND DISCUSSION ON THE VALIDITY OF *CRICETINUS VARIANS* (RODENTIA: CRICETIDAE)

B77 **C. B. Withnell, C. J. Bell, C. N. Jass** EXCEPTIONAL ARVICOLINE DENTITIONS FROM FROMAN FERRY (PLIOCENE) AND LITTLE DELL DAM (PLEISTOCENE)

B78 **C. N. Jass, J. I. Mead, S. L. Swift** ARVICOLINE RODENTS FROM PERSISTENCE CAVE, WIND CAVE NATIONAL PARK, SD

B79 **F. M. Socki, R. W. Burroughs** REASSESSING THE BIOCHRONOLOGY OF KENNEWICK ROADCUT (WASHINGTON, USA) USING ARVICOLINE RODENTS.

B80 **J. X. Samuels, R. J. Zakrzewski, C. Crowe, S. C. Wallace, B. W. Schubert** SMALL MAMMALS AND A REFINED AGE ESTIMATE OF THE GRAY FOSSIL SITE IN TENNESSEE

B81 **D. Oberg, J. X. Samuels** MOLES (TALPIDAE) FROM THE GRAY FOSSIL SITE, TN

B82 **W. Von Koenigswald** ENAMEL DIFFERENTIATION IN SORICID MOLARS

B83 **P. D. Gingerich, S. Zouhri** BIOSTRATIGRAPHY OF MARINE MAMMALS (CETACEA AND SIRENIA) FROM COASTAL SECTIONS OF THE EOCENE SAMLAT FORMATION SOUTH OF AD DAKHLA, MOROCCAN SAHARA

B84 **B. K. Shipps, C. M. Peredo, M. D. Uhen** ANALYSIS OF FOSSIL ENVIRONMENTS REVEALS BIASES IN THE FOSSIL RECORD OF MYSTICETE PRESERVATION.

B85 **B. Borce, E. G. Ekdale, R. Racicot, S. Darroch** SPECIES DELIMITATIONS WITHIN THE EXTINCT RIVER DOLPHIN GENUS *PARAPONTOPORIA* BASED ON QUANTITATIVE ANALYSIS OF THE PERIOTIC BONES

B86 **N. Smith, R. Boessenecker, D. Long, C. Powell Ii** A NEW MARINE VERTEBRATE ASSEMBLAGE FROM THE WILSON GROVE FORMATION AT BLOOMFIELD QUARRY (LATE MIOCENE), SONOMA COUNTY, CALIFORNIA

B87 **H. Uno, S. Sakata, T. Ohno** CONSIDERING FEASIBILITY OF U-PB DATING APPLIED TO CENOZOIC ISOLATED TOOTH FOSSIL

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POSTER SESSION III
(CONTINUED)

B88 **A. J. McGrath, A. Wyss** ESCAPE BEHAVIOR IN LITOPTERNS (MERIDIUNGULATA; MAMMALIA) ACROSS THE GREAT AMERICAN BIOTIC INTERCHANGE

B89 **C. M. Janis, C. Billingham, A. Martin-Serra** LOCOMOTION IN STHENURINE KANGAROOS: DID THEY USE THEIR ARMS?

B90 **E. Tschopp, F. A. Tschopp, O. Mateus** THE OVERLAP INDEX, A TOOL TO QUANTIFY THE AMOUNT OF ANATOMICAL OVERLAP AMONG GROUPS OF INCOMPLETE TERMINAL TAXA IN PHYLOGENETIC ANALYSES

B91 **L. T. Holbrook** COMPARISON OF MAXIMUM PARSIMONY AND BAYESIAN APPROACHES TO EARLY PERISSODACTYL (MAMMALIA) PHYLOGENY

B92 **C. Bronnert, E. Gheerbrant, M. Godinot, G. Métais** EARLIEST EOCENE PERISSODACTYLS (MAMMALIA, LAURASIATHERIA) OF EUROPE: REVIEW AND NEW DISCOVERIES

B93 **L. K. Stroik, K. Townsend** CHANGES IN RHINOCEROTOID BODY MASS DIVERSITY ACROSS THE EOCENE OF NORTH AMERICA

B94 **O. Sanisidro, J. Cantalapiedra** DIVERSIFICATION PATTERNS IN THE FAMILY RHINOCEROTIDAE

B95 **R. Schellhorn** TWO REMARKABLE CARPAL BONE POSITIONS IN *PROSANTORHINUS GERMANICUS* (MAMMALIA: RHINOCEROTIDAE)

B96 **N. Handa** A REVIEW OF JAPANESE PLEISTOCENE RHINOCEROTIDAE (MAMMALIA, PERISSODACTYLA) AND PALEOBIOGEOGRAPHICAL SIGNIFICANCE

B97 **G. M. Semprebon, R. L. Bernor, U. B. Gohlich, M. Harzhauser** DENTAL MORPHOLOGY AND DIET OF THE FIRST OCCURRING OLD WORLD HIPPARIONS FROM THE BASAL VALLESIAN OF THE VIENNA BASIN (MN9, 11.4-11.0 MA)

B98 **R. L. Bernor, B. Sun** AN ENIGMATIC LINEAGE OF CHINESE HIPPARION, *BARYHIPPARION*

B99 **Y. Li, T. Deng, H. Hua, Y. Li, Y. Zhang** ASSESSMENT OF DENTAL ONTOGENY IN LATE MIOCENE HIPPARIONINES FROM THE LAMAGOU FAUNA OF FUGU, SHAANXI PROVINCE, CHINA

B100 **H. M. Flora, E. B. Davis** INFERRING BEHAVIORAL AND SOCIAL ORGANIZATION IN FOSSIL ANTILOCAPRIDAE

B101 **A. Hall, S. Cote** RUMINANT DENTAL WEAR SUPPORTS THE EXISTENCE OF HETEROGENEOUS ENVIRONMENTS IN THE EAST AFRICAN EARLY MIOCENE

B102 **D. R. Prothero** REVIEW OF THE PLIOCENE SPECIES OF THE FLAT-HEADED PECCARY *PLATYGONUS* (MAMMALIA: ARTIODACTYLA) FROM NORTH AMERICA

B103 **J. Campos Medina, K. Moreno** FIRST RECORD OF THE ICHNOSPECIES *LAMAICHNUM GUANICOE AFF.* (ARAMAYO AND BIANCO 1987) FROM CHILE

B104 **D. Rubilar-Rogers, C. Gutstein** SYNTHESIS ON THE VERTEBRATE PALEONTOLOGICAL HERITAGE IN CHILE

*Numbers beginning with "B" represent the poster board number in Exhibit Hall.

SATURDAY MORNING, AUGUST 26, 2017

TECHNICAL SESSION XVI

TELUS CONVENTION CENTRE, MACLEOD C

MODERATORS: Victoria Arbour and Femke Holwerda

8:00 **M. G. Baron** A NOVEL HYPOTHESIS OF DINOSAUR INTERRELATIONSHIPS

8:15 **O. R. Regalado Fernández, P. Upchurch, P. M. Barrett, P. Mannion, S. C. Maidment, A. Goswami** REASSESSMENT OF THE PHYLOGENETIC RELATIONSHIPS OF BASAL SAUROPODOMORPH DINOSAURS AND THE ORIGINS OF QUADRUPEDALITY

8:30 **F. M. Holwerda** PHYLOGENETIC RELATIONSHIPS OF *PATAGOSAURUS FARIASI* AND EVOLUTIONARY IMPLICATIONS FOR EARLY-MIDDLE JURASSIC SAUROPODS

8:45 **A. J. Moore, X. Xu, J. M. Clark** ANATOMY AND SYSTEMATICS OF *KLAMELISAURUS GOBIENSIS,* A MAMENCHISAURID SAUROPOD FROM THE MIDDLE-LATE JURASSIC SHISHUGOU FORMATION OF CHINA

9:00 **K. Waskow** GROWTH RATES OF GIANTS: HISTOLOGICAL EVIDENCE FOR SIZE RELATED DIFFERENCES IN GROWTH MODELS BETWEEN NORMAL SIZED DIPLODOCOIDS AND A UNIQUE ASSEMBLAGE OF DWARFED LATE JURASSIC DIPLODOCOIDS FROM THE MOTHER'S DAY QUARRY (MORRISON FORMATION, MONTANA, USA)

9:15 **P. V. Ullmann, K. J. Lacovara** APPENDICULAR OSTEOLOGY OF *DREADNOUGHTUS SCHRANI*, A GIANT TITANOSAURIAN (SAUROPODA, TITANOSAURIA) FROM THE LATE CRETACEOUS OF PATAGONIA, ARGENTINA

9:30 **S. Bansal, M. Habib** CONSTRUCTING THE COLOSSUS: NEW TITANOSAUR MATERIAL FROM NEW MEXICO REVEALS NOVEL MECHANISMS FOR ACCOMMODATING GIGANTISM AND NECK ELEVATION

9:45 **D. J. Button, L. E. Zanno** REACHING CONVERGENCE: BIOMECHANICAL ANALYSIS OF THE FEEDING APPARATUS INDICATES CONSERVED FUNCTIONAL PATHWAYS IN THE EVOLUTION OF SAURISCHIAN HERBIVORY

10:00 **BREAK**

10:15 **A. Nabavizadeh** REAPPRAISAL OF ORNITHISCHIAN DINOSAUR JAW MUSCULATURE: IMPLICATIONS FOR FEEDING MECHANISMS AND PREVIOUSLY PROPOSED"CHEEK" ANATOMY

10:30 **P. Godefroit, S. M. Sinitsa, M. E. McNamara, A. C. Cincotta, D. Dhouailly, S. Reshetova** INTEGUMENTARY STRUCTURES IN *KULINDADROMEUS ZABAIKALICUS*, A BASAL NEORNITHISCHIAN DINOSAUR FROM THE JURASSIC OF SIBERIA

10:45 **P. Bell, M. Herne, E. Smith** NEW ORNITHOPODS (DINOSAURIA) FROM THE LOWER CRETACEOUS GRIMAN CREEK FORMATION (ALBIAN) AT LIGHTNING RIDGE, NSW, AUSTRALIA

11:00 **J. P. Wilson, M. J. Ryan, D. C. Evans** A NEW CENTROSAURINE CERATOPSID FROM THE UPPER CRETACEOUS TWO MEDICINE FORMATION OF MONTANA AND THE EVOLUTION OF THE 'STYRACOSAUR' DINOSAURS

11:15 **D. W. Fowler, E. A. Freedman Fowler** THE OLDEST "*CHASMOSAURUS*"? A NEW SKULL FROM THE JUDITH RIVER FORMATION OF MONTANA

11:30 **W. Zheng, X. Jin, X. Xu, Y. Azuma, Q. Wang, K. Miyata** A NEW BASAL ANKYLOSAURINE DINOSAUR (ORNITHISCHIA: ANKYLOSAURIDAE) FROM THE ALBIAN–CENOMANIAN OF CHINA, WITH IMPLICATIONS FOR THE EVOLUTION OF THE TAIL CLUB

SATURDAY MORNING, AUGUST 26, 2017
TECHNICAL SESSION XVI
(CONTINUED)

11:45 **V. Arbour, D. C. Evans** AN EXCEPTIONALLY PRESERVED SKELETON OF A NEW ANKYLOSAURINE DINOSAUR FROM THE JUDITH RIVER FORMATION OF MONTANA, USA

12:00 **C. M. Brown** NEW EXCEPTIONALLY PRESERVED NODOSAUR (ORNITHISCHIA: ANKYLOSAURIA) EXHIBITS EXTENSIVE EPIDERMAL SCALES, *IN SITU* OSTEODERMS, AND THEIR ASSOCIATED KERATINOUS SHEATHS, AND REVEALS STRONG POSITIVE ALLOMETRY IN THE BOTH BONY OSTEODERMS AND HORNY SHEATHS

SATURDAY MORNING, AUGUST 26, 2017
TECHNICAL SESSION XVII
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Melissa Pardi and Win McLaughlin

8:00 **J. J. Calede, S. S. Hopkins** X-RAY MICRO-COMPUTED TOMOGRAPHY OF PREMOLARS INFORMS THE TAXONOMY OF THE MYLAGAULIDAE (MAMMALIA: RODENTIA)

8:15 **R. W. Burroughs** ASSESSING THE PALEOBIOGEOGRAPHIC HISTORY OF *LEMMISCUS CURTATUS* (MAMMALIA, RODENTIA): SINGLE SPECIES OR SPECIES COMPLEX?

8:30 **J. Cramb, G. Price, S. Hocknull** THE IMPORTANCE OF RATS: MURID RODENT FOSSILS FROM AUSTRALIA AND WHY THEY MATTER

8:45 **A. M. Jukar** LATE QUATERNARY EXTINCTIONS IN SOUTH ASIA

9:00 **B. W. Schubert, J. C. Chatters, J. Arroyo-Cabrales, H. McDonald, C. Widga, D. Rissolo, A. Nava Blank, A. Alvarez Enriquez, R. Chavez Arce, P. Luna Erreguerena** UNDERWATER CAVES OF THE YUCATÁN PENINSULA REVEAL UNEXPECTED RECORDS OF LATE PLEISTOCENE FAUNAL INTERCHANGE

9:15 **R. K. McAfee, S. M. Beery** HISPANIOLA-LA! UNDEREXPLORED INTRASPECIFIC VARIATION AND TAXONOMIC IMPLICATIONS FOR ISLAND SLOTHS (MAMMALIA: PILOSA: MEGALONYCHIDAE).

9:30 **M. I. Pardi, F. Smith** USING FOSSIL FRAGMENTS AND NEW ALLOMETRIES TO REVEAL THE BODY SIZE COMPOSITION AND COMMUNITY ECOLOGY OF LATE QUATERNARY CANIDAE COMMUNITIES IN TEXAS

9:45 **T. S. Cammidge, C. I. Barron-Ortiz, C. N. Jass** MORPHOLOGICAL CORRELATES OF INTERBREEDING IN PLEISTOCENE MAMMOTHS (*MAMMUTHUS*) FROM ALBERTA

10:00 **BREAK**

10:15 **S. M. Smith, C. J. Sprain, G. P. Wilson, W. A. Clemens, P. Renne** EARLY MAMMALIAN FAUNAL RECOVERY FOLLOWING THE CRETACEOUS-PALEOGENE MASS EXTINCTION EVENT IN MCGUIRE CREEK, MONTANA, USA

10:30 **I. Fendley, Y. Park, P. A. Holroyd** CLIMATE CHANGE IN THE EOCENE WASATCH FORMATION OF SOUTHWESTERN WYOMING

10:45 **J. R. Moore, W. Abt** TAPHONOMIC AND ECOLOGICAL SHIFTS ACROSS THE EOCENE-OLIGOCENE BOUNDARY IN SOUTH DAKOTA AND NEBRASKA

11:00 **G. J. Retallack, J. X. Samuels** PALEOSOL-BASED NICHES OF OLIGOCENE MAMMALS FROM THE JOHN DAY FORMATION OF OREGON

SATURDAY MORNING, AUGUST 26, 2017
TECHNICAL SESSION XVII
(CONTINUED)

11:15 **Z. Li, Y. Li, Y. Liu** NANPOPING FAUNA OF THE LANZHOU BASIN AND ITS ENVIRONMENTAL SIGNIFICANCE

11:30 **W. N. McLaughlin** EVOLUTION OF NEOGENE KYRGYZ MAMMALIAN FAUNAS IN THE LIGHT OF TECTONIC AND CLIMATIC CHANGE

11:45 **T. Deng, X. Wang, Q. Li, F. Wu, S. Wang, S. Hou** PALEO-ALTIMETRY RECONSTRUCTIONS OF THE TIBETAN PLATEAU BASED ON VERTEBRATE FOSSILS

12:00 **A. Novello, C. A. Strömberg, B. F. Jacobs, K. P. McNulty, L. A. Michel, K. T. Uno** THE ROLE OF GRASSES IN EAST AFRICAN VEGETATION DURING THE PAST 30 MILLION YEARS: NEW RESULTS AND PERSPECTIVES FROM PLANT SILICA (PHYTOLITH) ANALYSES

SATURDAY MORNING, AUGUST 26, 2017
TECHNICAL SESSION XVIII
TELUS CONVENTION CENTRE, MACLEOD A
MODERATORS: Kenneth Angielczyk and Katrina Jones

8:00 **S. C. Jasinoski, F. Abdala, J. A. Hopson** CRANIAL ONTOGENETIC PATTERNS IN PERMO-TRIASSIC BASAL CYNODONTS FROM SOUTHERN AFRICA

8:15 **J. Botha-Brink, M. Bento Soares, A. Guillermo Martinelli** GROWTH PATTERNS OF LATE TRIASSIC PROZOSTRODONTIAN CYNODONTS FROM BRAZIL

8:30 **S. J. Norris, A. M. Paredes, N. Immega, D. Temple, R. T. Bakker** RELEASE OF OSTEOCYTES AND LAMELLAE THROUGH CHEMICAL DISSOLUTION REVEALS THE INTRICATE, ANASTOMOSING CIRCUMFERENTIAL PATTERN OF BLOOD VESSELS IN *DIMETRODON* NEURAL SPINES

8:45 **J. L. Green, K. D. Angielczyk, S. Beld, D. C. Fisher** HIERARCHICALLY-ORGANIZED GROWTH INCREMENTS IN THE TUSK ORTHODENTIN OF DICYNODONTS (THERAPSIDA, DICYNODONTIA)

9:00 **M. Whitney, C. A. Sidor** TAPHONOMIC INDICATORS OF TOOTH ATTACHMENT IN FOSSIL SYNAPSIDS WITH IMPLICATIONS FOR ORAL FOOD PROCESSING IN TAPINOCEPHALIDS

9:15 **S. L. Olroyd, C. A. Sidor, K. D. Angielczyk, R. M. Smith, S. J. Nesbitt, S. Tolan** PATTERNS OF TOOTH REPLACEMENT IN THE EARLY DICYNODONT *ABAJUDON* AND THE ORIGIN OF MULTIPLE TOOTH ROWS IN *ENDOTHIODON*

9:30 **C. A. Sidor, K. D. Angielczyk, S. J. Nesbitt, B. Peecook, R. H. Smith, N. J. Tabor, S. Tolan, M. Whitney** BURNETIAMORPHS DID IT FIRST: CRANIAL ADORNMENT AND RATES OF SPECIATION IN A PERMIAN LINEAGE OF THERAPSIDS

9:45 **D. P. Groenewald, B. S. Rubidge, M. O. Day** EVIDENCE FOR FAUNAL PROVINCIALISM IN THE PERMIAN BEAUFORT GROUP (KAROO SUPERGROUP) OF SOUTH AFRICA.

10:00 **BREAK**

10:15 **B. S. Rubidge, M. O. Day, K. Angielczyk, S. Jirah** MIDDLE PERMIAN DICYNODONT (THERAPSIDA, ANOMODONTIA) STRATIGRAPHIC RANGES IN THE MAIN KAROO BASIN – IMPLICATIONS FOR CONTINENTAL BIOSTRATIGRAPHY

SATURDAY MORNING, AUGUST 26, 2017
TECHNICAL SESSION XVIII
(CONTINUED)

10:30 **K. D. Angielczyk, J. Benoit, B. S. Rubidge, C. A. Sidor, J. Steyer, S. Tolan** A NEW CISTECEPHALID DICYNODONT FROM THE UPPER MADUMABISA MUDSTONE FORMATION (UPPER PERMIAN), LUANGWA BASIN, ZAMBIA: ENDOCRANIAL ANATOMY AND BIOGEOGRAPHIC IMPLICATIONS

10:45 **R. M. Araujo, K. D. Angielczyk, R. Rabbitt, M. Orliac, R. David, J. Benoit, E. G. Ekdale, R. M. Martins** ELEVATED SEMICIRCULAR CANAL ECCENTRICITY IN DICYNODONT THERAPSIDS (SYNAPSIDA): IMPLICATIONS FOR BEHAVIOR?

11:00 **E. Hoffman, T. B. Rowe** POSTCRANIAL ANATOMY OF *KAYENTATHERIUM WELLESI*: SWIMMING ADAPTATIONS IN A MAMMALIAMORPH FROM THE EARLY JURASSIC

11:15 **K. Jones, L. Benitez, K. D. Angielczyk, S. E. Pierce** A QUANTITATIVE APPROACH TO SYNAPSID VERTEBRAL EVOLUTION AND IMPLICATIONS FOR MAMMALIAN ECOLOGICAL DIVERSIFICATION

11:30 **S. Lautenschlager, P. Gill, Z. Luo, M. Fagan, E. J. Rayfield** RETENTION OF CRANIAL FUNCTION ACROSS THE CYNODONT-MAMMALIAN TRANSITION

11:45 **J. Benoit, V. Fernandez, P. R. Manger, B. S. Rubidge** EVIDENCE FOR ENDOTHERMY IN BASAL THERAPSIDA REVEALED BY SYNCHROTRON SCANNING

12:00 **M. Marzola, O. Mateus, J. Milàn, L. B. Clemmensen** SYNRIFT SEDIMENTARY DEPOSITION AND VERTEBRATE FOSSIL ABUNDANCE: THE TETRAPOD RECORD FROM GREENLAND

SATURDAY AFTERNOON, AUGUST 26, 2017
TECHNICAL SESSION XIX
TELUS CONVENTION CENTRE, MACLEOD C
MODERATORS: Mateo Fabbri and Kohei Tanaka

1:45 **P. M. Barrett, T. J. Broderick, K. Chapelle, J. N. Choiniere, S. Edwards, D. Munyikwa, P. Viglietti, M. Zondo** NEW INFORMATION ON THE UPPER KAROO VERTEBRATE FAUNAS OF THE LAKE KARIBA REGION, ZIMBABWE

2:00 **G. Niedzwiedzki, T. Sulej** A NORIAN COELOPHYSOID THEROPOD FROM FLEMING FJORD FORMATION, EAST GREENLAND

2:15 **N. Smith, W. R. Hammer, P. Makovicky** NEW INFORMATION ON THE THEROPOD DINOSAUR *CRYOLOPHOSAURUS ELLIOTI* FROM THE EARLY JURASSIC HANSON FORMATION OF THE CENTRAL TRANSANTARCTIC MOUNTAINS

2:30 **M. Fabbri, C. Dal Sasso, S. Maganuco, S. Zouhri, D. Martill, N. Ibrahim** BONE MICROSTRUCTURE AND HETEROCHRONY SHAPE FISH-EATING HABITS IN SPINOSAURS

2:45 **A. Samathi, P. Chanthasit** TWO NEW BASAL MEGARAPTORA (DINOSAURIA: THEROPODA) FROM THE EARLY CRETACEOUS OF THAILAND WITH COMMENT ON THE PHYLOGENETIC POSITION OF *SIAMOTYRANNUS* AND *DATANGLONG*

3:00 **R. J. Bykowski** THE EVOLUTION OF CARNIVOROUS DINOSAURS IN RESPONSE TO CHANGING PREY BODY SIZE

3:15 **D. D. Cashmore, R. A. Close, R. J. Butler** COMPLETENESS OF THE GLOBAL NON-AVIAN THEROPOD FOSSIL RECORD: DISENTANGLING BIOLOGICAL, GEOLOGICAL AND SAMPLING BIASES

SATURDAY AFTERNOON, AUGUST 26, 2017
TECHNICAL SESSION XIX
(CONTINUED)

3:30 **R. J. Brocklehurst** VERTEBRAL MORPHOMETRICS AND LUNG STRUCTURE IN NON-AVIAN DINOSAURS

3:45 **A. R. Fiorillo, Y. Kobayashi, P. McCarthy, T. Tanaka, R. S. Tykoski** DINOSAUR ICHNOLOGY AND PALEOENVIRONMENTS FROM THE CHIGNIK FORMATION (ANIAKCHAK NATIONAL MONUMENT, LATE CRETACEOUS, SOUTHWESTERN ALASKA)

4:00 **K. Tanaka, D. Zelenitsky, F. Therrien, Y. Kobayashi** DINOSAUR NESTING AT HIGH-LATITUDE: IMPLICATIONS FROM NEST MATERIAL, NEST STRUCTURES, AND INCUBATION HEAT SOURCES

SATURDAY AFTERNOON, AUGUST 26, 2017
TECHNICAL SESSION XX
TELUS CONVENTION CENTRE, MACLEOD D
MODERATORS: Ornella Bertrand and Abagael West

1:45 **M. Castiello, M. D. Brazeau** NEUROCRANIAL ANATOMY OF TWO UNUSUAL PLACODERMS REVEALED BY COMPUTED TOMOGRAPHY SCANNING, AND THEIR IMPLICATIONS FOR EARLY GNATHOSTOMES EVOLUTION

2:00 **S. Brusatte, T. E. Williamson, O. Bertrand, J. Cameron, J. Napoli, S. Shelley** THE BRAINS AND SENSES OF EARLY PLACENTAL MAMMALS: NEW INSIGHT FROM CT AND NT SCANS OF PALEOCENE SPECIMENS FROM NEW MEXICO, USA

2:15 **O. Bertrand, F. Amador-Mughal, M. Lang, M. Silcox** VIRTUAL ENDOCASTS OF EARLY APLODONTOIDEA AND SCIURIDAE: BRAIN EVOLUTION AND LOCOMOTION

2:30 **A. Boscaini, D. A. Iurino, G. Billet, L. Hautier, R. Sardella, G. Tirao, T. J. Gaudin, F. Pujos** DIGITAL CRANIAL ENDOCAST OF THE GROUND SLOTH *GLOSSOTHERIUM ROBUSTUM* (OWEN, 1842) (XENARTHRA, PILOSA) FROM THE PLEISTOCENE OF ARGENTINA

2:45 **C. Heck, H. Woodward Ballard** INTRATENDINOUS METAPLASTIC TISSUE IN THE TIBIA OF THE NINE-BANDED ARMADILLO (*DASYPUS NOVEMCINCTUS*) AND ITS USE AS A COMPARATIVE MODEL FOR METAPLASTIC TISSUE IN EXTINCT TAXA

3:00 **R. D. MacPhee, G. Slater, S. Presslee, A. Forasiepi, J. I. Bloch, R. S. Feranec, M. Collins** PALEOPROTEOMIC ANALYSIS OF THE RELATIONSHIPS OF QUATERNARY WEST INDIAN FOLIVORANS (PILOSA, XENARTHRA)

3:15 **A. R. West** RESOLVING THE AFFINITIES OF NOTOUNGULATA: CHARACTER SELECTION, TAXON SAMPLING, AND THE INFLUENCE OF ANCIENT MOLECULAR DATA

3:30 **A. Goswami, E. Noirault, R. N. Felice, A. Watanabe, A. Fabre, A. Curtis, N. Simmons, D. L. Fox, M. Churchill** DENSE PHENOMIC ANALYSIS OF CRANIAL SHAPE EVOLUTION ACROSS LIVING AND EXTINCT PLACENTAL MAMMALS

3:45 **Z. S. Morris, S. E. Pierce, A. Abzhanov** INSIGHTS FROM MORPHOMETRIC ANALYSIS OF ONTOGENETIC AND PHYLOGENETIC CHANGES IN THE SHAPE OF THE CROCODYLIAN SKULL

4:00 **P. C. Sereno** THE CENTRAL ROLE OF FUNCTIONAL MODULARITY IN VERTEBRATE EVOLUTION

SATURDAY AFTERNOON, AUGUST 26, 2017

TECHNICAL SESSION XXI

TELUS CONVENTION CENTRE, MACLEOD A

MODERATORS: Judith Pardo-Pérez and Dean Lomax

1:45 **R. Motani, D. Jiang, A. Tintori, C. Ji, J. Huang** TESTING IF MESOZOIC MARINE REPTILES EMERGED BEFORE OR AFTER THE END-PERMIAN MASS EXTINCTION

2:00 **D. Jiang, R. Motani, A. Tintori, M. Zhou, X. Wang, H. Lu** DIRECT EVIDENCE OF REPTILE PREDATION BY A LARGE MIDDLE TRIASSIC ICHTHYOSAUR FROM XINGYI OF SOUTHWESTERN CHINA

2:15 **A. S. Wolniewicz** A REASSESSMENT OF THE CRANIAL ANATOMY OF *CYMBOSPONDYLUS* AND ITS IMPLICATIONS ON THE TAXONOMY AND PHYLOGENY OF CYMBOSPONDYLIDAE

2:30 **J. M. Pardo-Pérez, E. Maxwell, B. P. Kear** ICHTHYOSAUR PALEOPATHOLOGY: DIAGNOSING INJURY AND DISEASE IN EARLY JURASSIC 'FISH-LIZARDS'

2:45 **D. R. Lomax, J. A. Massare** THE TAXONOMIC UTILITY OF HINDFIN MORPHOLOGY IN *ICHTHYOSAURUS*

3:00 **B. C. Moon, M. J. Benton, M. Williams** MORPHOFUNCTIONAL DIVERSITY IN TOARCIAN (EARLY JURASSIC) ICHTHYOSAURS

3:15 **M. DeBlois, R. Motani** A QUANTITATIVE METHOD TO RECONSTRUCT THE FLIPPER SOFT TISSUE MARGIN OF PLESIOSAURS AND ICHTHYOSAURS FROM THE FLIPPERS OF EXTANT MARINE TETRAPODS

3:30 **U. Witzel, A. Krahl, P. Sander** FINITE ELEMENT HYDRODYNAMIC INVESTIGATION OF SWIMMING BEHAVIOR OF A MIDDLE JURASSIC PLESIOSAUR IN COMPARISON TO RECENT SEA TURTLES

3:45 **D. J. Morgan, F. O'Keefe** NEW INSIGHTS INTO THE PHYLOGENY OF THE POLYCOTYLIDAE

4:00 **T. Wintrich** THE AMAZING PLESIOSAUR NECK: SUBCENTRAL FORAMINA AND IMPLICATIONS FOR THERMOREGULATION AND DEEP DIVING

SATURDAY, AUGUST 26, 2017

POSTER SESSION IV

TELUS CONVENTION CENTRE, MACLEOD A1-A4 AND PREFUNCTION

Authors must be present from 4:15 - 6:15 p.m. Saturday, August 26

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

Education & Outreach Poster Session

B1 **J. H. Nestler, S. K. Drumheller-Horton, D. L. Rook, A. C. Pritchard, E. L. Gold, M. R. Borths, J. Miller-Camp, K. M. Claeson** HORSE-SIZED DUCKS AND DUCK-SIZED HORSES: THREE YEARS OF LARGE-SCALE OUTREACH ON THE INTERNET FORUM ASKSCIENCE

B2 **G. J. Bradley, V. Arbour, M. Campbell, A. Torices, H. P. Street, T. Miyashita, S. Blais, W. S. Persons Iv** DIG LOCALLY, TEACH GLOBALLY: USING MASSIVE OPEN ONLINE COURSES TO MAKE PALAEONTOLOGY EDUCATION ACCESSIBLE WORLDWIDE

B3 **M. L. Gold** DRNEUROSAURUS: A BILINGUAL BLOG FOR CHILDREN ABOUT PALEONTOLOGICAL NEWS

B4 **R. K. Hunt-Foster** IMAGINE STEM: GIRL SCOUTS IN PALEONTOLOGY

*Numbers beginning with “B” represent the poster board number in Exhibit Hall.

SATURDAY, AUGUST 26, 2017
POSTER SESSION IV
(CONTINUED)

B5 **J. Pirlo, C. A. Grant, S. Moran, R. Mussetter, S. Sahlstrom** IDIGFOSSILS: ENGAGING K-12 STUDENTS IN INTEGRATED STEM VIA 3D DIGITIZATION, 3D PRINTING, AND PALEONTOLOGY

B6 **G. Santos, T. Lepore** UTILIZING AUGMENTED REALITY FOR INCLUSIVE EXHIBIT DESIGN

B7 **J. M. Northover, J. Graham-Heggie, L. MacNeil, S. Knowles, M. C. Laframboise, E. Wiebe, S. Mathiasen, D. B. Brinkman** HOW TO CONSTRUCT A REALISTIC SIMULATED DIG SITE AND ITS BENEFITS FOR PALAEONTOLOGY OUTREACH AND EDUCATION

B8 **S. J. ElShafie** INTEGRATING FILM, THEATER, AND DESIGN APPROACHES WITH PALEONTOLOGICAL PERSPECTIVES TO EXPLAIN SCIENCE

B9 **S. Moore, N. Carroll, A. Weikert, C. Hammel, S. Carroll, M. Struble** MAIA MOBILE SCIENCE LAB: USING MATHEMATICAL AND BIOLOGIC CONCEPTS OF GROWTH CURVES TO CONNECT STUDENTS WITH MONTANA'S AGRICULTURAL ECONOMY AND RICH FOSSIL HISTORY

B10 **M. R. Borths** TEACHING CORE PHYLOGENETIC SYSTEMATIC CONCEPTS THROUGH PRACTICAL EXPERIENCE BUILDING A HOMININ FAMILY TREE

B11 **M. Pittman, X. Xu, A. Cheng** DINOSAUR ECOSYSTEMS, A FREE ONLINE SCIENCE COURSE BY THE UNIVERSITY OF HONG KONG

B12 **A. Weil, L. T. Yann, N. J. Czaplewski, K. L. Davies, J. Hargrave, K. Smith, D. J. Froehlich, R. Whitten** SUCCESSFULLY SUPPORTING MULTIPLE CURRICULA ONSITE AT A SINGLE DINOSAUR LOCALITY

B13 **L. D. White, P. A. Holroyd** GLOBAL WARMING AND IMMIGRANTS: LESSONS FROM THE EOCENE

B14 **D. J. Urban, J. A. Maier, A. Sadier, K. E. Sears** BUILD-A-BONE SKELETON JIGSAW

B15 **K. D. Kavanagh** "BONES -- YOUR INNER ANIMAL", EVOLUTIONARY CONCEPTS TAUGHT TO K-8 STUDENTS BY COMPARATIVE VERTEBRATE ANATOMY STUDENTS

B16 **T. Boodhoo, M. Bolortsetseg, B. Munkhbat, T. Yoshikami** THE MOVEABLE DINOSAUR MUSEUM IN MONGOLIA: RESULTS AND CHALLENGES TWO SEASONS IN

B17 **M. D. Celeskey, T. Donovan, A. B. Heckert, L. H. Waterworth** FROM BARE BONES TO TRIASSIC PARK: CREATING A LIFE RECONSTRUCTION OF THE AETOSAUR *GORGETOSUCHUS* WITH A MULTIDISCIPLINARY TEAM OF SCIENTISTS, ARTISTS, AND STUDENTS

B18 **A. C. Dooley, K. M. Smith, B. E. Stoneburg, D. Radford, M. Ozolins, K. Drouault, B. S. Dooley** VALLEY OF THE MASTODONS: CASE STUDY OF AN INTEGRATIVE APPROACH TO RESEARCH COLLABORATION, OUTREACH, AND EXHIBITS

B19 **A. Hastings** DINOSAURS AND COMIC BOOKS: QUANTITATIVE REVIEW OF PALEONTOLOGICAL ACCURACY AND THE POTENTIAL FOR COMIC BOOKS FOR INFORMAL EDUCATION

B20 **T. Ohashi, Y. Kimura, Y. Hasegawa, I. Takahashi, M. Manabe** ACCOMPLISHMENT REPORT: SPECIMEN RESCUE PROJECT WITH THE TSUNAMI RELIEF FUND RAISED IN THE 2011 SVP MEETING, LAS VEGAS

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MACLEOD A1-A4 AND PREFUNCTION

Regular Session Posters

B21 **J. M. Kibii** BRIDGING THE GAPS: A NEW NATIONAL MUSEUMS OF KENYA-PALEONTOLOGICAL APPROACHES TO BRINGING RESEARCHERS, STUDENTS AND GENERAL PUBLIC TOGETHER

B22 **N. Egi, T. Tsubamoto, Z. Maung-Thein, T. Htike, M. Takai** A NEW HYPERCARNIVOROUS HYAENODONT (MAMMALIA) FROM THE MIDDLE EOCENE PONDAUNG FORMATION OF MYANMAR AND ITS INFLUENCE TO THE BIOGEOGRAPHIC ORIGIN HYPOTHESES OF THE PONDAUNG HYAENODONTS

B23 **L. Fowler, P. A. Holroyd** DENTAL ERUPTION SEQUENCE FOR LIMNOCYONINE HYAENODONTANS (CREODONTA)

B24 **M. R. Borths, N. J. Stevens** GIGANTIC HYAINAILOURINE (HYAENODONTA,"CREODONTA") FROM THE EARLY MIOCENE OF KENYA

B25 **T. Tsubamoto** DENTAL ANOMALIES FOUND IN LIVING RACCOON DOG (*NYCTEREUTES PROCYONOIDES*) AND THEIR IMPLICATION TO DENTAL MORPHOLOGY OF EOCENE MAMMALS

B26 **A. K. Jones, D. Schreve, C. Carbone** CHANGES OF THE CRANIO-DENTAL MORPHOLOGY OF SPOTTED HYAENA (*CROCUTA CROCUTA*, ERXLEBEN 1777) IN BRITAIN FROM THE EARLY MIDDLE PLEISTOCENE TO MARINE OXYGEN ISOTOPE STAGE 3

B27 **P. Barrett** FIRST REPORTED OCCURRENCE OF *LEPTOCYON* FROM THE MIOCENE OF OREGON

B28 **J. D. Orcutt, C. Vietri** HEMPHILLIAN CARNIVORANS FROM THE INLAND NORTHWEST

B29 **Y. Li, N. Spassov** A NEW SPECIES OF *PARAMACHAERODUS* (MAMMALIA, CARNIVORA, FELIDAE) FROM THE LATE MIOCENE OF CHINA AND BULGARIA

B30 **R. C. Hulbert, S. C. Wallace, J. I. Bloch** OLDEST SMILODONTIN (FELIDAE, MACHAIRODONTINAE) SKULL FROM THE LATE MIOCENE OF NORTH AMERICA

B31 **D. Ruiz Ramoni, M. Montellano, A. Rincón** A NEW LOOK AT THE MATERIAL ASSIGNED TO *MACHAIRODUS* SP. CF. *M. COLORADENSIS* (HOMOTHERIINI: MACHAIRODONTINAE) FROM THE LATE HEMPHILLIAN OF GUANAJUATO, MEXICO

B32 **C. Grohe, B. Lee, Z. Calamari, J. J. Flynn** RUN CHEETAH RUN: EVIDENCE OF A RECENT SENSORY PERCEPTION SPECIALIZATION FOR HIGH-SPEED HUNTING

B33 **G. R. Hurlburt, C. Churcher** SIZE, NOT EVOLUTION OF NEW FUNCTIONS, MOST PARSIMONIOUSLY EXPLAINS PROLIFERATING CORTEX SHOWN IN AN ENDOCAST OF *CIVETTICTIS LEAKEYI*, AN EXTINCT LARGE EARLY PLIOCENE VIVERRID (MAMMALIA, CARNIVORA, VIVERRIDAE)

B34 **T. M. Kantelis, B. W. Schubert** MORE THAN LENGTH AND WIDTH: A NEW TECHNIQUE FOR DISTINGUISHING BROWN BEARS (*URSUS ARCTOS*) AND BLACK BEARS (*U. AMERICANUS*) IN NORTH AMERICA

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B35 **A. Pérez-Ramos, B. Figueirido, B. W. Schubert, F. Serrano-Alarcón, A. Farrell, A. Romero** DENTAL CARIES IN THE EXTINCT SHORT-FACED BEAR (ARCTODUS SIMUS) AND INTRA-GUILD COMPETITION DURING THE LATE PLEISTOCENE

B36 **L. Koper, S. Rahmat, I. Koretsky** ORIGIN AND DISPERSAL OF TRUE SEALS (FAMILY PHOCIDAE) BASED ON RECENT FOSSIL EVIDENCE

B37 **S. J. Boessenecker, R. W. Boessenecker, J. Geisler** YOUNGEST RECORD OF EXTINCT WALRUS *ONTOCETUS EMMONSI* (CARNIVORA: ODOBENIDAE): PLIO-PLEISTOCENE AUSTIN SAND PIT, SOUTH CAROLINA, USA

B38 **C. Redman, J. Meachen, D. Lovelace** THE RELATIVE ABUNDANCE OF MAMMALIAN CARNIVORES FROM NATURAL TRAP CAVE, WYOMING (LATE PLEISTOCENE-EARLY HOLOCENE)

B39 **L. M. Lyon, S. C. Wallace** NICHE MODELING OF THE EXTANT AILURID TAXON TO IMPROVE SAMPLING PROBABILITY OF EXTINCT RELATIVES (CARNIVORA, MUSTELOIDEA)

B40 **R. A. Short-Martin, L. G. Emmert, N. A. Famoso, J. I. Mead, S. L. Swift** PERISSODACTYLA, NON-RUMINANT ARTIODACTYLA, AND CARNIVORA FROM THE LATE PLEISTOCENE OF TÉRAPA, SONORA, MEXICO

B41 **M. A. Weaver, F. W. Croxen, Iii, R. Predmore, C. A. Shaw** PREDMORE MICROSITE, EL GOLFO DE SANTA CLARA, SONORA, MEXICO: THE GIFT THAT KEEPS ON GIVING

B42 **J. López-García, H. Blain, I. Lozano-Fernández, E. Luzi, A. Folie** THE SMALL-MAMMAL ASSEMBLAGE FROM CAVERNE MARIE JEANNE (HASTIÈRE-LAVAUX, BELGIUM): ENVIRONMENTAL AND CLIMATIC APPROACH OF THE MARINE ISOTOPE STAGE 3 IN NORTH-WESTERN EUROPE

B43 **C. I. Barron-Ortiz, C. N. Jass, M. S. Bolton** PATTERNS OF EXTIRPATION PRIOR TO THE LAST GLACIAL MAXIMUM IN ALBERTA, CANADA

B44 **R. C. Terry, E. B. Davis, M. Emery-Wetherell, D. L. Jenkins** THE SMALL MAMMALS OF PAISLEY CAVES: DETECTING ENVIRONMENTAL CHANGE AND COMPOSITIONAL TURNOVER AT THE YOUNGER DRYAS-HOLOCENE TRANSITION

B45 **S. A. Rushing, D. W. Krause, G. W. Flora** TAPHONOMIC ANALYSIS OF MAMMALIAN REMAINS FROM THE GENERATOR DOME LOCALITY OF PORCUPINE CAVE, PARK COUNTY, COLORADO

B46 **R. M. Laker, M. Clementz** USING NON-DESTRUCTIVE RAMAN SPECTROSCOPY AS A TOOL TO INVESTIGATE SUB-FOSSIL AND YOUNG FOSSIL DIAGENESIS

B47 **S. H. Hay-Roe, R. C. Terry** WHO ATE THESE BONES? SEM ANALYSIS OF DIGESTIVE WEAR ON THE BONES OF SMALL MAMMALS

B48 **L. M. Hall** A PLEISTOCENE RANCHOLABREAN LARGE MAMMALIAN FAUNA FROM THE ARANSAS RIVER, SAN PATRICIO COUNTY, TEXAS

B49 **N. S. Fox, J. R. Southon, B. T. Fuller, G. T. Takeuchi, A. B. Farrell, E. L. Lindsey, J. L. Blois** A TALE OF TWO FAUNAS: SMALL MAMMAL PALEOECOLOGY WITHIN AND AMONG PROJECT 23 DEPOSITS AT RANCHO LA BREA

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B50 **C. A. Shaw, M. A. Weaver** VERTEBRATE PALEOPATHOLOGICAL COLLECTIONS FROM RANCHO LA BREA AND A CENTURY OF RESEARCH

B51 **T. Annoor, D. R. Prothero, V. Syverson** HOW DID LA BREA COLTS GROW UP? A STUDY OF POSTNATAL ALLOMETRIC GROWTH IN THE LIMB BONES OF *EQUUS OCCIDENTALIS*

B52 **T. Htun, D. R. Prothero** POSTNATAL ALLOMETRIC LIMB GROWTH IN JUVENILE CAMELS FROM THE PLEISTOCENE OF RANCHO LA BREA TAR PITS

B53 **S. U. Galvez, D. R. Prothero, V. J. Syverson** HOW DID BISON CALVES GROW UP? POSTNATAL LIMB ALLOMETRY IN *BISON ANTIQUUS* FROM LA BREA TAR PITS

B54 **T. Rallings, H. Duran, J. D. Yeakel** MAPPING MAMMALIAN MORPHOLOGICAL TRAITS TO DIETS WITH MACHINE LEARNING

B55 **M. A. Madan, D. R. Prothero, V. Syverson** STASIS IN RANCHO LA BREA LITTLE OWLS OVER THE LAST GLACIAL-INTERGLACIAL CYCLE

B56 **P. Gillespy, D. R. Prothero, V. J. Syverson** STASIS IN TERATORNS FROM THE LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

B57 **D. Smith Paredes, D. Núñez León, S. Soto-Acuña, J. F. Botelho, J. O'Connor, A. Vargas** EMBRYONIC DEVELOPMENT AND EVOLUTION OF THE AVIAN SKULL

B58 **R. D. Marek, K. T. Bates, P. L. Falkingham** REGIONALISATION OF THE AVIAN CERVICAL COLUMN: A LINK BETWEEN MORPHOLOGY AND ECOLOGY

B59 **A. P. McIntosh** GEOMETRIC MORPHOMETRIC ANALYSIS OF THE PEDAL CLAW OF *CONFUCIUSORNIS SANCTUS* AND ITS IMPLICATIONS FOR CORRELATION TO ECOLOGICAL BEHAVIOR

B60 **D. Hu, L. Gao, X. Xu, L. Hou** A NEW *LIAONINGORNIS* SPECIMEN FROM THE LOWER CRETACEOUS JEHOL GROUP OF NORTHEASTERN CHINA

B61 **D. Simon, D. C. Evans** A SMALL-BODIED *FUMICOLLIS*-LIKE HESPERORNITHIFORM FROM THE HELL CREEK FORMATION OF MONTANA

B62 **T. Tanaka, Y. Kobayashi, T. Tokaryk** EVOLUTION OF BODY MASS IN THE HESPERORNITHIFORMES

B63 **L. E. Wilson** SEABIRDS AS ECOLOGICAL INDICATORS IN LATE CRETACEOUS MARINE ENVIRONMENTS

B64 **L. G. Buckley, R. T. McCrea, M. G. Lockley** CONGRUENCE BETWEEN TARSOMETATARSUS OSTEOLOGY AND TRACK MORPHOLOGY IN EXTANT SHOREBIRDS, AND IMPLICATIONS FOR CRETACEOUS BIRD TRACK ICHNOTAXONOMY AND PALEODIVERSITY

B65 **T. Ohashi** WELL-PRESERVED PELVISES OF PLOTOPTERID BIRDS FROM THE ASHIYA GROUP (LATE OLIGOCENE), NORTHERN KYUSHU, JAPAN

B66 **T. Ando** THE LARGEST STERNUM AND THE UNDERWATER FLYING IN PLOTOPTERIDS

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B67 **J. A. Bright, L. E. Roberts, P. G. Cox, J. M. Warnett, M. A. Williams, R. B. Benson** INFERENCE OF FEEDING BEHAVIOUR IN A MORPHOLOGICALLY UNIQUE EXTINCT BIRD, THE DODO (*RAPHUS CUCULLATUS*)

B68 **D. C. D'Amore, M. Harmon, S. K. Drumheller, J. Testin** QUANTITATIVE HETERODONTY IN CROCODYLIA: ASSESSING FUNDAMENTAL NICHE IN EXTINCT TAXA.

B69 **G. Sobral, H. Zaher** DEVELOPMENTAL AND PHYLOGENETIC ORIGINS OF THE LATEROSPHENOID IN CROCODYLIANS

B70 **M. M. Johnson , M. T. Young, L. Steel, S. Brusatte** EVOLUTIONARY RELATIONSHIPS AND BIODIVERSITY OF MACHIMOSAURINI (THALATTOSUCHIA, TELEOSAURIDAE)

B71 **A. J. Adams, C. A. Brochu** MORPHOLOGY OF THE MIDDLE EOCENE CROCODYLOID *'CROCODYLUS' AFFINIS*, SYSTEMATICS OF BRIDGER FORMATION CROCODYLOIDS, AND PHYLOGENETIC RELATIONSHIPS NEAR THE ROOT OF CROCODYLIDAE

B72 **C. F. Geroto** APPLICATION OF BROOKS PARSIMONY ANALYSIS TO REVEAL THE RELATIONSHIP BETWEEN THE AREAS IN MESOEUCROCODYLIA PALEOBIOGEOGRAPHY

B73 **R. C. Andrade, M. V. Sena, J. M. Sayão, G. R. Oliveira** MICROANATOMY OF *PEPESUCHUS DEISEAE* (MESOEUCROCODYLIA, PEIROSAURIDAE) REVEALS A MATURE FEMALE SPECIMEN FROM THE LATE CRETACEOUS OF BRAZIL

B74 **R. G. Figueiredo, B. M. Hörmanseder, F. Dalla Vecchia, A. W. Kellner** A NEW CROCODYLIFORM SPECIMEN FROM THE CRETACEOUS OF MOROCCO WITH *HAMADASUCHUS* AFFINITIES AND THE MORPHOLOGICAL VARIATION WITHIN THE GENUS.

B75 **A. I. Rego, D. C. Evans** A NEW SPECIES OF NOTOSUCHIAN CROCODYLIFORM FROM THE LATE CRETACEOUS OF MOROCCO

B76 **C. R. Noto, A. H. Turner, T. L. Adams, S. Drumheller** MORE CROCS, MORE PROBLEMS: ENIGMATIC SMALL CROCODYLIFORM MATERIAL FROM THE WOODBINE FORMATION OF TEXAS

B77 **A. P. Cossette, C. A. Brochu** THE RECORD OF *DEINOSUCHUS* EAST AND WEST OF THE WESTERN INTERIOR SEAWAY.

B78 **D. A. Tarailo, D. Hester, C. A. Brochu** OCEANIC DISPERSAL RATES WITHIN CROCODYLIA AND THEIR SIGNIFICANCE TO THE DEVELOPMENT OF SALT TOLERANCE IN CROCODYLOIDS

B79 **R. E. Molnar, G. Price, I. Sobbe** THE ROLE OF LARGE REPTILIAN, ESPECIALLY ZIPHODONT CROCODILIAN, PREDATORS IN AUSTRALIAN PLEISTOCENE TERRESTRIAL TETRAPOD TROPHIC SYSTEMS

B80 **A. M. Oliveira, C. C. Geroto** FIRST OCCURRENCE OF A LARGE PLEISTOCENE ALLIGATORIDAE FROM THE CENTRAL BRAZIL

B81 **M. G. Lockley, N. A. Matthews, B. H. Breithaupt, K. Cart, G. Gierlinski, R. K. Hunt-Foster** EVIDENCE OF LOCAL NICHE PARTITIONING AMONG EARLY JURASSIC DINOSAURS AT LARGE KAYENTA SANDSTONE TRACKSITES NEAR MOAB, UTAH

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B82 **Q. Zhang, H. You, T. Wang** A NEARLY COMPLETE SKELETON OF A TRANSITIONAL SAUROPODIFORM DINOSAUR FROM THE EARLY JURASSIC OF LUFENG, YUNNAN PROVINCE, CHINA

B83 **Y. Wang, H. You, A. Otero, T. Wang** TAXONOMY OF "*GYPOSAURUS*" *SINENSIS* YOUNG, 1941 FROM THE EARLY JURASSIC LUFENG FORMATION OF YUNNAN PROVINCE, SOUTHWESTERN CHINA

B84 **T. J. Fedak** TAPHONOMY AND TECTONIC DEFORMATION OF CANADA'S OLDEST DINOSAURS: 3D DIGITAL RECONSTRUCTION OF THE FUNDY DINOSAUR BONE BED

B85 **S. Hattori, T. Tsuihiji** RECONSTRUCTION OF THE PEDAL MUSCULATURE IN *HERRERASAURUS ISCHIGUALASTENSIS* (DINOSAURIA: THEROPODA) AND ITS IMPLICATIONS IN THE TRANSITION FROM THE ARCHOSAURIAN ANCESTRAL CONDITION

B86 **E. Payne** ALLOSAURUS CRANIAL ELEMENTS SUPPORT THE UTILITY OF USING PERIOSTEAL AGING TO ASSESS MATURITY IN ISOLATED THEROPOD CRANIAL ELEMENTS.

B87 **E. Malafaia, P. Mocho, F. Escaso, P. Dantas, F. Ortega** ANALYSIS OF THE CRANIAL ANATOMY OF *ALLOSAURUS* FROM THE ANDRÈS FOSSIL SITE (PORTUGAL, UPPER JURASSIC)

B88 **E. Cuesta, D. Vidal, F. Ortega, J. Sanz** THE SKULL OF *CONCAVENATOR CORCOVATUS* (DINOSAURIA; THEROPODA) FROM LAS HOYA(EARLY CRETACEOUS, SPAIN): OSTEOLOGY AND 3D RECONSTRUCTION.

B89 **R. A. Coria, P. J. Currie, F. Ortega, M. Baiano** A POSSIBLE CARCHARODONTOSAURID THEROPOD RECORD FROM THE VALANGINIAN (EARLY CRETACEOUS) OF PATAGONIA, ARGENTINA

B90 **T. Brougham, P. Bell** TWO NEW THEROPODS DESCRIBED FROM ASSOCIATED MATERIAL FROM THE LOWER CRETACEOUS GRIMAN CREEK FORMATION OF LIGHTNING RIDGE, NSW, AUSTRALIA

B91 **E. D. Johnson-Ransom, P. Makovicky, L. Zanno, K. Shimada** NEW COELUROSAURIAN REMAINS (DINOSAURIA: THEROPODA) FROM THE CENOMANIAN MUSSENTUCHIT MEMBER OF THE CEDAR MOUNTAIN FORMATION, UTAH, USA

B92 **B. I. Johnson, A. Matthias, J. Sertich** A UNIQUE LATE JURASSIC MICROVERTEBRATE ASSEMBLAGE FROM A DINOSAUR NESTING SITE

B93 **J. R. Foster, K. C. Trujillo, K. R. Chamberlain** A PRELIMINARY U-PB ZIRCON AGE FOR THE FRUITA PALEONTOLOGICAL AREA MICROVERTEBRATE LOCALITIES, UPPER JURASSIC MORRISON FORMATION, MESA COUNTY, CO

B94 **S. A. Ostrowski, C. R. Noto** HOLD ME CLOSER TINY FOSSIL: A RICH MICROVERTEBRATE FAUNA FROM THE ARLINGTON ARCHOSAUR SITE (WOODBINE FORMATION, CENOMANIAN) OF NORTH-CENTRAL TEXAS

B95 **T. C. Wyenberg-Henzler, J. Scott** STRATIGRAPHY, BIOSTRATIGRAPHY AND X-RAY FLUORESCENCE ANALYSIS OF MUDSTONE AND HETEROLITHIC FACIES IN THE DINOSAUR PARK FORMATION, DINOSAUR PROVINCIAL PARK, ALBERTA

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B96 **A. L. Hendrix, A. M. Deans, C. Lewis, S. G. Lucas, A. A. Harrison, A. B. Heckert** A TETRAPOD MICROFOSSIL ASSEMBLAGE FROM THE ALLISON MEMBER OF THE MENEFEE FORMATION (UPPER CRETACEOUS: EARLY CAMPANIAN), SAN JUAN BASIN, NEW MEXICO

B97 **S. G. Lucas, S. G. Dalman, A. J. Lichtig, S. D. Elrick, W. J. Nelson, K. Krainer** STRATIGRAPHIC DISTRIBUTION AND AGE OF THE DINOSAURS OF THE UPPER CRETACEOUS HALL LAKE MEMBER OF THE MCRAE FORMATION, SIERRA COUNTY, NEW MEXICO

B98 **J. M. Richard, A. Bercovici, D. Pearson** DID SIZE MATTER FOR SURVIVING THE CRETACEOUS-PALEOGENE MASS EXTINCTION EVENT?

B99 **J. Claytor, M. T. Carrano** LANDSCAPE DIVERSITY OF THE UPPER CRETACEOUS JUDITH RIVER FORMATION TRANSCRIPT

B100 **T. Beveridge, E. Roberts, J. Ramezani, D. Eberth, R. R. Rogers, S. Bowring** A NEW APPROACH TO CORRELATING VERTEBRATE FAUNAS BY COMBINING HIGH PRECISION U-PB GEOCHRONOLOGY WITH GEOCHEMICAL TEPHROSTRATIGRAPHY: A CASE EXAMPLE FROM THE CAMPANIAN WESTERN INTERIOR BASIN

B101 **E. M. Roberts, H. Gardner, C. Placzek, P. M. O'Connor, M. C. Lamanna, J. A. Clarke, S. W. Salisbury, K. Claeson** NEW HIGH-RESOLUTION TAPHONOMIC, GEOCHRONOLOGIC AND PALEOENVIRONMENTAL RECORDS OF LATEST CRETACEOUS BIRD, DINOSAUR AND OTHER VERTEBRATE FAUNAS FROM VEGA ISLAND, ANTARCTICA PENINSULA

B102 **C. R. Torres, S. N. Davis, L. T. English, R. D. MacPhee, J. Meng, J. Proffitt, A. R. West, J. A. Clarke** NEW FOSSILS FROM THE LA MESETA FORMATION OF SEYMOUR ISLAND, ANTARCTICA EXPAND OUR UNDERSTANDING OF MIDDLE-LATE EOCENE ANTARCTIC FAUNA

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

LATE EOCENE-EARLY OLIGOCENE TURTLE DIVERSIFICATION FROM EGYPT

ABDELGAWAD, Mohamed K., Cairo University, Giza, Egypt; ALY, Mohamed F., Cairo University, Giza, Egypt; EL-GHAREEB, Abdel-Wahab, Cairo University, Giza, Egypt; SILEEM, Afifi, Egyptian Geological Museum, Giza, Egypt; SHAHATA, Mohamed, Egyptian Environmental Affairs Agency, Giza, Egypt

In Africa, the Fayum Depression is considered as one of the best windows for the vertebrate evolution during the Eocene-Oligocene times. The Paleogene formations in the Fayum Depression, bearings the vertebrate fauna are the Birket Qarun, Qasr el Sagha and the Jebel Qatrani formations. Stratigraphically, the section consists of the middle Eocene Gehannam Formation; the upper Eocene nearshore marine and fluvial deposits of the Birket Qarun and the Qasr El Sagha formations; Oligocene fluvial sediments of the Jebel Qatrani Formation; and capped by the Lower to Middle Oligocene and Early Miocene Widan El Faras Basalt and Miocene fluvial deposits of the Kashab Formation. In the Fayum depression, the Late Eocene-Early Oligocene sediments were deposited in a basin aligned west-southwest-east-northeast and isolated from the Tethys Sea at the north by structural highs. The turtle assemblages found in the whole Late Eocene –Early Oligocene succession are Neochelys fajumensis; Cordichelys antiqua; Stereogenys cromeri; Dacquemys paleomorpha; Albertwoodemys testudinum; Gigantochersina ammon; and Stereogenys libyca. The present work represents a re-evaluation for the turtle older collection housed in the Egyptian Geological Museum, Egypt; Division of Fossil Primates, Duke University Lemur Center, North Carolina; USA and Natural History Museum, London, United Kingdom. The specimens are comprises relatively two complete cranial remains with at least one new taxon. Also, the collection records the presence of the Dacquemys paleomorpha through the Early Oligocene deposits, with complete cranial remains.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

DISCOVERY OF TESTUDINES MATERIALS FROM THE EARLY CENOMANIAN MAGHRABI FORMATION, SOUTH WESTERN DESERT, EGYPT

ABUELKHEIR, Gebely, Assuit University, New Valley Branch, New Valley, Egypt; ABDELGAWAD, Mohamed K., Cairo University, Giza, Egypt

Early to Late Cretaceous stages are very poorly documented time intervals in the Egyptian record of the testudines evolution. The Maghrabi Formation is an Early Cenomanian, Late Cretaceous site, that is mainly crops out in the south Western Desert of Egypt. The locality comprises a clastic sequence of bioturbated mudstone and sandstone intercalations, which contains rare scattered and fragmented vertebrate remains such as fish teeth, dinosaur bones and turtle plates. A new excavation found a turtle material which has been collected from the Maghrabi Formation east of the Kharga oasis. The collected specimens are preserved in the New Valley Branch, Geology Department, Assuit University. The majority of the discovered materials are isolated plates; no cranial elements have been recovered so far. However, a well-preserved, mostly complete shell including both carapace and plastron has been collected from compacted mudstone with thin layers of sandstone intercalations at the uppermost part of the formation. These sediments indicate a supratidal marshes environment. The specimen can be considered as the first collected material of testudines from the Early Cenomanian, upper part of the Maghrabi Formation in the south Western Desert of Egypt.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MORPHOLOGY OF THE MIDDLE EOCENE CROCODYLOID *'CROCODYLUS' AFFINIS*, SYSTEMATICS OF BRIDGER FORMATION CROCODYLOIDS, AND PHYLOGENETIC RELATIONSHIPS NEAR THE ROOT OF CROCODYLIDAE

ADAMS, Amanda J., The University of Iowa, Iowa City, IA, United States of America; BROCHU, Christopher A., University of Iowa, Iowa City, IA, United States of America

The middle Eocene Bridger Formation of Wyoming is known for its vertebrate fauna, including a diverse crocodylian assemblage. Many were historically classified as crocodylids, but at present, only one valid crocodyloid has been named from the unit – *"Crocodylus" affinis*. All other species of *Crocodylus* described from the unit are either nomina dubia, junior synonyms of *"C." affinis*, or referable to non-crocodyloid taxa. Fossil and molecular data both put the origin of crown-genus Crocodylus in the Miocene, but nomenclatural revision of basal crocodyloids referred to *Crocodylus*, including *"C." affinis*, has been held back by a lack of resolution among the various North American and Eurasian forms. A complete skull and lower jaws referable to *"C." affinis*, including an undistorted braincase with well-preserved sutures, allows us to more fully assess the morphology and relationships of the species, which in turn will further facilitate ongoing revisionary work. The braincase preserves plesiomorphic states, such as a broad lateral exposure of the prootic, not found in crown-genus *Crocodylus*, and although the splenial passes anteriorly into the mandibular symphysis, the splenials themselves do not meet at the sagittal plane. A species of the crocodyloid *Brachyuranochampsa* (*B. zangerli*) has been named from the Bridger Formation, but the holotype is a small specimen of *"C." affinis*; nevertheless, an unnamed species of *Brachyuranochampsa* does, indeed, exist within the Bridger Formation. A phylogenetic analysis reinforces the basal position for *"C." affini*s among crocodyloids; Bridger *Brachyuranochampsa* is closely related to Uintan *B. eversolei* and Wasatchian *"Crocodylus" acer*, and this group is more closely related to Crocodylidae than *"C." affinis* is. These fossils provide a critical glimpse at animals close to the divergence of modern crocodylids.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

HISTOLOGICAL STRUCTURE OF THE EXOSKELETON OF *ATELEASPIS, RETICULASPIS* AND *ESCUMINASPIS* (OSTEOSTRACI, AGNATHA): PRELIMINARY ANALYSIS OF DATA

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Histological features of the external skeleton of the osteostracans *Ateleaspis* (early Silurian – early Devonian), *Reticulaspis* (early Devonian) and *Escuminaspis* (late Devonian) were investigated and compared based on published data and new material. The remains came from the Jaagarahu Stage, lower Wenlock, Saaremaa, Estonia (*Ateleaspis*), the Severnaya Zemlya Formation, Lochkovian, Severnaya Zemlya Archipelago, Russia (*Ateleaspis, Reticulaspis*), and the Escuminac Formation, Frasnian, Miguasha, Quebec, Canada (*Escuminaspis*). Tessellated shields of *Ateleaspis* and *Escuminaspis* are covered by the tubercles (isolated odontodes) of different sizes. There are the tubercles of the first dentine generation on the tessellated shield of *Reticulaspis*. The exoskeleton of *Ateleaspis* is well-developed and is formed by the three layers typical of the osteostracans: the superficial dentine layer, the middle (spongy) and the basal (laminated) bony layers. The superficial layer consists of comparatively compact tissue of typical mesodentine. The network of vascular canals is well-developed in the dense middle layer, the vascular canals are opened by the apertures between the tubercles. There are no numerous radiating canals in the exoskeleton of *Ateleaspis* microremains from Estonia, the radiating canals are well-developed in the material from Russia. The layers of the exoskeleton of investigated materials of *Ateleaspis* are comparatively equal in thickness. The exoskeleton of *Reticulaspis menneri* is formed by the three layers and is strongly developed. Mesodentine tubercles of the armor are covered by three-dimentional dentine network. The study has shown that the superficial layer of the exoskeleton is composed of the dentine of at least two generations. The radiating canals are well-developed, usually positioned in several layers. The basal layer of the exoskeleton is relatively thick and strongly developed on reinforcing ribs of the shield. In *Escuminaspis laticeps*, the tubercles of the shield are formed by the dentine tissues of two types: dense tissue of pallial mesodentine and vasculated tissue of osteo-mesodentine. The tubercles are arranged on the strongly developed radiating canals of the middle layer. Thus, preliminary comparison of the data reveals the hard structures of the exoskeleton of *Ateleaspis, Reticulaspis* and *Escuminaspis* are composed of tissues of different types and their exoskeletal layers have different degrees of development.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE BRAINCASE AND THE ENDOCRANIAL ANATOMY OF *TETHYSAURUS NOPCSAI*, A PRIMITIVE MOSASAUROID (REPTILIA, SQUAMATA) FROM THE LOWER TURONIAN (LATE CRETACEOUS) OF GOULMIMA (SOUTHERN MOROCCO)

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Mosasaurs are an extinct group of marine reptiles, known from the Upper Cretaceous and whose precise phylogenetic affinities among squamates remain controversial. Here, we provide the first detailed description and comparative analysis of the braincase of a relatively primitive mosasaur, *Tethysaurus nopcsai* from the Lower Turonian of Morocco, and present new details about its neuroanatomy. Using high-resolution computed-tomography data sets from five specimens illustrating different ontogenetic stages, we reconstruct the cast of the brain, the cranial nerves, and the inner ear, and provide comparisons with a number of varanids and snakes. The braincase of *Tethysaurus* does not exhibit any character suggesting a close relationship between mosasaurs and snakes. The parietals of *Tethysaurus* lack any substantial down-growth of the parietal margins and the lateral walls of the braincase remain open, unlike the condition in some advanced mosasaurs and snakes, a feature here considered to be convergent. The topological relationships of the bony elements of the braincase are remarkably similar to the varanid condition, as are the placement of foramina, with the exception of the occipital recess that is smaller and more anteriorly positioned than in other squamates, but there is no evidence of a recirculating fluid system as in snakes. Though the anterior part of the brain is difficult to reconstruct, the length and shape of the olfactory tracts and the shape of the pituitary bulb are most similar to the varanid condition. The dorsum sellae is medially constricted as previously recognized in more advanced mosasaurs. Additionally, some features, such as the cartilage between the parietal and the supraoccipital, the topological relationships of the supratemporal, and the morphology of the inner ear, are typical of mosasaurs and differ from the conditions found in both snakes and varanids. Though certain aspects of the neuroanatomy of advanced mosasaurs was already known, this work constitutes the first detailed description and comparison of the braincase of a relatively primitive mosasaur and thus can be of great value in better understanding the evolutionary history, paleobiology, and phylogenetic position of this group.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

ISOTOPIC PALAEOECOLOGY ($\delta^{13}C$) OF THE LATE PLEISTOCENE MEGAMAMMALS OF AMERICA (FLORIDA, MEXICO AND BRAZIL): FINDING THE KEY SPECIES IN THE STRUCTURATION OF THESE COMMUNITIES

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To find out which was the key species in ancient American megamammal assemblages, we compared the isotopic paleoecology ($\delta^{13}C$) of three American assemblages with the ecological setting of one of the last remaining megamammal assemblage from the savanna of Amboseli (Kenya, Africa). *Loxodonta africana* Blumenbach, 1797 is the key species in the structure of savannah ecosystems in Africa, acting at several levels such as modification of the environment by facilitating the access to resources by other species, and limiting the abundance of other megamammal species through competition for resources. Were used published carbon isotopic data (in bioapatite) for mammals taxa (weight > 1 ton) found in Brazilian Intertropical Region (Brazil), México and Florida (USA). The proportion (p_i) of resources consumed (between C_3 and C_4plants) was established through a single isotope mathematical mixing model, then the standardized isotopic niche breadth (B_A) was calculated. In Africa, *L. africana* presented the widest niche breadth ($\delta^{13}C$ = *-8.42*±2.14 ‰; B_A = 0.49±0.41; W = 5 ton) among the terrestrial herbivorous mammal species from the Amboseli assemblage. The niche breadth value and the weight of this taxa could be used as criteria to identify the possible key species in the structure of an extinct ecosystem. In BIR there are data for *Notiomastodon* ($\delta^{13}C$ = *-1.17*±2.76 ‰; B_A = *0.30*±0.28; W = 6 ton), *Eremotherium* ($\delta^{13}C$ = *-4.35*±2.87 ‰; B_A= 0.71±0.33; W = 3 ton) and *Toxodon* ($\delta^{13}C$ = *-5.74*±4.80 ‰; B_A = *0.49*±0.41; W = 3 ton). In México, *Eremotherium* ($\delta^{13}C$ = -7.70 ‰; B_A = 1.00; W = 3 ton) and *Cuvieronius* ($\delta^{13}C$ = -10.80±1.19 ‰; B_A = 0.71±0.19; W = 3.5 ton) had a wide niche breadth, with a generalist diet composed by C_3/C_4 plants. In contrast, *Mammuthus* ($\delta^{13}C$ = -3.24±1.41 ‰; B_A = 0.39±0.21; W = 8 ton), *Stegomastodon* ($\delta^{13}C$ = -4.26±0.53 ‰; B_A = 0.56±0.10; W = 4.7 ton) and *Paramylodon* ($\delta^{13}C$ = -2.60±1.13 ‰; B_A = 0.26±0.20; W = 1 ton) were C_4 specialists with narrow niche breadth. In Florida, *Mammut* ($\delta^{13}C$ = -11.18±1.02 ‰; B_A = 0.65±0.18; W = 8.8 ton) had a diet composed mainly of C_3 plants, whereas *Cuvieronius* ($\delta^{13}C$ = -4.73±0.95 ‰; B_A = 0.63±0.16; W = 3.5 ton) and *Mammuthus* ($\delta^{13}C$ = -2.35±1.87 ‰; B_A = 0.25±0.27; W = 8 ton) were predominantly C_4plant feeders. The wide B_A associated to the high weight of *Eremotherium* allow us to suggest that this species was a superior resource competitor in México and BIR, and thus may have directly limited the population growth of other taxa. In Florida, there is no data for *Eremotherium*, and it seems that *Mammut* and *Cuvieronius* were the key species.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW GENUS OF SCIURAVID (SCIURAVIDAE, RODENTIA) FROM THE LATEST EARLY EOCENE (EARLIEST BRIDGERIAN) OF RAVEN RIDGE, UTAH AND THE EARLY MIDDLE EOCENE (MIDDLE BRIDGERIAN) OF GREEN RIVER BASIN, WYOMING

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During the Early and Middle Eocene, sciuravids were a significant and abundant component of several North American mammal communities. Recent study of rodents collected from two such communities, Raven Ridge, Utah (biochron Br1a) and new specimens from the Green River Basin (biochron Br2) has led to the discovery of a new genus and two new species of sciuravids. The new form has a crested pattern and length/width dimensions of the upper molars previously unknown in Bridgerian sciuravids. Features shared with *Taxymys* include: the protoloph and metaloph are essentially complete with the metaloph anteriorly displaced relative to the metacone, a distinct protocone, hypocone, and anterior cingulum. Features shared with *Sciuravus* include: a unique protoconule anteriorly offset from the protoloph, and a subequal hypocone and protocone. Features unique to the new genus include: molar length exceeds the anterior and posterior widths, which are subequal; the protocone and hypocone are spaced far apart and connected by a crest (endoloph). In the past, these upper molar length/width proportions and the presence of the endoloph have been treated as ancestral features. However, these characters are not found in the ischyromyids and the potentially closely related middle Eocene cylindrodontids. Evolution of a new sciuravid genus at Bridgerian biochron Br1a is consistent with other reports of evolutionary diversification occurring during this interval of the EECO. Early development of cresting and unique upper molar dimensions may represent a response to the cooler, more seasonal climate that developed at this time. Regardless, discovery of this new genus advances our knowledge about Bridgerian rodent evolution.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE LARGEST STERNUM AND THE UNDERWATER FLYING IN PLOTOPTERIDS

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A large sternum of a plotopterid found in the Oligocene Yukiaino Sandstone, Southwest Japan is one of the largest sternum among the wing-propelled diving birds ever known. It is wider than the largest sternum in penguins (Kairuku penguin, *Kairuku grebneffi* from the Late Oligocene New Zealand, making the sternum largest based on the sternal body area. The morphology is rather similar to that in modern penguins than that in suloid birds, the living relatives of plotopterids. The apex of carina expands for the furcular articulation as in *Copepteryx hexeris* and other suloid birds. It lacks the middle part of the sternal body and most of carina but retains the overall morphology. The sternum is larger than that in *Hokkaidornis abashiriensis* by c.a. 20% and the estimated body length is about 2 meters. This figure is equivalent to the estimated body length of the largest known plotopterid *C. titan* and the largest fossil penguin *Palaeeudyptes Klekwkowskii*. However, it is much larger than that of the Kairuku penguin despite the comparative sterna size. Such disparity suggests the different body plan between penguins and plotopterids. In plotopterids, the body trunk must be shorter and stouter relative to the body length, than that in penguins.

The intermuscular line on the muscular surface of the starnal body that bounds the attachment area of two flight muscles, m. pectoralis and m. supracoracoideus, runs more posteriorly than that in volant suloids. The m. supracoracoideus is a major wing-upstroke muscle and is well-developed in the wing-propelled diving birds. The large area for m. supracoracoideus is consistent with the hypothesis that plotopterids were flightless, wing-propelled diving birds such as penguins, led by the morphological similarity of the coracoid and wing elements to other penguin-like birds. Penguins are the only diving birds that produce the propulsive force by the wing-upstroke and this efficient propulsion is enabled by the large m. supracoracoideus. The large m. supracoracoideus in plotopterids implies that they might have produced the propulsive force by the wing-upstroke, although the area for m. supracoracoideus is relatively smaller than that in penguins. The contribution of the upstroke movement of the wing must be much lower or none. The angle of anterior margins is smaller than that in *H. abashiriensis* indicating the morphological variation in the sterni and thus possible functional shift in the thoracic girdle and the wing in plotopterids as that have occurred in penguins.

Technical Session VI (Thursday, August 24, 2017, 11:30 AM)

A QUESTION OF TIME IN TEMNOSPONDYL EVOLUTION AND THE SURVIVAL OF CAPITOSAURIA THROUGH THE PERMO-TRIASSIC EXTINCTION EVENT

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The Permo-Triassic (P-Tr) extinction is considered one of the most dramatic events in the history of life. Estimates provide extinction rates within the range of 90–95% of known taxa. Few taxa, such as the dicynodont genus *Lystrosaurus*, are reported from both older (Permian) and younger (Triassic) strata, representing evolutionary branches that survived through the P-Tr extinction event. MCP-4275PV is a mostly preserved (right) hemimandible, which belongs to a large-sized temnospondyl. The specimen has several characteristics typical of Capitosauria. We analyzed a large phylogenetic dataset (73 taxa, 271 characters, implied weighting) that places MCP-4275PV as a derived Capitosauria, nesting the specimen within the genus *Parotosuchus*. With the exception of fragmentary capitosauroid material from the Permo-Triassic of Uruguay, all Capitosauria are known from the Triassic. However, MCP-4275PV comes from the Rio do Rasto Formation (Passa Dois Group, Paraná Basin), which is firmly assigned to the Permian (Guadalupian) through geological and biostratigrafic data. Thus, MCP-4275PV currently stands out as the oldest representative of a Capitosauria and of genus *Parotosuchus*. As consequence, the first radiation of Capitosauria (as well as the radiation of Stereospondyli) is moved ~10 m.y. back in time, to the Guadalupian, therefore placing these radiation events under different a context and constraints. This also increases the number of temnospondyl ghost-lineages crossing through the P-Tr boundary. Henceforth, *Parotosuchus* and *Lystrosaurus* can be regarded as examples of clades that survived through the P-Tr extinction event. The presence of *Parotosuchus* in the Guadalupian of South America challenges the current knowledge on the diversity of Permian taxa in Gondwanan sedimentary units. The subsampling of past diversity impacts studies on evolution and our knowledge of past biotas. The presence of a large-sized derived capitosaur in the Guadalupian is evidence that we may have insufficient information to properly access Permian diversity, particularly in South America. Therefore, it is possible that the P-Tr extinction event may have been not as dramatic as previously conceived, at least in the Gondwanan territory.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MICROANATOMY OF *PEPESUCHUS DEISEAE* (MESOEUCROCODYLIA, PEIROSAURIDAE) REVEALS A MATURE FEMALE SPECIMEN FROM THE LATE CRETACEOUS OF BRAZIL

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Paleohistology has been considered an effective tool to interpret bone adaptation to aquatic locomotion and to make functional inferences on extinct taxa. Here we present new records on the peirosaurid *Pepesuchus deiseae* microanatomy from the Presidente Prudente Formation (Campanian–Maastrichtian), Bauru Group, in southwestern Brazil and provide insight into its paleobiology. We carried out thin sections of four appendicular bones and one osteoderm from an individual of *Pepesuchus deiseae* (MN 7466-V). Both metacarpals show a broad cortex and a tiny marrow cavity, the largest one has 40 cyclic growth marks and haversian system in the inner cortex. The ulna has a highly porous bone with several Howship's lacunae. The osteoderm is composed by parallel-fibered bone (PFB) forming the basal and external cortex and fibro-lamellar bone (FLB) constituting the internal cortex. The tibia shows the presence of External Fundamental System (EFS) and the cortex presents FLB and PFB intercalated. There are two bone specializations recorded. The mecarpal elements exhibit pachyostosis and the ulna shows osteoporotic-like bone. In metacarpals, the occurrence of bone mass increase would have implied life in rather shallow-water environments. The ulnar shows a reduction in bone mass, providing a better manoeuvrability between its joints. The tibia was the only element indicating the specimen reached the somatic maturity by the presence of EFS. Thus it was used as a proxy to the maximum growth rate.The presence of fibro-lamellar tissue in advanced ontogenetic stage indicates a peculiar feature recorded until nowdays only for eusuchian long bones. This unusual growth pattern could be related with the semi-aquatic habits of the recent crocodylians. The Howship's lacunae

in the osteoderm's internal cortex, probably indicate bone reabsorption to calcium mobilization during eggshell's formation. In addition, the haversian system is an indication that largest metacarpal belonged to mature female individual which had accomplished several ovogenetic cycles. In conclusion, our analysis suggest that MN 7466-V was an adult and mature female individual which had performed some ovogenetic cycles. Also, based on the internal organization, *Pepesuchus deiseae* was considered a semi-aquatic Peirosauridae.
Grant Information:
CAPES and CNPq

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

SYSTEMATICS AND DESCRIPTION OF THE "PROCTOR LAKE ORNITHOPOD"

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Material from over thirty individuals of a new ornithopod, representing nearly every skeletal element, was recovered from the Proctor Lake locality in the Twin Mountains Formation (Aptian) of north-central Texas. The range of size as expressed by femur length, 5.1cm to 31.5cm, suggests the presence of different ontogenetic stages. A preliminary phylogenetic analysis including 25 taxa and 92 characters was conducted using the traditional search option in the software package TNT 1.5. The analysis recovered 4 most parsimonious trees with a best score of 268 steps. The strict consensus tree places the Proctor Lake taxon basal to Iguanodontia, but more derived than *Hypsilophodon foxii*. The presence and morphology of 4 premaxillary teeth along with a combination of both basal and derived characters distinguish this taxon from all other ornithopods. Characters including the presence of premaxillary teeth, the shape of the dentary teeth, and shape of the postacetabular process place the Proctor taxon basal to Iguanodontia while the presence of a distal anterior extensor groove on the femur, expansion of the distal end of the ischium, opisthocoelous cervical vertebra, and curved maxillary teeth suggest the Proctor taxon is more derived than most basal neornithischians. The phylogeny of basal ornithopods is poorly resolved; thus, this new taxon provides crucial support and insight into the evolution of basal ornithischians.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TOWARD DISCOVERING THE ADAPTIVE FUNCTIONS OF CERATOPSIAN ROSTRALS

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Although the rostral (or "upper beak") bone is an important synapomorphy distinguishing ceratopsian dinosaurs, its functional significance has not been well studied. Rather than being a holdover trait or the result of phylogenetic inertia, the evolutionary history of Ceratopsia indicates that the rostral bone itself is an evolutionary novelty, and thus likely holds real adaptational significance and clues to the feeding ecology of horned dinosaurs. Unlike the highly varied "rostra" of modern birds, whose functions have been thoroughly studied, the functional morphology of the ceratopsian rostral bone, both in general and as differs between individual taxa, has not yet been investigated in depth. This study begins forming a framework for determining the adaptational significance of ceratopsian rostrals, first by comparing morphology between ceratopsians and other vertebrate groups possessing superficially similar rostra, such as the extinct rhynchosaurs and dicynodonts, as well as extant groups of similarly beaked vertebrates whose behaviors and feeding ecology we may directly observe. This study found informative similarities between the beaks of ceratopsians and those of modern parrots, turtles, and parrotfishes, providing a basis for forming testable hypotheses about the feeding behavior and ecology of ceratopsians as a group. Although comparison with other vertebrate groups may offer clues for the function of the ceratopsian rostral in general, future researchers should take caution before drawing morphological comparisons between different ceratopsian taxa, especially when these comparisons are based on few specimens. This study's examination of many *Triceratops* rostrals demonstrates that significant morphological disparity may exist even among specimens from the same geologic formation, due to a myriad of variables such as geography, stratigraphy, taphonomy, ontogeny, and individual variation within a population. Before comparing specimens of disparate ceratopsian taxa to form hypotheses about differences in behavioral and feeding ecology, future researchers should take care to account for these variables in order to achieve more robust results.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THREE DIMENSIONAL VIRTUAL RECONSTRUCTION OF A *CORYPHODON* MAXILLA FROM THE EOCENE OF WYOMING

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Tools for reconstructing fragmentary fossils within a virtual, 3-dimensional environment allow paleontologists and paleoanthropologists to visualize and interpret incomplete, damaged, or distorted skeletal morphology in a non-destructive and reproducible fashion. Several different approaches to virtual reconstruction have been proffered by researchers including methods for dealing with post-depositional deformation and restoration of missing anatomy. This work has the potential to democratize paleontology by increasing access to (virtual or printed) 3D models of always rare and often unique vertebrate specimens. The recent recovery of a fragmentary cranium and upper dentition of *Coryphodon* from the early Eocene, Main Body of the Wasatch Formation near Bitter Creek station in the Washakie Basin of SW Wyoming, has allowed us to virtually reconstruct this specimen. We present a novel method for virtual fossil reconstruction that utilizes hardware (e.g., laser and structured light surface scanners) and software (e.g., Geomagic Wrap, Rapidworks, Blender) that is becoming increasingly common in many vertebrate paleontology research laboratories. This approach makes few assumptions, is repeatable and testable, and offers many advantages over traditional physical reconstruction of fossil material. The specimen includes a nearly complete upper dentition with preserved parts of the hard palate, several lower molars and premolars, numerous but extremely fragmentary parts of the cranium, and multiple fragmentary postcranial elements. There is no indication of taphonomic deformation of any of the specimens. We began by scanning all maxillary elements with Next Engine laser scanner, creating .ply models in Rapidworks, and importing these models into Blender, where we placed the scanned fossils upon a photographic template of a well-preserved *Coryphodon* skull, aligned and scaled to the size of the fossil molar row. Mirror imaging was used to create bilaterally symmetrical counterparts to preserved teeth and bony structures, and missing details were modeled based on homologous regions in the photographic template. The modeling process is conservative with baseline assumptions of symmetry and homology, and the final model clearly distinguishes between original, mirror-imaged, and reconstructed elements. A series of linear and areal measurements of the completed virtual model (made in Geomagic Wrap) indicate no significant deviations from these assumptions, and strengthen our confidence in the utility of this novel method.
Grant Information:
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Technical Session XVIII (Saturday, August 26, 2017, 10:30 AM)

A NEW CISTECEPHALID DICYNODONT FROM THE UPPER MADUMABISA MUDSTONE FORMATION (UPPER PERMIAN), LUANGWA BASIN, ZAMBIA: ENDOCRANIAL ANATOMY AND BIOGEOGRAPHIC IMPLICATIONS

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Cistecephalidae is a clade of Lopingian dicynodonts known by skulls and postcrania that are modified for a fossorial lifestyle. Four species are recognized: *Cistecephalus microrhinus*, *Kawingasaurus fossilis*, *Cistecephaloides boonstrai*, and *Sauroscaptor tharavati*. Each is a basinal endemic (*C. microrhinus* and *Ci. boonstrai* in the Karoo Basin; *K. fossilis* in the Ruhuhu Basin; *S. tharavati* in the Pranhita-Godavari Basin). A fifth species from the Luangwa Basin has been noted briefly in the literature. Here we describe the Luangwa cistecephalid. The new taxon differs from all other cistecephalids by the presence of maxillary caniniform tusks. It resembles *S. tharavati* in having a relatively narrow temporal bar and a posteriorly-located pineal foramen that is supported by the nuchal crest, but differs in having an undivided nuchal crest extending from the interparietal to the supraoccipital. Postcranial anatomy of the Luangwa form is consistent with fossoriality, including possession of a prominent olecranon process of the ulna. One specimen preserves a natural endocast, including impressions of canals for the opthalmic branch of the trigeminal nerve, which are weakly ramified compared to those of *Moschops* or *Thrinaxodon*. Micro-CT data indicate that the vestibule was larger than typical for dicynodonts, but not inflated to the extreme degree seen in *K. fossilis* (interpreted as improving sensitivity to low frequency and/or ground-borne vibrations). Phylogenetic analysis places the Luangwa form near the base of Cistecephalidae, close to *S. tharavati*. The Luangwa form and *S. tharavati* provide a new model for the ancestral morphology of cistecephalids, and show that the evolution of many "typical" cistecephalid characters (e.g., highly roofed over skull; reduced orbits; modified inner ear and forelimb) occurred in a mosaic fashion. The Luangwa form extends the pattern of basinal endemism among cistecephalids, although it was widespread within its own basin. Given the large geographic range of *C. microrhinus* in the Karoo Basin, and the increasingly large range of Cistecephalidae as a whole, the emerging picture of cistecephalid biogeography paradoxically suggests that they were effective dispersers yet prone to geographic isolation.
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HOW DID LA BREA COLTS GROW UP? A STUDY OF POSTNATAL ALLOMETRIC GROWTH IN THE LIMB BONES OF *EQUUS OCCIDENTALIS*

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The amazing fossil collections at the La Brea Tar Pits Museum includes huge numbers of juvenile limb bone in every stage of growth, allowing us to examine how limb bones changed shape as colts of *Equus occidentalis* grew from the smallest juvenile to adult size. We measured the diaphysis length, circumference, and cross-sectional area of a minimum of 50 juvenile specimens of humeri, radii, femora, and tibiae. Previous studies of the growth series of *Equus burchelli*, the common zebra, allows for comparison. The expectation is that in cursorial animals like horses, the distal limb segments (radius, tibia) show grow longer faster than they grow thicker, so they become more gracile as they grow up. In the radius of *E. occidentalis* (n = 60), the growth is significantly more gracile (expected slope of radius vs. circumference = 1, actual slope = 1.68) as the colts grew, even more gracile than *E. burchelli* (slope = 0.76, which is robust). Likewise, tibia is highly gracile in its growth trends (slope = 2.15), while *E. burchelli* has more robust tibial growth (slope = 0.88). Even the femora of *E. occidentalis* are gracile (slope = 2.11), while the femora of E. burchelli show the expected isometric slope (slope = 1.09). This is surprising, because the adult limb proportions of *E. occidentalis* have been considered robust or normal for horses like zebras, and they are not members of the stilt-legged lineage of horses at all—yet their growth series is highly gracile.

Technical Session XVIII (Saturday, August 26, 2017, 10:45 AM)

ELEVATED SEMICIRCULAR CANAL ECCENTRICITY IN DICYNODONT THERAPSIDS (SYNAPSIDA): IMPLICATIONS FOR BEHAVIOR?

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The morphology of the semicircular canal (SC) system is expected to be finely tuned with animal behavior. Using computed tomography data, we compiled a morphological dataset of dicynodont (n=18) and mammalian (n=54) bony labyrinths and found that dicynodonts have significantly higher eccentricity of the vertical SCs than mammals. Biomechanical modeling indicates that an increase of the SC long axis decreases the lower corner frequency of the system, therefore increasing its bandwidth and mechanical sensitivity. Bandwidth is the range of head movement frequencies over which the labyrinth has a flat mechanical gain, and sensitivity is the maximal endolymph displacement after a step stimulus. In the mammalian sample, higher levels of SC eccentricity seem to be found in species (n=8) characterized by rapid head movements. Few mammals of comparable body mass to dicynodonts have elevated SC eccentricity, but grazing suids with rooting behavior (n=3) show similar, albeit slightly lower, levels of eccentricity. Because dicynodonts have been proposed to be substrate-directed feeders, their convergence in SC eccentricity with extant rooting suids raises the possibility that they also displayed rooting behavior, although further research on SC morphology and biomechanics is needed to fully resolve the interplay between function and SC eccentricity.

Grant Information:
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Technical Session XVI (Saturday, August 26, 2017, 11:45 AM)

AN EXCEPTIONALLY PRESERVED SKELETON OF A NEW ANKYLOSAURINE DINOSAUR FROM THE JUDITH RIVER FORMATION OF MONTANA, USA

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The terrestrial Judith River Formation of northern Montana was deposited over an approximately 5 million year interval during the Late Campanian, but despite having been collected continuously by palaeontologists for over a century, few relatively complete dinosaur skeletons have been recovered. Here we report a new genus and species of ankylosaurid dinosaur from the Coal Ridge Member of the formation, based on an exceptionally complete and well-preserved skeleton. Remarkably, this is the first ankylosaurin skeleton known with a complete skull and tail club, and it is the most complete ankylosaurid ever found in North America. The presence of abundant soft tissue preservation across the skeleton, including *in situ* osteoderms, skin impressions, and dark films that likely represent preserved keratin, make this exceptional skeleton an important reference for understanding the evolution of dermal and epidermal structures in this clade.

The new specimen differs from all ankylosaurines in the possession of imbricated, peaked frontonasal and frontoparietal caputegulae, prominent longitudinal furrows on the lateral surface of the squamosal horn, and the shape of the lateral caudal osteoderms along the tail club (excluding the knob osteoderms), which are strongly concave on the leading edge with posteriorly offset apices. Phylogenetic analysis recovers this specimen as an ankylosaurin ankylosaurid within a clade of *Dyoplosaurus* and *Scolosaurus*, with *Euoplocephalus* being more distantly related within Ankylosaurini. This specimen fills a gap in the ankylosaurine stratigraphic and geographic record in North America, and further highlights that Campanian ankylosaurines were undergoing rapid evolution and stratigraphic succession of taxa as observed for Laramidian ceratopsians, hadrosaurs, pachycephalosaurs, and tyrannosaurs. Ongoing refinement of ankylosaur diversity, biostratigraphy, and systematics documents relatively higher rates of morphological evolution in this group during the Late Campanian of Laramidia than in the Maastrichtian, which is consistent with the pattern observed in several other dinosaur groups.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

HISTORICAL BIOGEOGRAPHY OF INSULAR WHITE-FOOTED MICE (*PEROMYSCUS LEUCOPUS*) IN NORTHEASTERN NORTH AMERICA

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Records of the white-footed mouse, *Peromyscus leucopus,* have been documented from a minimum of 16 localities in North America as far back as 1.8 my bp. Systematic analyses were conducted on 23 populations of *Peromyscus leucopus* representing the eastern North American range of the species. We tested the hypothesis that previously unsubstantiated northeastern glacial refugia, in the vicinity of George's and Brown's Banks, served as colonizing sources of extant northeastern insular populations. Analyses using combined morphometric, mtDNA, paleoclimatological, palynological, and geographical data sets were conducted.

Variation in the mtDNA control region was analyzed in 99 individuals representing 23 populations (nine insular, 14 mainland) from Nova Scotia to Georgia. Phylogenetic and Network analyses were conducted using 895 bp of mtDNA control region to assess genetic variation within and among northeastern insular and eastern coastal mainland populations. Among populations sampled, 59 haplotypes were identified of which 26 were endemic to insular populations. Although there is limited evidence for phylogeographic structuring, interdigitation of haplotypes among populations suggests recent interchange of mitochondrial lineages. Mismatch distribution of pairwise haplotype frequencies indicates recent expansion for mainland populations, and a pattern of allopatric stability for insular populations.

Interpretation of combined data sets does not support the hypothesis for existence of northeastern Pleistocene glacial refugia, in the vicinity of George's and/or Brown's Banks, as colonizing sources for extant northeastern insular populations. Phenotypic and nucleotide sequence divergences among contiguous mainland populations reveals clinal differentiation resulting from late Wisconsin/Holocene northward migration along the coastal mainland and emergent coastal plain from southeastern United States Pleistocene (Wisconsin) refugia. Insular populations are Holocene coastal plain relicts, isolated by vicariance on topographic high spots that became islands in the northeast. Differentiation of insular populations is the result of a combination of genetic drift due to initial founding events and subsequent lack of gene flow resulting from isolation by rising sea level, and localized insular phenotypic adaptation to variable environmental selective pressures during the Holocene.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

STABLE ISOTOPIC EVIDENCE OF PALEOENVIRONMENTS AT EARLY MIOCENE LOCALITIES FROM TINDERET, KENYA

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Early Miocene fossil-bearing localities associated with the extinct Tinderet volcano in Western Kenya (~20 Ma) have yielded an abundant mammalian fauna with more than 80 species, including at least eight species of catarrhine primates. These primate assemblages are crucial for understanding the evolution and diversification of modern catarrhine lineages, and ongoing integrative research at these and other early Miocene localities includes refining and characterizing the environmental context of early Miocene catarrhine taxonomic and adaptive shifts. Previous environmental reconstructions suggest that Tinderet catarrhines were generally associated with tropical forested environments. However, catarrhine species composition varies among sites, indicating the possibility of habitat driven variation in assemblage composition. Therefore, placing the Tinderet primates in clear environmental contexts is critical for resolving the ecological preferences of these catarrhines.

Stable carbon isotope ratios ($\delta^{13}C$) were measured from the tooth enamel of 37 specimens of suids, tragulids, proboscideans, rhinocerotids, and hyracoids at three Tinderet localities: Songhor, Legetet, and Chamtwara. The $\delta^{13}C$ values were used to characterize herbivore dietary ecology to reconstruct the habitat of these faunal communities. Herbivore $\delta^{13}C$ values from all localities range from -12.2 to -6.7‰, indicating paleohabitats dominated by C_3 dietary resources. $\delta^{13}C$ values fall outside the range typical of herbivores inhabiting modern closed canopied forests and are more consistent with dietary guilds associated with broken canopy or woodland habitats. Carbon isotope ratios from Legetet specimens are 1.6-2.5‰ higher than those from Songhor and Chamtwara, perhaps indicating more water-stressed habitats at Legetet. In addition, $\delta^{13}C$ values for the fossil ruminant, *Walangania africanus,* are statistically lower at Chamtwara than at Songhor and Legetet, suggesting inter-site variability in feeding ecology for this species. These results indicate mammalian taxa may have been living in more open and arid C_3 ecosystems than previously recognized. This reinforces the need for a reevaluation of the context in which early catarrhines were evolving.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

CLAW FUNCTIONAL MORPHOLOGY OF *DEINONYCHUS ANTIRRHOPUS* AND OTHER THEROPODS

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The function of body parts of extinct taxa can be hard to determine since we cannot directly observe their behaviors in the wild, especially when there are very few to no extant species with analogous forms. Non-avian dinosaurs have unique morphologies in being bipedal terrestrial animals with often large sharp claws on their forelimbs, or with single hypertrophied claws on their pedal digits, such as in the case of dromaeosaurids. The uses of their large claws are not readily apparent, and have been debated in numerous studies, with hypotheses ranging from slashing and disemboweling prey, to pinning down small prey, and to aiding the animals in climbing.

In this study, the outlines of claws of extant birds, mammals, and reptiles whose lifestyles are known were examined using geometric morphometrics. The claws of extant species are compared to the claws of *Deinonychus antirrhopus* to test the hypothesis that the large second pedal (PII) unguals were used for climbing. A discriminant function analyses (DFA) was used to assign claws to one of four categories based on shape: scansorial, fossorial, raptor, and terrestrial generalist. Cross-validation on extant taxa showed that 77.62% of the claws could be assigned accurately. Accuracy was highest for the raptor category, followed by scansorial and fossorial categories.

One out of two PII claws of *Deinonychus* analyzed was categorized as scansorial and the other as a raptor. Four of the 9 non-specialized PIII and PIV claws analyzed were classified as terrestrial generalists and the rest as raptors. These results support the hypothesis that the specialized PII claws helped *Deinonychus* climb in certain situations, whilst maintaining an overall terrestrial mode of locomotion. The PII unguals of 4 smaller dromaeosaurids, such as *Microraptor* and *Rahonavis*, are all categorized as raptors. The similarities with raptor birds may be partly due to phylogenetic influences, as the two taxa are closely related.

Grant Information:
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Technical Session VI (Thursday, August 24, 2017, 9:15 AM)

BRAINCASE EVOLUTION IN DISSOROPHOIDEA

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Dissorophoidea is a clade of temnospondyl amphibians that first appear in the Late Carboniferous and persist today as lissamphibians. Dissorophoidea is divided into two groups, the Olsoniformes and Amphibamidae, the latter of which likely includes lissamphibians. The braincase morphology of lissamphibians and their extinct relatives in Dissorphoidea have long been thought to be representative of the ancestral tetrapod braincase morphology. Older research suggested that early tetrapods, as well as lissamphibians, had fewer elements in their braincases and that the evolution of amniotes involved the recruitment of additional elements. However, recent research has shown that this is not the case, and the lissamphibian braincase morphology may be the product of a complex series of transformations. Hindering research into this question has been the lack of a high-resolution phylogenetic analyses of Dissorophoidea that includes both taxonomically dense sampling and characters to document changes in the braincase. Thus, the goal of the present research is twofold: (1) produce a high-resolution phylogeny for Dissorophoidea and then (2) use this phylogeny to visualize braincase evolution in this clade. Our analysis includes 117 characters, including new braincase characters, and samples taxa generously from both Olsoniformes and Amphibamidae (47 taxa), including extant amphibians. Using our matrix, distinct olsoniform and amphibamid clades are recovered, where lissamphibians are nested within Amphibamidae. This high-resolution matrix allows us to study braincase evolution leading to the extant amphibian brain and shows a clear evolutionary trend towards reduction of the braincase in the lineage leading to extant amphibians. The reduction of the braincase is represented by one absence and three loss events. All Dissorophoidea lack a supraoccipital. Whereas olsoniforms have a basioccipital, this element has been lost in amphibamids. Lissamphibia, including extinct members, share the loss of the basisphenoid and the loss of hypoglossal nerve foramina. Previous studies have shown that the braincase is strongly constrained by early development and is therefore less variable than other regions of the cranium. Therefore, it is likely that these losses represent a single loss event each and suggests that the extant amphibian braincase is highly derived and not representative of the ancestral morphology for tetrapods.

Grant Information:
Ontario Graduate Scholarship awarded to JA.
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Technical Session VIII (Thursday, August 24, 2017, 3:00 PM)

NEW MIDDLE EOCENE OMOMYINES (PRIMATES, HAPLORHINI) FROM THE FRIARS FORMATION OF SAN DIEGO COUNTY, SOUTHERN CALIFORNIA

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The Middle Eocene strata of San Diego County are composed of mammal-bearing fluvial deposits interfingering with fossiliferous marine units. The mammalian fauna from these formations represents a Uintan assemblage and includes the omomyoid primates *Dyseolemur, Chumashius, Yaquius, Ourayia, Macrotarsius, Washaskius*, and *Stockia*. Here we describe three new genera of omomyine primates from the Friars Formation of San Diego County and analyze their phylogenetic position relative to other North American omomyoids. A sample of thirty-two teeth represent Taxon A. Taxon A is the smallest of the new omomyine taxa and has an estimated body mass of 119 g. This new genus is distinguished by discontinuous lingual cingulum and a waisted distal margin on the upper molars. Sixty-four specimens represent Taxon B. At 289 g estimated body mass, Taxon B is intermediate in size between the other 2 new genera. Taxon B has a distinctive upper fourth premolar with a mesio-buccally oriented protocone and upper molars with a strong, lingually continuous cingulum. A sample of thirty-nine teeth and mandibular fragments represent a third new genus, Taxon C. With an estimated body mass of 757 g, this large omomyine is similar in size to *Macrotarsius jepseni*. Nevertheless, Taxon C is distinct from other large omomyines in having a small p4 paraconid and large m2-m3 paraconids that are twinned with the metaconid. The results of phylogenetic analyses vary according to (1) the choice of character-taxon matrix and (2) the use of parsimony versus Bayesian tree building methods. Nevertheless, all preliminary phylogenetic analyses are congruent in recovering a close relationship between the three new San Diego taxa and the omomyines *Ourayia*, *Utahia*, and *Omomys*. Prior research has documented a shift in omomyoid diversity in North America from the anantomophine-rich Bridgerian to the omomyine-rich Uintan. Our description of three new Uintan omomyine taxa from the Friars Formation further emphasizes these opposite trends in anaptomorphine and omomyine species richness during the Middle Eocene. All three of the new taxa are currently only known from the Friars Formation in San Diego County, California. Four of the previously known genera from San Diego County (*Dyseolemur, Chumashius, Yaquius,* and *Stockia*) are endemic to Southern California, further highlighting the provincial character of primate faunas in Utah, Southern California, and West Texas during the Uintan.

Grant Information:
Atwater is a National Science Foundation Graduate Research Fellow.

Technical Session XII (Friday, August 25, 2017, 8:30 AM)

A NEW SPECIES OF *CONIASAURUS* (SQUAMATA:) FROM THE MIDDLE CENOMANIAN OF TEXAS (USA) AND REASSESSMENT OF THE COMPOSITION OF DOLICHOSAURIDAE

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We report here a new species of *Coniasaurus* from North America, on the basis of a remarkably complete specimen (DMNH-1601), housed at the Perot Museum of Nature and Science. Previously published accounts of *Coniasaurus* from Texas were largely based on isolated and fragmentary material and originally assigned to *Coniasaurus crassidens* due to shared characteristic dentition and vertebral morphology. The new specimen consists of an associated skeleton of a gravid individual including a partial skull, much of the vertebral column and some appendicular elements. Remains of multiple embryonic individuals represented by skull, vertebral and appendicular elements are also present. Comparisons of the holotype and referred specimens of both *C. crassidens* and *C. gracilodens* reveals DMNH-1601 is a distinct species supported by six unique characters: (1) laminae in neural arch separating zygosphenes only slightly notched or with no notch, and variably presenting a medial projection; (2) ventral surface of dorsal vertebrae straight in lateral view; (3) first sacral broader and shorter than the second; (4) sacrals fused; (5) well developed femoral articular head; (6) femoral distal epiphysis subtriangular, with distinct facets for tibia and fibula. Of the aforementioned, the sacral vertebrae and limb characters cannot be compared with the holotype specimens of *C. crassidens* and *C. gracilodens*. Nonetheless, DMNH-1601 shares three characters with both nominal species of *Coniasaurus* (heterodont dentition; anteriormost teeth conical and posteriormost swollen; tall neural arches on dorsal vertebrae) and three with *C. crassidens* exclusive of *C. gracilodens* (well developed lateral groove in the mid-to-posterior teeth; carinae forming a straight line, anterodorsally oriented; maxilla long and low). Additionally, DMNH-1601 shares five characters with *Dolichosaurus longicollis* (more than 30 dorsal vertebrae; pre- and post-zygapophyseal articulations of first cervicals nearly horizontal; greatly developed deltopectoral crest; ectepicondylar foramen absent; acetabular region of ilium reduced), and thus the character distribution may justify synonymy of *Dolichosaurus* and *Coniasaurus*, the latter having priority. The new material helps clarify internal relationships and patterns of diversity of dolichosaurids, and their biogeographic patterns, with four species of closely related dolichosaurids present in the Tethyan Biogeographic Province and the southern aperture of the Western Interior Seaway during the early Late Cretaceous.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

QUANTIFYING SHAPE VARIATION AMONG THEROPOD TEETH FROM THE UPPER CRETACEOUS (CENOMANIAN) MUSSENTUCHIT MEMBER OF THE CEDAR MOUNTAIN FORMATION, UTAH

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The Upper Cretaceous Mussentuchit Member (Cenomanian) of the Cedar Mountain Formation yields some of the earliest records of specialized coelurosaurian theropods bearing Asian affinities in North America. These taxa are key for understanding the continental origin, extirpation, and Laurasian dispersal of theropod dinosaurs. Yet, refining the temporal context of these events requires a comprehensively sampled record of taxonomic diversity, and well-preserved theropod skeletons of this interval are rare. Mussentuchit taxa known from diagnostic partial skeletons include the allosaurian *Siats*, a new genus of caenagnathoid, and at least two additional coelurosaurians. Gross morphological studies of isolated teeth suggest an expanded diversity of theropods, including Tyrannosauroidea, Dromaeosauridae, Troodontidae, and Avialae; however, to date, little work has been done to quantify theropod tooth morphodiversity in the Mussentuchit Member. Here we evaluate a sample of isolated theropod teeth (n=18) recovered from a variety of micro- and macrovertebrate localities, using principal components and discriminant functions analyses and multiple, independently derived taxonomically comprehensive databases of theropod tooth measurements.

An unexpectedly high proportion of sampled teeth (~35%) plot outside the morphospace generated in existing databases, thereby expanding the range of quantified global theropod tooth morphodiversity. We find evidence for probable paravian crowns including several plotting within "*Paranychodon*" (near Troodontidae) and a single "*Richardoestesia*"-type crown. Multiple, highly elongate, mesiodistally narrow crowns bearing abrupt apical recurvature, plot with *Nuthetes*, an enigmatic theropod potentially referable to dromaeosaurids or tyrannosauroids. Additional more compact morphotypes plot indistinctly among early diverging tyrannosaurs, neovenatorids, megalosaurs, and/or dromaeosaurs. We attribute much of the inability of existing databases to account for subtle shape variation and ambiguous taxonomic referrals to their reliance solely on a limited series of linear measurements. To better approximate crown shape we developed a protocol quantifying the entire crown perimeter and applying geodesic distance and Procrustes semilandmark coordinate analyses. Size, translation, and rotation of tooth shape were controlled by using Procrustes superimposition. These additional analyses offer a refinement for isolated crown identification.

Technical Session IX (Thursday, August 24, 2017, 2:15 PM)

NON-IRIDESCENT STRUCTURAL COLORS (NISC) IN BIRD PLUMAGE AND THEIR DETECTION IN THE FOSSIL RECORD

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Colors in bird plumage are either structural or pigmentary. Pigmentary colors are produced by absorption and reflection of light from pigment molecules. Structural colors are produced by scattering of light on nanostructural assemblages in bird plumage, and are classified as iridescent and non-iridescent. The color producing nanostructure in NISC is β-keratin and air-filled matrix (or a "spongy layer") of the feather barbs. Despite the fact that a spongy layer is responsible for color production in NISC, a layer of melanosomes placed underneath color producing structures has been observed. These melanosomes are not directly involved in color production as they absorb incoherently scattered light relative to the coherently scattered light produced by the overlying spongy layer. Without them, i.e. in amelanotic birds, the NISC is found to be washed out. It has been shown that fossil melanosomes in bird feathers are preserved as layers of spherical and cylindrical structures. Melanosomes vary in shape and have been correlated to some categories of colours. However, what types of melanosomes are involved in generating NISC and will there be overlap with other melanin based colors? To address the question on whether NISC can be detected in the fossil record, melanosomes from extant NISC colored feathers were extracted and their shapes determined. One-way ANOVA and Turkeys' post hoc test were used to compare them to other color categories. Results indicate a significant overlap with melanosomes from gray color, being very large and wide. While NISC appear to be relatively consistent in its morphology, gray category is becoming less distinct. Quadratic discriminant analysis was used to determine the ability to predict coloration from unknown melanosome samples and applied to a fossil member of the Coraciidae, *Eocoracias brachyptera* from the Messel pit in Germany. This fossil was chosen due to the high occurrence of NISC in the Coraciidae. The plumage color of *Eocoracias brachyptera* was predicted to be dominated by NISC as expected. To further illuminate categorization of melanosome shape, ancestral state reconstruction of plumage color for upupiform, alcediniform, and coraciiform birds was performed to discriminate between gray and NISC. In this analysis, *Eocoracias* was also predicted to have NISC colouration. Our study demonstrates that NISC is not conflated with most melanin based colors and has classificatory strength, which, at least in certain cases, allows for detecting NISC in the fossil record based on melanosome morphology alone.

Grant Information:
Frane Babarovic was funded by ERASMUS+ Internship Program as an Intern at the University of Bristol.

Technical Session XI (Friday, August 25, 2017, 8:00 AM)

EOCENE PACHYNOLOPHINAE (PERISSODACTYLA, PALAEOTHERIIDAE) FROM CHINA AND ITS PALEOBIOGEOGRAPHIC IMPLICATIONS

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The Eocene Palaeotheriidae was traditionally considered a nearly endemic European group within Equoidea in Europe, but a few palaeotheres have been reported from Asia. The Eocene palaeotheres known from China includes *Propalaeotherium sinense*, *Propachynolophus hengyangensis*, and *Qianohippus magicus*. Here I reanalyze a maxilla containing M1-3 from the Lunan Basin, Yunnan Province, China. This element was initially assigned to a new tapiromorph species, *Lophialetes yunnanensis*, but I reassign it to the otherwise European pachynolophin genus *Paranchilophus* based mainly on the absence of mesostyles, the strongly oblique metalophs, the strong developments of lophodonty, and the fact that M3 is longer than wide and has a large and buccally deflected metastyle. *P. yunnanensis* differs from European species of *Paranchilophus* in that the parastyles are situated mesial or even slightly lingual, rather than mesiobuccal, to the paracones. I further reanalyze *Qianohippus magicus* from the Shinao Basin of Guizhou Province, China, in which the complete dentition is known. *Qianohippus* was first described in 1982, but rarely mentioned by following studies. *Qianohippus* is characterized by a molariform P2 compared to non-molariform P3-4, a relatively high degree of lophodonty, the mesostyles absent, the protoloph of P3-M3 and the metaloph of upper molars with an angular bending at the paraconule and metaconule, respectively, and the weak twinned metaconid on the lower cheek teeth. The cladistic analysis supports the assignment of species *yunnanensis* in the genus *Paranchilophus*, and suggests the affinity of *Qianohippus* with some derived pachynolophs. The appearance of pachynolophin *P. yunnanensis* and *Qianohippus* in China further supports that there to have been a geographic connection between Europe and Asia in the Middle-Late Eocene, and the dispersal route was probably along the Tethyan shore in the south.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

FURTHER DESCRIPTION OF *APATEODUS BUSSENI*, A LIZARDFISH (TELEOSTEI, AULOPIFORMES) FROM THE LATE CRETACEOUS, SMOKY HILL MEMBER, NIOBRARA CHALK (EARLY CAMPANIAN), KANSAS, USA

BAIR, Mark A., Columbus State University, Columbus, GA, United States of America; NEWBREY, Michael G., Columbus State University, Columbus, GA, United States of America

Extinct lizardfishes, such as *Enchodus* and *Cimolichthys*, are popular among fish enthusiasts because of their impressive teeth and body size; however, much work is needed to unravel aulopiform evolution. While *Enchodus* and *Cimolichthys* are commonly recovered in Late Cretaceous fossil deposits, *Apateodus busseni* is known from a single partial skeleton from the Smoky Hill member of the Niobrara Chalk in western Kansas, and it represents the only species of a traditionally European genus of aulopiform to be found within North America. The skeleton of *A. busseni* consists of a neurocranium preserved with the ventral side exposed, partial vertebral column, partial operculum, left dentary, and both left and right ectopterygoids and dermopalatines. Since the initial description of the type specimen, further preparation has revealed additional characters that are not present in either *A. striatus* or *A. glyphodus*. The neurocranium, in ventral view, is triangular in shape, with the widest part of the skull located at the posterior margin of the pterotics. The pterotics are small and very shallow in profile. The facet of the dorsal arm of the posttemporal extends directly posterior from the epiotic and beyond the posterior margins of either the epiotic or pterotic. The sphenotics are tapered and subtriangular, with robust spines oriented posteriorly. The dentary is laterally thin, and the lateral face of the dentary is deep and flat. The teeth of the dermopalatine and ectopterygoid are gracile, shorter, and more numerous. The mesocoracoid concavity is deeply excavated, but constricted. The fossae of the second vertebral centrum are long and narrow. The unique morphology of *A. busseni* suggests a generic affinity that differs from that of *Apateodus*, and alludes to greater morphological and ecological diversity in Late Cretaceous, North American aulopiforms.

Technical Session V (Wednesday, August 23, 2017, 2:30 PM)

MARINE INFLUENCE AS A HIDDEN DRIVER OF PALEOBIODIVERSITY: AN EXAMPLE FROM THE LATEST CRETACEOUS (66 MA) OF SOUTHWEST SASKATCHEWAN, CANADA

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Marine environments are generally readily identifiable in the geological record. However, marine influences on terrestrial ecosystems can be more difficult to detect, especially in cases where such influences are not expected. The Frenchman Formation of southwest Saskatchewan, Canada represents the last half-million years of the Maastrichtian ('Lancian') period, and is coeval with the Hell Creek Formation in the United States. During this time, the Western Interior Sea is conventionally thought to have permanently receded from the region, as the Frenchman Fm lacks definitive marine deposits (e.g. shale), taxa (e.g. marine reptiles) or ichnofossils.

In our broad study of pre-extinction paleobiodiversity within the Frenchman Fm, four independent lines of evidence were discovered to suggest an increasing marine influence towards the K-Pg Boundary, challenging this conventional view. Firstly, the proportional representation of 'coastal taxa' (as defined in biodiversity publications from the Dinosaur Park Formation, Alberta) within the study's 42 microvertebrate sites increases up-section towards the K-Pg Boundary. In the Frenchman Fm's uppermost lithostratigraphic units, coastal taxa make up 70-100% of the occurrence-based taxonomic diversity. Secondly, we discovered an independent turnover in fossil turtle diversity within the formation, with inland taxa being replaced by more salt-tolerant taxa over time. Thirdly, the occurrence of waterlogged paleosols (gleysols), often associated with transgression events, increases towards the K-Pg Boundary. Finally, in the uppermost Hell Creek Fm, there is a small marine transgression known as the Cantapeta Advance documented in North Dakota. As this interfingered marine unit is found less than 600 km from the coeval Frenchman Fm exposures, it is possible that this transgression reached Saskatchewan just prior to the end-Cretaceous mass extinction.

This study demonstrates that marine influences can be important drivers of paleobiodiversity. Not only do small-scale marine transgressions introduce brackish or salt-tolerant taxa into a region, they also affect the habitat heterogeneity, local weather patterns and drainage. When considering pre-extinction biodiversity patterns, it is critical to consider these local and regional drivers alongside larger, global factors such as mass volcanism and climate change. Though often more difficult to document in the fossil record, these smaller-scale drivers may have the greatest influence on a paleoecosystem.

Technical Session XVI (Saturday, August 26, 2017, 9:30 AM)

CONSTRUCTING THE COLOSSUS: NEW TITANOSAUR MATERIAL FROM NEW MEXICO REVEALS NOVEL MECHANISMS FOR ACCOMMODATING GIGANTISM AND NECK ELEVATION

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The giant size and elongate necks of large sauropod dinosaurs presented unique mechanical challenges. A recently discovered titanosaur specimen from New Mexico (LACM 7948) contains undistorted cervical vertebrae, in articulation, along with well preserved ossified tendons. The ossified tendons are up to 1.8 meters in length, and each overlap three vertebrae. LACM 7948 also preserves internal structures of the cervical centra. The excellent preservation of these features in LACM 7948 provides new insights into the mechanics and proportions of titanosaur neck anatomy. We applied two types of functional analysis to the neck of LACM 7948: spring modeling and optimal lattice modeling. Our spring model of ossified tendon function in sauropods posits that the ossified hypaxial tendons acted as leaf springs and reduced the cost of an elevated neck by dampening oscillatory neck motions and simultaneously assisting with pressure maintenance in the vertebral arteries. We used a standard equation from mechanical engineering that relates the elastic modulus, characteristic length, applied force, and shape of a non-uniform leaf spring to its deflection and maximum stress. For the lattice optimization, we modeled the optimal spacing of the cross-braces within the cervical centra, given their measured thickness. We used literature values of avian ossified tendon elastic modulus to model the ossified cervical tendons in LACM 7948. We used avian bone density values (measured using quantitative CT imaging) to model the material properties of the pneumatic lattice in LACM 7948. Scaling against prior mass estimates of Alamosaurus, we estimated a total mass for LACM 7948 of 40 tons. At a neck elevation angle of 35 degrees we found that the ossified cervical tendons would be able to effectively dampen the majority of the expected neck oscillations during locomotion. Combined with ligamentous support, the cervical musculature would have to exert only a small fraction (10-15%) of its estimated available power to stabilize an elevated neck. We found that the internal bracing of the centra in LACM 7948 were not fully optimized, but the bracing did approximate the predicted mechanical optima. Our results indicate that the passive mechanical support mechanisms in the neck of LACM 7948 were highly scalable. Mechanical property changes in the cortical bone and cervical tendons could

significantly improve the passive support of the neck, which suggests that mineralization changes would be viable mechanisms for improved passive support in larger sauropods.
Grant Information:
Gretchen Augustyn and family provide funding for the LACM New Mexico expeditions

Technical Session XVI (Saturday, August 26, 2017, 8:00 AM)

A NOVEL HYPOTHESIS OF DINOSAUR INTERRELATIONSHIPS

BARON, Matthew G., University of Cambridge, Cambridge, United Kingdom

For nearly 130 years dinosaurs have been divided into two distinct clades - Ornithischia and Saurischia. Since the advent of modern phylogenetic methods and the revival of the hypothesis of dinosaur monophyly, this fundamental scheme of classification has been supported by the majority of studies of dinosaur origins and early evolution. However, many of these studies have been limited to include only a handful of the relevant taxa and incorporate numerous *a priori* assumptions regarding the relationships between taxonomic groups; no studies on early dinosaurs include an adequate sample of early ornithischians and the majority also exclude pivotal taxa from other major dinosaur and dinosauromorph lineages. In order to address this, this study has undertaken a novel phylogenetic analysis of basal Dinosauria, compiling the largest and most comprehensive dataset of these taxa ever assembled; 74 taxa scored for 457 characters. This study has drawn upon previous studies but has made no prior assumptions about correlated patterns of character evolution or dinosaur interrelationships. Parsimony analyses were carried out using TNT and recovered a novel tree topology that challenges the consensus concerning dinosaur interrelationships and necessitates fundamental reassessment of early dinosaur evolution, paleoecology, and paleobiology. These results also highlight problematic aspects of current cladistic definitions and require rediagnosis of Dinosauria and the subsidiary dinosaurian clades. This study recovers, for the first time, a sister-group relationship between Ornithischia and Theropoda (named Ornithoscelida), with Sauropodomorpha + Herrerasauridae forming its monophyletic outgroup. This topology suggests the independent acquisition of hypercarnivory in herrerasaurids and theropods, and offers an explanation for many of the anatomical features previously regarded as striking convergences between theropods and early ornithischians. More fundamental to this is the implication that the timing and geographic setting of dinosaur evolution may require reappraisal as some northern hemisphere taxa are recovered close to the base of the dinosaur tree. Additionally, this new hypothesis also raises numerous questions about the ancestral dinosaur bauplan, the sequence of evolution of anatomical features within the clade (e.g. fathers), and the timing of many of the radiations that occurred during the rise in prominence of these important and iconic animals.
Grant Information:
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Technical Session XIX (Saturday, August 26, 2017, 1:45 PM)

NEW INFORMATION ON THE UPPER KAROO VERTEBRATE FAUNAS OF THE LAKE KARIBA REGION, ZIMBABWE

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Southern Africa provides one of the best windows on the composition and evolution of terrestrial tetrapod faunas during the Late Triassic–Early Jurassic. The majority of fossil sites are known currently from the Elliot and Clarens formations of South Africa and Lesotho: localities in adjacent countries have been less thoroughly explored. Early Jurassic sites in Zimbabwe have yielded a variety of important material, including specimens of early theropods, the basal sauropodomorph *Massospondylus*, and the early-branching sauropod *Vulcanodon*. Late Triassic localities are more rare, less productive, and have generally yielded fragmentary material. Fieldwork conducted by a joint South African-Zimbabwean-UK team in early 2017 explored the upper Karoo-aged deposits that crop out along the shores of Lake Kariba, northern Zimbabwe (Mid-Zambesi Basin), and provided new information on the stratigraphy, sedimentology, and paleontology of this region. Re-assessment of the *Vulcanodon* type locality showed that contrary to previous reports this site pre-dates the onset of Drakensburg volcanism (referred to locally as the Batoka Basalt) and is located within the Lower Jurassic Forest Sandstone Formation, indicating that this taxon is at least 10 million years older than previously appreciated. In addition, exploration of nearby islands and the mainland shore revealed numerous previously undocumented sites in the Pebbly Arkose unit (part of the Tashinga Formation: Late Triassic), as well as the Forest Sandstone Formation, which all provide evidence of terrestrial and freshwater aquatic vertebrate faunas. Sauropodomorph dinosaurs are found at many sites in both the Forest Sandstone and upper Tashinga formations. A distinctive grey mudstone facies in the Pebbly Arkose yields lungfish, indeterminate carnivorous archosaurs, and phytosaurs, but sauropodomorphs seem to be absent. The phytosaur is represented by craniodental material and osteoderms and is the first occurrence of this clade on the African mainland south of the Sahara. The presence of abundant phytosaur and lungfish specimens, as well as sedimentological evidence, indicates that both the Late Triassic and Early Jurassic sites were deposited in more mesic environments than their lateral equivalents in South Africa and elsewhere in Zimbabwe, but this observation conflicts with assessments based on General Circulation Models of global climate.
Grant Information:
NRF AOP Grant, NRF CPRR Grant, DST/NRF CoE Operational Support Grant, Palaeontological Scientific Trust (PAST) Grant: all to JNC
NHM Earth Sciences DIF Grant: PMB

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

FIRST REPORTED OCCURRENCE OF *LEPTOCYON* FROM THE MIOCENE OF OREGON

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The Hemingfordian has fewer Pacific Northwest localities than any other Neogene North American Land Mammal Age. Fortunately, new finds in central Oregon are contributing significantly to our understanding of the ecology of the middle Miocene. Both Hawk Rim, and the stratigraphically associated new site the present material comes from, have yielded a diverse, though puzzling carnivore-rich, assemblage of mammalian material. Hawk Rim carnivorans include the following taxa: one felid, one amphicyonid, three borophagines, and one mustelid. The present material, a partial dentary containing p4-m1, identified as *Leptocyon leidyi* adds a canine to the faunal list. This is the first occurrence of *Leptocyon*, or any canine, in the Miocene of Oregon. Before this specimen, the fossil record indicated the extirpation of the Caninae from the Pacific Northwest following the medial Arikareean, and not repopulating the region until the late Clarendonian. With this specimen, it is suggestive that canines lingered long after the Arikareean in the Pacific Northwest and were simply unsampled.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

PATTERNS OF EXTIRPATION PRIOR TO THE LAST GLACIAL MAXIMUM IN ALBERTA, CANADA

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Throughout much of the Pleistocene regions of western Canada acted as a passageway between Beringia and unglaciated areas of the North American mid-continent. Geological and paleontological evidence indicates that during the Last Glacial Maximum (LGM; ca. 24,000 to 18,000 calendar-equivalent years before present [cal yrs BP]), the Laurentide and Cordilleran ice sheets coalesced over much of western Canada, effectively closing that passageway and resulting in the complete eradication of animal and plant populations over the glaciated area. Exactly how individual species and populations in this region responded to environmental changes leading up to the LGM is currently unclear. In this study, we used new and previously published radiocarbon data to provide insights into the timing of pre-LGM animal and plant extirpation in Alberta. Using Bayesian modelling techniques, as implemented in the software OxCal 4.3, we estimated timing of pre-LGM extirpation using radiocarbon data for six mammalian taxa (*Equus* sp., *Bison* sp., *Mammuthus* sp., *Mammut americanum*, *Megalonyx jeffersonii*, and *Cynomys niobrarius churcherii*; n=27) and one genus of coniferous evergreen (*Picea* sp.; n=4). Although the sample size for some taxa is low, our results indicate that *Mammut americanum*, *Megalonyx jeffersonii*, and *Picea* sp. probably disappeared from Alberta approximately 42,200 to 35,200 cal yrs BP, prior the onset of the LGM. The apparently concurrent disappearance of these species agrees with previous interpretations of *Mammut americanum* and *Megalonyx jeffersonii* as animals that preferred habitats with a fair amount of tree cover. Moreover, the disappearance of *Mammut americanum* well before the LGM is comparable to patterns observed in Beringia. These lines of evidence suggest that Alberta experienced an environmental shift to more open habitats prior to the coalescence of the ice sheets. The results for the remaining species suggest that they survived to a time between 27,700 and 24,100 cal yrs BP. An additional analysis combining the radiocarbon data of all seven taxa as well as data for five specimens identified as Proboscidea indeterminate (n=36) provides a more precise estimate for the timing of animal and plant extirpation prior to the LGM, yielding a median date of 25,969 cal yrs BP. After this time there is a hiatus in the fossil record of Alberta, which is interpreted to indicate either the presence of continental ice sheets or a landscape rendered uninhabitable due to the proximity of ice.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

ONTOGENETIC CHANGES IN THE OSTEOHISTOLOGY OF *HAYA GRIVA*, A BASAL NEORNITHISCHIAN DINOSAUR FROM THE UPPER CRETACEOUS JAVKHLANT FORMATION OF MONGOLIA

BARTA, Daniel E., American Museum of Natural History, New York, NY, United States of America; NORELL, Mark A., American Museum of Natural History, New York, NY, United States of America

Growth patterns in long bone histology are well documented for basal neornithischian and ornithopod dinosaurs ("hypsilophodontids") owing to the availability of partial ontogenetic series for many taxa. Despite this, histological analysis reveals that skeletally mature individuals of these animals are rare, often leaving morphology and body size at somatic maturity undetermined. The basal neornithischian dinosaur *Haya griva* is known from dozens of specimens, including a partial growth series, from the Upper Cretaceous Javkhlant Formation of southeastern Mongolia. Given the wide size range of *Haya griva* femora in the collection, we examined bone microstructure to ascertain whether any of the individuals had reached somatic maturity. This study represents the second histological report on an Asian basal neornithischian dinosaur, expanding the global comparative histological dataset for these animals, which primarily comprises North American and pan-Gondwanan taxa. These data also inform our work on morphological variation and the systematics of *Haya* by placing the morphology of the specimens in an ontogenetic context.

To investigate the maturity of individual specimens, we sampled three femora, representing the longest (162 mm) and shortest (~64 mm) presently available, as well as one intermediate in length (129 mm). Transverse sections of the bones were embedded in epoxy, mounted on glass slides, and ground and polished until transparent. Microscopy reveals predominantly parallel-fibered bone and longitudinal vascularization in the smaller two femora, and fibrolamellar bone and longitudinal and reticular vascularization in the largest. Overall, these bone tissue types are similar to those of other small-bodied dinosaurs. The smallest femur lacks growth lines (lines of arrested growth and annuli). Growth lines are difficult to discern in the medium-sized femur because of poor preservation. The largest femur contains at least four growth lines, but lacks an external fundamental system, indicating it had not slowed growth asymptotically at the time of

death. The shift from slower to faster-growing tissue types between the smaller and largest individuals provides further evidence that the largest was actively growing until its death. Body masses estimated from the femoral circumferences of the sectioned individuals are 0.95, 11, and 30 kg. We conclude that, as for closely related taxa, all *Haya griva* specimens discovered so far are probably skeletally immature and that the upper limit of body size for this taxon remains unknown.
Grant Information:
Richard Gilder Graduate School Fellowship, American Museum of Natural History Division of Paleontology, Macaulay Family Endowment

Technical Session III (Wednesday, August 23, 2017, 2:45 PM)

RELATING ECOLOGY TO STERNUM MORPHOLOGY IN "WATER BIRDS"
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The sternum anchors the major flight muscles in birds yet remains poorly studied from a comparative perspective. Sternum morphology varies greatly in shape and relative size among birds. Previous studies show that keel shape and size are strongly correlated with flight muscle mass and mechanical advantage. Disparity in sternum morphology, thus, may hold clues to differences in flight mechanics and to extrapolating those results to extinct taxa. Here I examine the sterna of "water birds" using two-dimensional geometric morphometrics on the ventral and lateral surfaces with both homologous landmarks and semi-landmarks. The resulting phylomorphospaces reveal several instances of convergence, and Pagel's lamba is highly significant, indicating a strong phylogenetic signal. PC1 of the lateral view represents the size of the keel and the portion of the sternum length that the keel covers, and PC2 represents the degree to which the keel is anteriorly inclined. PC1 of the ventral view represents length of the sternum and PC2 represents the width of the sternum and how far the keel projects anteriorly. The presence or absence of additional trabeculae in the posterior region of the sternum generated a significant amount of diversity but required simplification to avoid overrepresentation in this analysis.
Plotting foraging behavior onto the phylomorphospaces reveals regions of shape space in which certain groups inhabit and others do not. Surface divers generally have a distinct keel and sternum morphology from the rest of the "water bird" clade, and fall on the opposite side of shape space as birds that spend much of their time foraging on the ground or at the water's edge. Aerial divers tend to have a short, wide sternum in contrast to the long, narrow sternum of shorebirds. These results combined with wing morphometric studies suggest that sternum morphology should be taken into account and analyzed with wing shape to more fully test coevolution, convergence, and disparity of functional adaptations in the forelimb and pectoral girdle for flight.
Grant Information:
U.S. Dept. of Education's Integrative Neuromechanics GAANN (P200A150077)

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A LARGE *SQUALICORAX* (CHONDRICHTHYES: LAMNIFORMES) FROM THE LATE CRETACEOUS OF SWEDEN AND THE ASSOCIATION OF SHARKS AND MOSASAURS
BAZZI, Mohamad, Uppsala University, Uppsala, Sweden; EINARSSON, Elisabeth, Lund University, Lund, Sweden; NEWBREY, Michael, Columbus State University, Columbus, GA, United States of America; CAMPIONE, Nicolas E., Uppsala University, Uppsala, Sweden; KEAR, Benjamin P., Uppsala University, Uppsala, Sweden; SIVERSSON, Mikael, Western Australian Museum, Welshpool, Australia
Reconstructing trophic dynamics in the fossil record is fundamental for understanding the structure of past ecosystems and interpreting evolutionary ecology in deep time. Among marine apex predators, hypotheses of competitive exclusion and niche partitioning are particularly difficult to test and generally addressed on qualitative grounds. Sharks and marine amniotes (e.g., mosasaurs) are both common during the Late Cretaceous and are often penecontemporaneous. Evidence for predatory/scavenging interactions between the two groups is sparse, but evidenced through bite-marks and the occasional preserved gut-contents in both groups. The traditional view of Late Cretaceous trophic marine dynamics asserts that mosasaurs were the dominant apex-predators. Yet, the ecological, taxic, and morphological diversity of sharks is suggestive of non-competitive exclusion caused by marine amniotes. Here we describe vertebral shark remains collected from the informal *B. mammillatus* Zone (latest early Campanian) Ignaberga Quarry, Kristianstad Basin, southern Sweden, and contextualize its ecological significance.
A total of 10 articulated, surface-eroded centra are identified as pertaining to one selachian individual of *Squalicorax lindstromi* (Lamniformes, Anacoracidae). The diagnosis is based on the presence of numerous concentric lamellae of consistent thickness, and a thick corpus calcareum with broad concentric ridges adjacent to prominent radial canals. In addition, these centra are found in the same formation as a monotypic anacoracid assemblage of >1,000 isolated teeth of *S. lindstromi*. Based on their sheer size, depth of the amphicoelous cones, shape of the centra, and relative thickness of the corpus calcareum, these centra are from the abdominal region. The maximum diameter of the least distorted centrum is 8 cm. Using a small data set of *Squalicorax* (n=9), a least squares linear regression between maximum centrum diameter and total length (R^2=0.99) suggests a total body length estimate of 381 cm for the specimen. The current analysis does not allow us to comment on potential predator-predator interactions but our size estimate affirms the presence of a large-bodied shark and alludes, at the very least, to a sympatric coexistence with marine amniotes (e.g., *Tylosaurus ivoensis*) known from the basin. Future investigations of trophic dynamics between marine predators should incorporate the quantification of ecologically-relevant anatomy (such as body size and dental morphology).

Technical Session XV (Friday, August 25, 2017, 3:30 PM)

THE IMPACT OF INCORPORATING TEMPORAL INFORMATION INTO PHYLOGENETIC ANALYSES: RESOLVING THE EVOLUTIONARY AFFINITIES OF "SPARASSOCYNIDS" (DIDELPHIMORPHIA; MARSUPIALIA)
BECK, Robin M., Salford, United Kingdom; TAGLIORETTI, Matias L., Museo Municipal De Ciencias Naturales Lorenzo Scaglia, Mar del Plata, Argentina
Sparassocynids are small (<0.5kg), carnivorously-adapted marsupials known from Miocene and Pliocene of South America. They have long been thought to be related to modern opossums (Didelphidae), within the order Didelphimorphia, but this proposal has never been adequately tested. An exquisitely preserved, undescribed skull of a juvenile *Sparasssocynus derivatus* from the Pliocene Chapadmal Formation provides new data on sparassocynid morphology, notably the deciduous dentition and palate, and confirms that the auditory region of sparassocynids is highly derived. This and other *Sparassocynus* specimens demonstrate that the interparietal and supraoccipital had fused prior to adulthood, which is a distinctive feature of didelphids, and that the maxilla and alisphenoid are in contact, which occurs in the didelphids *Lutreolina*, *Monodelphis* and *Thylatheridium*, but among marsupials is otherwise known only in some Australian diprotodontians. This raises the possibility that "sparassocynids" fall within Didelphidae. Undated Bayesian analysis of a total evidence matrix comprising 132 craniodental characters and 7.3 kb of DNA sequence data from five nuclear genes places "sparassocynids" in a surprising position, namely within the modern didelphid genus *Monodelphis*, at the end of a very long branch that reflects their numerous apomorphies. However, repeating the analysis using a total evidence dating approach that implements an Independent Gamma Rates (IGR) clock model and that incorporates temporal information (tip ages and constraints on the ages of selected nodes) places "sparassocynids" in a more plausible position, as sister to *Monodelphis*, but still within Didelphidae. The resultant divergence dates within Didelphidae are broadly congruent with recent molecular clock studies. This study demonstrates that temporal information can have a major impact on phylogenetic topology, by favouring phylogenies that are optimal not just with respect to character data, but also to distribution in time.
Grant Information:
This research was partially supported by a Santander Universities Travel Award

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

EXPLORATION OF INTERSPECIFIC VARIATION IN *PAROCNUS* (MAMMALIA: PILOSA: MEGALONYCHIDAE) FROM HISPANIOLA: PRELIMINARY IMPLICATIONS FOR TAXONOMIC REVISION AND DIVERSITY
BEERY, Sophia M., Ohio Northern University, Ada, OH, United States of America; MCAFEE, Robert K., GA campus - Philadelphia College of Osteopathic Medicine, Suwanee, GA, United States of America
Radiation of fossil sloths across the Antillean islands is a major and unique event in sloth paleohistory, which is further distinguished as being colonized by member of just one sloth family: Megalonychidae. The group is best represented by fossils recovered from Pleistocene cave deposits within the Greater Antilles (Cuba, Hispaniola, Puerto Rico), with the most numerous collections coming from Hispaniola, although newer Dominican Republic (DR) specimens are not yet published. Much of the DR material is assignable to *Parocnus*, which previously has been poorly represented or documented across the island. The excess of *Parocnus* specimens enables a more thorough review of the genus on Hispaniola and to explore intraspecific variation trends within the island habitat. Although collected in what is geographically considered to be DR, specimens hail from two paleogeographic regions (Southern and Central Hispaniola) that were separated by a small seaway. An unaccounted barrier may also have separated Central Hispaniola into western and eastern portions. *Parocnus* is much more abundant in Central Hispaniola (DR) and is commonly found in association with *Acratocnus ye*. While not numerous in Haitian sites (Southern and western Central Hispaniola), there is sufficient *Parocnus* material to demonstrate size differences in the limb bones between the two divisions of the island with "Haiti" specimens being somewhat larger than those from "DR." This disparity is somewhat muddled by recent discoveries of an even larger *Parocnus* morph from two separate Dominican localities, which also have smaller sized specimens of *Parocnus*. No drastic size morphs have been found in "Haiti" specimens but there is a trend for long and short forms in the limb elements; a similar occurrence is also documented for other Greater Antillean sloth taxa. This lesser variation in specimen size is thought to reflect sexual dimorphism, especially as the pattern is seen also in "Dominican" sloths. It yet remains unclear if all three size morphs for *Parocnus* are synonymous as *P. serus*, or if they represent a potential geographic subspecies or novel species altogether. The occurrence of two drastic morphs from Central Hispaniola of DR provides an argument toward the existence for new, unnamed species of *Parocnus*, with *P. serus* likely being representative of the "Haiti" forms. As radiometric dates have not yet been obtained for DR material, temporal variation cannot be ruled out and so further or more definitive taxonomic assignments are restrained until any temporal issues are resolved.

Technical Session IX (Thursday, August 24, 2017, 3:30 PM)

THE TYRANNY OF TRANSPORT IN TAPHONOMY – HOW FAR DO BONES REALLY MOVE AND HOW MUCH DOES IT MATTER?
BEHRENSMEYER, Anna K., Smithsonian Institution, Washington, DC, United States of America; ROGERS, Raymond R., Macalester College, St Paul, MN, United States of America
It is widely accepted that remains found together in vertebrate fossil assemblages do not necessarily represent animals that lived together. It is also commonly assumed that spatial averaging by fluvial or other processes is the cause, mixing together bones from multiple, potentially distant sources and resulting in an ecologically biased assemblage. We challenge the assumption that bone transport is a serious source of taphonomic bias as the "tyranny of transport." The publications of Shotwell in the 1950's, Voorhies in the 1960's, and subsequent studies convinced generations of paleontologists that bone

transport was a problem, limiting the ecological fidelity of taxa found together as fossils. While this helped to promote necessary caution in reconstructing paleocommunities, we advocate reconsidering this assumption because 1) decades of research on both modern and fossil assemblages has provided few examples showing transport as a major source of bias, and 2) transport is too often invoked as a "default" to explain discrepancies in faunal associations or damage characteristics of the fossils themselves (e.g., abrasion, breakage), when other explanations may be more realistic and more interesting. Modern analogue studies indicate that fluvial processes typically disperse rather than concentrate bones, suggesting that other causes (including biological agents and circumstances) are more important in forming fossil concentrations. Actualistic studies also indicate that criteria used to invoke long distances of transport, such as size and shape sorting, rounding, and abrasion, are not proportional to distance traveled. Although many preserved bones and carcasses undoubtedly were moved by water, scavengers, or other processes prior to final burial, in most cases the distances involved were likely minimal. Even if transported over larger distances (e.g., 100's of meters to kilometers), this probably would not exceed the ecological ranges of larger taxa. Small vertebrate remains would be more likely to experience out-of-habitat transport by water, but would not remain together unless burial is rapid and close to the initial concentration (e.g., scats or pellets). Time-averaging is likely to be a more significant source of bias than spatial averaging for many fossil vertebrate assemblages, but this too should be rigorously tested rather than tacitly assumed as a general bias that compromises the quality of the vertebrate fossil record.

Technical Session XVI (Saturday, August 26, 2017, 10:45 AM)

NEW ORNITHOPODS (DINOSAURIA) FROM THE LOWER CRETACEOUS GRIMAN CREEK FORMATION (ALBIAN) AT LIGHTNING RIDGE, NSW, AUSTRALIA

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Small, bipedal neornithischian dinosaurs ('hypsilophodontids' or 'basal ornithopods') are typically rare in most Cretaceous deposits, globally. In contrast, the Aptian–Albian aged deposits of south-eastern Australia have yielded an unusual preponderance of these enigmatic animals. Here we describe new cranial material from the Griman Creek Formation where it crops out near the town of Lightning Ridge in central northern New South Wales (NSW). The mostly isolated material includes at least two small-bodied (<2 m) taxa that differ in tooth form and jaw proportions from the penecontemporaneous *Atlascopcosaurus, Leallynasaura,* and *Qantassaurus* from Victoria. This record is supplemented by the partial skeleton of a new iguanodontian, which includes the first cranial material from NSW assignable to that clade. A preliminary phylogenetic analysis recovers the new iguanodontian as more derived than Rhabdodontidae and forming a polytomy with *Tenontosaurus* and *Muttaburrasaurus*+Dryomorpha. These findings confirm the presence of a flourishing ornithopod fauna at high southern palaeolatitudes (>60°S) during the Early Cretaceous.

Grant Information:
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Technical Session XVIII (Saturday, August 26, 2017, 11:45 AM)

EVIDENCE FOR ENDOTHERMY IN BASAL THERAPSIDA REVEALED BY SYNCHROTRON SCANNING

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Evolution of endothermy is difficult to reconstruct in the ancestry of mammals as it is mostly an attribute of the non-fossilizable anatomy. The presence of respiratory turbinates (RT) constitutes a benchmark to infer a sustained respiratory rate and thus an elevated metabolism in extinct species. Here we report and analyze the discovery, using synchrotron scanning, of RT in two representatives of the basal-most group of non-mammalian therapsids, the biarmosuchians. These taxa are from the late Permian of the South African Karoo, and thus represent the earliest occurrence of RT in the fossil record. The morphology of biarmosuchians RT is simple, without scrolls, but their surface area is comparable to that in mammals and birds. This strongly suggests that early therapsids were already able to sustain relatively high respiratory and metabolic rates in the late Permian, more than 260 million years ago, and that endothermy evolved at least 60 million years prior to the origin of Mammaliaformes.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

AN ENIGMATIC LINEAGE OF CHINESE HIPPARION, *BARYHIPPARION*

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The genus *Baryhipparion* is known only from areas around China. Thusfar, two species have been attributed to this genus, *Baryhipparion insperatum* and *Baryhipparion tchikoicum*. These *Baryhipparion* species originate from Shanxi Province, Inner Mongolia, China and Mongolia and are in the age from latest Miocene to Pliocene (ca. 6~3 Ma). Herein we report on a new skull of hipparion genus *Baryhipparion*. The skull has very large size, elongated snout and palatine part, shallow nasal notch, strong preorbital fossa, very weak cheek tooth plications and simple, single pli caballin on cheek teeth. The two recognized species of *Baryhipparion* are significantly different from the new material in body size, skull and tooth characters. Moreover the new material exhibits unique characters for this clade, including the smaller size, relatively small and preorbital fossa and elongated protocone with margins rounded buccally and flat lingually, This morphological complex is believed to represent the basal type of *Baryhipparion*. Two American species, *Hipparion shirleyi* and *Hipparion tehonense* exhibit these primitive features. However, the oldest Old World hipparions from the Pannonian C of the Vienna Basin (ca. 11.4-11.0 Ma) also retain similarly primitive cheek tooth characters. Present evidence suggests that *Baryhipparion* became isolated in China following the "Hipparion Datum" and evolved there in isolation from the rest of the Old World. In addition to *B. tchikoicum* and *B. insperatum* we believe that this new material may represent a new third species of *Baryhipparion*.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE MUMMY RETURNS: "LAURA", AN EXCEPTIONALLY PRESERVED HADROSAURID MUMMY FROM MONTANA (USA), WITH REMARKS ON THE FOSSILIZED INTEGUMENT

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The hadrosaurid fossil record ranges from isolated material to mostly complete skeletons, along with a rich record of fossilized integument. Recently, skin has been used as a proxy to distinguish different species of duck-billed dinosaurs, which study is becoming of primary importance to understand hadrosaur diversity. Here, we present new information on a hitherto undescribed hadrosaur skeleton found in 2001. The specimen was nicknamed "Laura", and it shows a large area of preserved skin. It was discovered in central Montana (Late Campanian, Judith River Formation), 36 km north of the City of Winifred, about 9 km north from Stafford Ferry, during works for a new country road. The specimen was excavated in the summer of 2001, and prepared between 2010 and 2011 in Italy by an Italian private firm, but remained unstudied until now. First, we photographed, measured, and documented the skeletal anatomy, providing a list of the original material preserved in the specimen. The specimen is missing the right scapula, both coracoids, the left humerus, radii and ulnae, the right pubis, the right tibia and fibula, and several elements of ribs, chevrons, hands, and feet. The skull is mostly reconstructed, as well as some cervical, dorsal and caudal vertebrae. Then, we also drilled a core in the midshaft of the left tibia, and a cross-section was taken from a mid-dorsal rib, to assess the ontogenetic stage of the specimen. Our first analysis indicates the specimen was on old individual. No growth marks could be observed due to heavy remodeling in both samples. The most important feature of "Laura" is the extended surfaces of fossilized skin, which cover the rib cage, the pelvic region and the proximal caudal vertebrae. Between the ribs, the integument is composed of small and homogeneous pebbly scales. The ventral side of the pelvis and the tail is characterized by a uniform covering of hexagonal basement-scales averaging 5 mm in diameter and devoid of patterns or other features. On the lateral side of the proximal caudal vertebrae, however, the scales are reduced in size, and some rosette-like patterns are visible. We did not find any feature scales in the specimen.

Grant Information:
OZR 1-year Mandate of the VUB

Technical Session XX (Saturday, August 26, 2017, 2:15 PM)

VIRTUAL ENDOCASTS OF EARLY APLODONTOIDEA AND SCIURIDAE: BRAIN EVOLUTION AND LOCOMOTION

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Extant Sciuridae are diverse in term of taxonomy and ecology, unlike their closest relative the mountain beaver (*Aplodontia rufa*), which is the only extant species included in Aplodontoidea. The fossil record indicates that this group displayed more taxonomic and ecological diversity in the past. Previous studies suggest that the burrowing adaptations of Aplodontia might be derived and that basal members may have been more generalized in skeletal anatomy and locomotion, similar to modern squirrels. This evolution towards greater specialization for fossoriality has never been studied from the perspective of brain size and morphology. We describe the first virtual endocasts of a modern mountain beaver and of three fossil aplodontoids *Prosciurus relictus* and *Pr. aff. saskatchewaensis* (Early Oligocene), and *Mesogaulus paniensis* (late Miocene).

Our results show that the endocast of early aplodontoid rodents was more similar to early arboreal squirrels such as *Protosciurus*, and *Cedromus* than to the later occurring aplodontoids *Mesogaulus* and *Aplodontia*. In particular, the earlier taxa share with sciurids larger paraflocculi and a more ventrally positioned orbitotemporal canal, associated with a larger neocortex. They are also similar in having higher EQs (*Prosciurus* = 0.99; *Protosciurus* = 0.96; *Cedromus* = 0.92) than younger aplodontoids (*Mesogaulus* = 0.89; *Aplodontia* = 0.68). These endocranial features have been associated with superior visual processing and the development of arboreality in squirrels. Basal Aplodontoidea known from postcrania have been described as generalists with at least some tendency to arboreality, which may provide a basis for these similarities. In contrast, the small paraflocculi and small neocortices observed in the later occurring *Aplodontia* and *Mesogaulus* could be a reflection of their burrowing adaptations, needing less vision and spending more time on the ground than early aplodontoid rodents. Sciuridae and Aplodontoidea likely evolved from an ischyromyid ancestor. Ischyromyidae had small paraflocculi and neocortices and a more terrestrial lifestyle. From the data gathered, early squirrels and aplodontoids diverged from this gestalt in becoming more arboreal and in showing greater brain complexity. Recent Aplodontoidea with terrestrial, fossorial adaptations returned to a more ischyromyid-like condition in their endocranial features. These results are consistent with previous observations that evolutionary changes in locomotion are reflected in shifts in endocranial anatomy in rodents.

Grant Information:

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Technical Session VII (Thursday, August 24, 2017, 3:45 PM)

GENOMIC SIGNATURE OF AN AVIAN LILLIPUT EFFECT ACROSS THE K-PG EXTINCTION

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Survivorship following major mass extinctions may be associated with a decrease in body size—a phenomenon called the Lilliput Effect. Since body size is a strong predictor of many life history traits (LHTs), which influence demography and intrinsic biological processes, pronounced changes in organismal size throughout Earth history are likely to be associated with concomitant genome-wide changes in evolutionary rates. Here, we report pronounced shifts in rates of molecular evolution (varying up to ~20-fold) across a large-scale avian phylogenomic dataset, and show that nucleotide substitution rates are strongly correlated with body size and metabolic rate while controlling for other life history variables. We also identify potential body size reductions associated with the Cretaceous-Paleogene (K-Pg) transition, consistent with a 'Lilliput Effect' in the wake of that mass extinction. We posit that such changes may have resulted in transient increases in substitution rate along the deepest branches of the avian tree of life, and suggest that this 'hidden' rate acceleration may result in both strict and relaxed molecular clocks over-estimating the age of the avian crown group through the relationship between life history and demographic parameters that scale negatively with molecular substitution rate. If reductions in body size (and/or selection for demographic parameters like short generation times) are a common property of lineages surviving mass extinctions, this phenomenon may help resolve persistent divergence time debates across the tree of life, and suggests that selection for certain life history traits may be associated with deterministic molecular evolutionary outcomes.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW APPROACH TO CORRELATING VERTEBRATE FAUNAS BY COMBINING HIGH PRECISION U-PB GEOCHRONOLOGY WITH GEOCHEMICAL TEPHROSTRATIGRAPHY: A CASE EXAMPLE FROM THE CAMPANIAN WESTERN INTERIOR BASIN

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Over the last decade, advances in high-precision U-Pb zircon geochronology of terrestrial rocks have led to unprecedented opportunities for resolving the temporal context of vertebrate fossil records. The Late Cretaceous has frequently been referred to as the 'zenith' of dinosaur evolution, and few continental settings are better suited for applying these new geochronological approaches as the Upper Cretaceous Western Interior Basin of North America. Our team has focused on systematic dating of interbedded bentonites from three presumed correlative, fossil-rich and geographically distinct stratigraphic units (as far as 1500 km apart), namely the Dinosaur Park Formation in Alberta, the Judith River-Two Medicine formations in Montana, and the Kaiparowits Formation in Utah. Preliminary U-Pb zircon dating by the CA-ID-TIMS method has been successful in identifying individual correlative bentonite marker beds with a precision of ± 25 kyr. However, geochemical fingerprinting of bentonites remains an invaluable correlation tool, if combined (and tested) by independent radioisotopic dating techniques. Here we present a complimentary new approach to tephrostratigraphy, which does not rely on traditional whole rock or mineral geochemistry of bentonites; it involves chemical and isotopic fingerprinting of minute, melt inclusions preserved as glass within the dated zircon populations. This approach combines trace element geochemistry and Hf-isotope analysis of the glass inclusions and host zircons, thus providing up to four discrete geochemical fingerprints for correlation purposes. Ten volcanic ash beds from the most vertebrate fossil-rich intervals of the Dinosaur Park, Two Medicine and Kaiparowits formations have been examined. Results exceed expectations and demonstrate that this approach can allow us to correlate single ash beds throughout and even between formations via fine-scale fingerprinting. In some cases, distant bentonites with practically identical U-Pb ages have yielded distinct chemical/isotopic fingerprints, which demonstrates for the first time that multiple volcanic systems were synchronously eruptive during the late Campanian. This approach has wide ranging application to other formations and basins, and promises to be a valuable and practical tool in evolutionary and ecological studies.

Grant Information:
National Science Foundation-EAR-1424892

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

LOCOMOTOR BEHAVIOUR RECONSTRUCTION FROM THE SEMICIRCULAR CANALS OF EARLY FOSSIL RODENTS: INSIGHTS INTO MAJOR EVOLUTIONARY TRANSITIONS FROM THE INNER EAR

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The semicircular canals (SSCs) of the inner ear are informative about agility level (i.e., jerkiness of movement). Animals with larger SSCs relative to body mass generally have faster, jerkier locomotion compared to animals with relatively smaller canals.

In this study, agility is reconstructed for fossil rodents in the families Ischyromyidae, Aplodontidae and Sciuridae, including some of the oldest rodents known, and the most primitive ancestors of squirrels. The locomotor behaviour of ischyromyid rodents has been debated, with postcranial reconstructions variously suggesting arboreality and terrestriality. Extinct members of Aplodontidae have been inferred to have diverse locomotor modes including fossorial, burrowing and arboreal lifestyles. In spite of their scarcity, postcranial elements for early sciurids reflect arboreal adaptations, in contrast to the inferred ancestral condition of terrestriality.

Dimensions of SSCs were calculated from microCT data for specimens of *Paramys copei* (Early Eocene), *Paramys delicatus* and *Reithroparamys delicatissimus* (Middle Eocene), and *Ischyromys typus*, *Cedromus wilsoni* and *Prosciurus relictus* (Early Oligocene). Agility scores ranging from 1 (very slow) to 6 (very fast) were calculated based on a modern dataset. Ischyromyids had varying agility scores ranging from medium-slow to medium-fast: *Paramys copei* = 3.6; *Paramys delicatus* = 3.4; *Ischyromys typus* = 3.8; *Reithroparamys delicatissimus* = 4.4. The lower agility scores for *Paramys* and *Ischyromys* are consistent with suggestions that they may have been terrestrially adapted, with *Ischyromys* possibly being semi-fossorial. The higher agility score for *R. delicatissimus*, a possible relative of living squirrels, may reflect behaviour evolving into faster, more active arboreality. The only aplodontid was *P. relictus* and its agility score (6.1) suggests it practiced fast, agile locomotor behaviour in contrast to the medium slow agility (3.0) of *Aplodontia rufa*, the only living aplodontid. The only sciurid in this study, *C. wilsoni*, was reconstructed as having fast, agile locomotor behaviour (5.5). Although *C. wilsoni* is unknown from postcranial material, endocranial features have been interpreted as showing evidence of the transition to an arboreal milieu, and this high agility score may also reflect that transition. In sum, SSC dimensions provide an independent source of data to reconstruct locomotion and can add to our understanding of major evolutionary transitions such as the adoption of arboreality in squirrels.

Grant Information:
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Technical Session I (Wednesday, August 23, 2017, 12:00 PM)

ITERATIVE EVOLUTIONARY AND DEVELOPMENTAL APPEARANCE OF THE AVIAN BEAK REVEALED BY NEW FOSSIL AND EMBRYOLOGICAL DATA

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The avian beak is a distinctive and evolutionarily significant innovation assembled from components of the ancestral dinosaurian rostrum between the common ancestor of Avialae and of crown-clade Aves. The initial stages in the evolutionary assembly of the beak, however, remain poorly understood. We investigated the architecture of the beak at its first appearance, the transition of this earliest incarnation toward the crown clade, the expansion of the horny rhamphotheca, and the overall embryonic development of the beak versus a more ancestral archosaurian snout. Crucial to this investigation was new material of Cretaceous interior seaway toothed stem-group birds and new embryonic data utilizing immunostaining combined with the CLARITY clearing technique. We found that the definitive beak appeared gradually through a series of transitional forms in which the premaxilla progressively took over the rostrum, but some version of the avian kinetic apparatus accompanied it beginning at or near its origin. This concordance supports the idea that the beak originated as a precision-grasping mechanism located at the tip of the snout. During beak evolution, more and more ossification extended across the palatal surface of the bone, and the rhamphotheca followed this reinforcement. Developmentally, our previous comparison of birds and reptiles had shown that there is an important central proliferative zone in the embryonic bird face that eventually produces a downgrowth that becomes the beak; lack of midfacial proliferation leads to a midfacial cleft in other amniotes. Following up on this work, we used new imaging techniques to follow the development of this primordium versus the ancestral cleft and found that other internal structures, notably neurovascular structures, are mustered and focused within the developing beak, possibly responding to the same developmental signals. In the nonavian, and specifically the alligator, snout, we found that the cleft progresses directly into the interpremaxillary suture, with neurovascular structures orienting themselves according to that architecture.

Grant Information:
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Technical Session XIV (Friday, August 25, 2017, 3:30 PM)

ELEVEN NEW SKULLS FROM THE LOS ANGELES BASIN, SOUTHERN CALIFORNIA, SHED LIGHT ON THE TIMING OF MAJOR WALRUS RADIATIONS

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Walruses (odobenids) today are represented by a single extant species, *Odobenus rosmarus*, which is confined to the Arctic. Odobenids were once numerous and widespread, with 20 species and 16 genera throughout the Pacific from early Miocene to the late Pliocene. Ongoing phylogenetic studies identify two major radiations of walruses, one in the early Miocene and one in the late Miocene. However these studies have just included a few specimens from the Miocene of Southern California. In addition to a nearly complete fossil walrus from Orange County, which has been reported before, we report 11 previously unreported middle to late Miocene skulls from the Los Angeles Basin. These specimens are housed at the Natural History Museum of Los Angeles County (LACM) and John D. Cooper Archaeological and Paleontological Center (OCPC) and represent 3-4 new genera and species. Five of these skulls from a middle Miocene portion of the Monterey Formation of Orange County together characterize males and

females of one species. A second, separate species is represented by two skulls from the Valmonte Diatomite of the Monterey Formation of Los Angeles County (late Miocene). Finally, three skulls from the Oso Member of the Capistrano Formation of Orange County (late Miocene) might represent a species different from the aforementioned complete specimen. A single skull from the same unit definitively represents an additional new species. In addition to these 11 skulls, more fragmentary material demonstrates that the presence of *Gomphotaria pugnax* in the Oso Member, which would mean that this unit would have 3-4 coeval walruses, making it the most diverse fossil odobenid assemblage. Our phylogenetic analysis demonstrates that instead of an early and late radiation of walruses, the second radiation may have begun in the middle Miocene, depending on the age resolution of the Monterey Formation walruses of Orange County.

Romer Prize Session (Thursday, August 24, 2017, 8:45 AM)

USING CANCELLOUS BONE ARCHITECTURE TO INFER THEROPOD DINOSAUR LOCOMOTOR BIOMECHANICS AND ITS EVOLUTION

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Cancellous bone is known for being sensitive to its mechanical environment, and its ability to adapt its architecture to this environment. It therefore has great potential utility for biomechanical inference in extinct vertebrates. Here, the three-dimensional architecture of cancellous bone was investigated in theropod dinosaurs, to quantitatively test hypotheses of posture, bone loading and muscle control, as well as how these evolved on the line to birds. The hindlimb bones of various non-avian theropods and modern birds (> 150 in total) were subject to computed tomographic scanning; the resulting data was then processed using quantitative image analysis. This identified several important architectural differences between species. For example, the primary direction of cancellous bone in the femoral head of derived non-avian species was more anteriorly inclined compared to basal species (e.g., *Troodon*, 15.8°; tyrannosaurs, 8°). This likely reflects differences in posture, as such patterns also occur in extant bipeds: birds (crouched femur, 21.7°) have a marked anterior inclination compared to humans (erect femur, 1.1°). The observations were also utilized in a reverse application of the 'trajectorial theory'. A novel integration of musculoskeletal and finite element models of the whole hindlimb was used to determine what posture could align stress trajectories with observed cancellous architecture in the femur, tibia and fibula. The approach was validated with a modern chicken, identifying a posture and loading mechanics comparable to empirical observations (femur 35° below horizontal, torsion exceeds bending, hip long-axis rotator muscles strongly recruited). It was then applied to two extinct theropods, *Daspletosaurus* (tyrannosaur) and *Troodon* (paravian). The posture identified for *Daspletosaurus* was largely erect (femur angle 70°), with bending-dominant bone loading and hip abductors being strongly recruited. In *Troodon*, the posture was of an intermediate nature (femur angle 55°), with bone loading and muscle recruitment patterns also intermediary. This study has provided new insight into locomotion in extinct theropods, and supports the hypothesis that the evolution of terrestrial locomotion in theropods occurred in a gradual fashion. The generality of the approaches used here means that they can also provide insight in other extinct vertebrate groups, such as ceratopsians, therapsids or stem-tetrapods.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

WATER FROGS (ANURA, RANIDAE) FROM THE PLIOCENE CAMP DELS NINOTS KONSERVAT-LAGERSTÄTTE (CALDES DE MALAVELLA, NE SPAIN)

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Water frogs are one of the most common vertebrate fossils in the European Cenozoic. Nevertheless, the rare reproductive phenomenon of hybridogenesis, as well as the absence of osteological studies on several living species within the group, makes it almost impossible either to distinguish fossil forms neither to distinguish between the various extant species. Here we present the description of 11 articulated fossil water frogs in different developmental stages and 353 isolated bones recovered from the 2005-2010 field campaigns at the Pliocene (ca. 3.2 Ma; MN15-16) Camp dels Ninots Konservat-Lagerstätte (NE Spain). This locality corresponds to a lacustrine sedimentary sequence in a maar infill which delivered complete articulated skeletons of large mammals (*Alephis tigneresi*, *Stephanorhinus jeanvireti* and *Tapirus arvernenis*), turtles and small vertebrates (as rodents, frogs, newts and fishes). Excellent preservation of the fossils was favored by the meromictic conditions of the lake. Frog's skeletons are all presented in dorsoventral aspect with snout-vent length ranging between 13 and 45 mm. Presence of diplasiocoelous vertebral column, with short and non-imbricate neural arch, sacral vertebra unfused with the urostyle that bears cylindrical sacral apophysis, bicondylar sacro-urostylar articulation, absence of transverse processes of the urostyle and of ribs, firmisternous sternum with ossified omosternum, premaxilla and maxilla teeth bearing clearly refer to the family Ranidae. Attribution to genus *Pelophylax* relies on a higher dorsal crest on the ilial shaft and more open sacral apophysis than in genus *Rana*. Approximation to a more precise systematic attribution among extant European and North African water frogs has been done using morphometrical measurements on the ilium, using a comparative modern sample of 506 ilia. Fossil ilia from Camp dels Ninots fall within the variability of extant *P. lessonae*, and thus would represent the earliest mention for this species. However attribution must be done carefully, as the status of the extinct species *Pelophylax pueyoi* from the late Miocene (MN9-10) Libros Konservat-Lagerstätte has still to be elucidated. Preliminary description of their physical taphonomy is also done, taking into account their distribution, completeness, articulation and limb position.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

LOCOMOTOR KINEMATICS OF THE MANUS AND PES IN DINOCEPHALIAN THERAPSIDS RECONSTRUCTED FROM THREE-DIMENSIONAL MORPHOLOGY OF FOOTPRINTS FROM GANSFONTEIN, SOUTH AFRICA

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The Gansfontein paleosurface from the Mid-Permian Abrahamskraal Formation (Beaufort Group, *Tapinocephalus* Assemblage Zone) of South Africa, preserves several vertebrate trackways. Among the best-preserved is a series of footprints attributed to a single dinocephalian therapsid walking across the surface. Trackmaker identification is based on the large size of the prints (25 cm wide) and the reduction of digit I in the manus and pes. A curious feature of the trackway is that, in contrast to the straight digital axis indicated by articulated bones of the dinocephalian manus and pes, digit impressions left by the trackmaker are curved so that their tips are directed towards the trackway midline. To test hypotheses about the locomotor kinematics of the tetrapod that produced these curved-digit prints, we constructed contour maps that depict how the depth of an impression varied within individual prints. In our initial analysis, we constructed the maps by pouring milk into the prints in successive increments of 2 mm in height and tracing the perimeters of filled areas on translucent paper fixed to the paleosurface by tape. We have also used surface scanners to generate depth profiles with finer scale resolution. Contour maps show several features consistent with outward rotation of the hand and foot during the stance phase of the step cycle. For example, impressions of digit I are shallow, but impressions of digit V are deeper. In addition, lateral edges of digit IV impressions are steeper than the medial edges in both manus and pes prints. Thus, where depth asymmetry is present in the print between or within digits, impressions are deeper or steeper laterally, consistent with outward foot rotation. Finally, the distal tips of digit impressions are among the shallowest portions of the prints; however, local 'overdeepened' depressions are present several centimeters from the distal tips of digit impressions, indicating that the toes had rotated out from their initial point of placement prior to lifting of the foot off the substrate. Besides these features, spacing between left and right prints is less than the breadth of individual prints, indicating an apparent 'narrow gauge' trackway. However, the presence of foot rotation during stance supports osteological evidence that dinocephalians used sprawling, rather than parasagittal limb posture. Close spacing of footprints likely resulted from a combination of lateral bending of the body and significant cranio-caudal limb excursion, rather than increased adduction of the limbs under the body.

Grant Information:
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Technical Session XI (Friday, August 25, 2017, 11:00 AM)

NEW DISCOVERIES OF XENOROPHIDAE FROM THE OLIGOCENE OF THE CAROLINAS: INSIGHTS INTO THE EVOLUTION OF FEEDING MORPHOLOGY, ENCEPHALIZATION, AND LOCOMOTION OF THE EARLIEST DOLPHINS (ODONTOCETI)

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The family Xenorophidae is a short-lived monophyletic radiation of odontocetes known only from the Oligocene of North and South Carolina. Xenorophids are typically long-snouted odontocetes that possess heterodont teeth, variably asymmetrical skulls, facial fossae suggesting the presence of air sinuses, and a cranial telescoping that evolved in parallel with taxa more closely related to the odontocete crown group. Recent studies on the facial osteology and inner ear of the xenorophids *Cotylocara* and *Echovenator* revealed traits consistent with echolocation, suggesting that echolocation and ultrasonic hearing evolved at the base of the odontocete radiation. New discoveries of xenorophid skulls and skeletons from the South Carolina include 1) specimens of *Albertocetus meffordorum* from the Ashley Formation; 2) new skulls and skeletons of a new species of *Xenorophus* from the Ashley and Chandler Bridge Formations; and 3) a skull of a diminutive, toothless, short-snouted xenorophid representing a new genus, also from the Ashley Formation. New material of *Albertocetus* (CCNHM 218, 303) includes a 50% complete vertebral column, with caudal vertebrae indicating the absence of a transversely narrowed caudal peduncle. A digital endocast extracted from CT data indicate that *Albertocetus* had the highest encephalization quotient (EQ) of any early Oligocene odontocete. New skulls and skeletons (n=11+; CCNHM 104, 168, 1077; ChM PV 4266, 4823, 7677) expand morphological details known for *Xenorophus* (including braincase, petrotympanic, mandibles, and vertebrae) and permit assessment of individual variation within a single xenorophid species. None of the new specimens appear referable to *Xenorophus sloani* and instead appear to represent a single new species. A new dwarf xenorophid possesses a shortened, downturned rostrum and lacks maxillary teeth-features associated with suction feeding in other odontocetes. The new dwarf species represents the earliest obligate suction feeding cetacean and demonstrates that odontocetes evolved suction feeding early in their radiation. Overall, xenorophids not only provide insights into early odontocete evolution, they also demonstrate that some aquatic adaptations (i.e. telescoping, short rostrum, tooth loss) evolved multiples times within Odontoceti. A

better understanding of the cause or causes of these convergences could help clarify unresolved questions in Oligocene odontocete phylogeny.
Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

YOUNGEST RECORD OF EXTINCT WALRUS *ONTOCETUS EMMONSI* (CARNIVORA: ODOBENIDAE): PLIO-PLEISTOCENE AUSTIN SAND PIT, SOUTH CAROLINA, USA

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The extinct North Atlantic walrus *Ontocetus emmonsi* is widely reported from Pliocene marine deposits in the eastern USA (New Jersey-Florida), Belgium, Netherlands, UK, and Morocco. *Ontocetus* was slightly larger than the modern walrus *Odobenus rosmarus*, may have had wider climatic tolerances (subtropical), and likely originated in the western North Pacific before dispersing through the Arctic. Owing to geochronologic uncertainties in the North Atlantic Plio-Pleistocene walrus record, it is unclear whether *Ontocetus* and *Odobenus* overlapped in time and thus may have competed, or whether the two were temporally separate invasions of the North Atlantic.

A new specimen of *Ontocetus emmonsi* (CCNHM-1144) from the Austin Sand Pit (Ridgeville, SC) is a complete, well-preserved right tusk that is proximally inflated and oval in cross-section, relatively short (maximum length: 369mm) and markedly curved (radius of arc of curvature: 197mm). Globular dentine is present, confirming assignment to Odobenini; proportions and curvature identify the specimen as *Ontocetus emmonsi* rather than *Odobenus*.

Deposits in the Austin Sand Pit lack calcareous macro and microinvertebrates, but vertebrate biochronology provides some temporal resolution. The co-occurrence of a capybara (*Neochoerus* sp.) and a snaggletooth shark (*Hemipristis serra*) indicate an age of 1.1-3.0 Ma (late Pliocene to early Pleistocene), consistent with the deposit underlying the Penholoway Formation (0.7-0.9 Ma). This age too young for the Raysor Formation and Goose Creek Limestone (3.1-3.9 Ma), and instead suggests it correlates with the lower Pleistocene Waccamaw Formation, which has yielded dates of 1.5-2.3 Ma in North Carolina. Other elements of the marine mammal assemblage suggest that the fauna of the Austin Sand Pit is intermediate in composition between the lower Pliocene Yorktown Formation of North Carolina and the modern fauna. This record reported here is the youngest of *Ontocetus emmonsi* from the Atlantic Coastal Plain, and a review of North Atlantic Plio-Pleistocene walrus records reveals no overlap between extinct *Ontocetus* and extant *Odobenus* – suggesting independent dispersal to the North Atlantic.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE MOVEABLE DINOSAUR MUSEUM IN MONGOLIA: RESULTS AND CHALLENGES TWO SEASONS IN

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Mongolia has been known for dinosaur fossils since the 1920s, but the Mongolian public remains largely uninformed due to a lack of educational resources and public exhibits. The Institute for the Study of Mongolian Dinosaurs (ISMD) began hosting educational workshops in 2009 to improve public knowledge on dinosaurs and related topics in Mongolia. In 2015, ISMD added the Moveable Museum (MM) to its outreach tool kit.

Officially named “Dinosaurs: Ancient Fossils, New Discoveries”, the MM is a large vehicle with 250 square feet of exhibit space inside, created by the American Museum of Natural History (AMNH) for use in the greater New York area. In 2013, AMNH donated the MM to ISMD. It was then shipped to Mongolia, where it has since educated children and adults about dinosaurs and paleontology over the course of two summers, 2015 and 2016.

On its first Mongolian tour in 2015, the MM visited the cities of Mandalgovi, Dalanzadgad, Bulgan, Ulaanbaatar, and Mandal-ovoo, reaching approximately 325 individuals. In 2016, it visited Bayankhongor, Arvaikheer, Dalanzadgad, Mandalgovi and Ulaanbaatar, reaching approximately 1000 individuals. Most visitors during both seasons were in the K-12 age group, and had never seen a dinosaur exhibit prior to their MM tour. Classroom workshops were typically held in conjunction with museum visits, and in 2016, there were noticeable differences in the starting knowledge levels of workshop participants in some small communities which the MM had visited the previous year.

Challenges facing the MM in Mongolia include road quality, translation, parking, follow-up, teacher training, staffing, storage, funding, vehicle maintenance and exhibit maintenance. Basic replacement parts like tires and interior light bulbs are not available in Mongolia. The on-board exhibits are still in English, so interpretive staff must be bilingual. Extreme weather normal to Mongolian winters puts significant wear and tear on the exterior, however, due to its unusual size relative to most Mongolian vehicles, indoor parking has been unfeasible. Outside of Ulaanbaatar, paved roads are rare, limiting range and making some communities near important fossil locales inaccessible.

Medium-term plans are in development for upgrading the MM and, in the long term, ISMD plans to limit its range to Ulaanbaatar as new permanent facilities are constructed in key regions.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SPECIES DELIMITATIONS WITHIN THE EXTINCT RIVER DOLPHIN GENUS *PARAPONTOPORIA* BASED ON QUANTITATIVE ANALYSIS OF THE PERIOTIC BONES

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Parapontoporia is an extinct genus of river dolphins found exclusively from late Miocene to Pliocene (7.2 – 1.8 Ma) rocks in California and Baja California, Mexico. There are currently three species recognized within the genus: *P. sternbergi*, *P. wilsoni*, and *P. pacifica* based on qualitative non-cladistic data. The goal of this study is to test the validity of the three *Parapontoporia* species using modern quantitative analysis.

Preliminary data on standard *Parapontoporia* cranial measurements has been minimally informative with regard to species delimitations. While *Parapontoporia* fossils are relatively abundant in late Neogene eastern North Pacific marine strata, only one of the six available skulls for study is preserved for its entire length. Thus, meaningful statistical analyses using traditional cranial measurements are not possible. Therefore, we chose to focus on morphology of the ear bones (periotics), which are especially useful in fossil cetacean studies. Periotics are relatively abundant and well preserved in the fossil record, and they have been used for species-level delimitation in both extant and extinct taxa.

We compare variation among *Parapontoporia* periotics to intraspecific variation in recent specimens belonging to three extant species of odontocetes for which there is high confidence in species-level designation: *Stenella attenuata*, *Stenella longirostris*, and *Delphinus delphis*. Data from 4 periotic measurements among approximately 40 recent and 13 *Parapontoporia* specimens, based on both traditional and CT scanning measurements, are analyzed using multivariate techniques. *Parapontoporia* periotic specimens are currently assigned to a single species, *P. sternbergi*. However, analysis of preliminary data suggests the presence of multiple fossil species. Next steps involve comparison of the variation within and among *Parapontoporia* clusters with the variation seen in extant species to determine if they can be recognized as different species. These results will allow us to rigorously assess the species diversity in *Parapontoporia*, and it will establish a framework for future studies on fossil species diversity in odontocetes.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

3D PHOTOGRAMMETRY MODELLING - THREE CASE STUDIES IN VERTEBRATE PALEONTOLOGY

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Three dimensional (3D) digital photogrammetry is both a scientific and a commercial modelling tool. It has been used for geological and archeological mapping, anatomical visualization, and engineering applications. Recently, 3D digital photogrammetry has become more widely utilized in paleontology, especially in the study of trackways. Here, three applications for 3D digital photogrammetry in paleontology are profiled: 1) reconstruction of a tyrannosaur skull; 2) documenting a fossil locality that may be lost to erosion; 3) using it as an analytical tool for trackways.

A complete, disarticulated *Daspletosaurus torosus* (TMP 2001.36.0001) skull was assembled for the first time ever after being rendered in 3D virtual space. Each skull element was photographed several hundred times from multiple angles and then rendered in Agisoft Photoscan (AP). After rendering, each element was manipulated into its anatomical position using Windows 3D Builder software. Digital reconstruction and 3D printing of the skull replaced molding and casting of the skull elements. 3D digital photogrammetry offered a less invasive and potentially quicker method to producing a replica of the original specimen.

Fossil localities can be lost to erosive forces such as floods or landslides; 3D photogrammetry can be implemented to record a site for future reference. A fossil-rich Paleocene bonebed in southern Alberta was discovered as part of a wider flood mitigation project. To preserve and map the site as it was, 3D photogrammetry was used before quarrying of the site could begin. A total of 822 photographs were taken of the entire site to produce a single, large render in AP. Additionally, 11 smaller models were made for sections with high fossil density within the larger area. These models preserve what the bonebed looked like in the 2016 field season and can be used more readily than mosaic photographs to produce maps of the specimens.

Fossil trackways are often difficult to interpret because changing lighting conditions may result in variable observations of ichnofossils. Using 3D digital photogrammetry, 3D models may be produced of preserved trackways allowing a user to artificially change the lighting on the surface to maximize the observed occurrences of tracks. Three trackway blocks from the St. Mary River Formation were rendered in 3D and in each case manipulation of the models revealed previously undetected tracks.

Each of these projects shows the potential utility of using 3D digital photogrammetry for display, preservation, and research of paleontological resources.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

GIGANTIC HYAINAILOURINE (HYAENODONTA, “CREODONTA”) FROM THE EARLY MIOCENE OF KENYA

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Hyainailourine hyaenodonts are among the largest terrestrial carnivorous mammals known. The dental record for the group is extensive, but relatively little associated cranial and postcranial material has been recovered, making locomotor reconstructions and phylogenetic analyses with more than dental characters difficult. Hyainailourines likely originated in Afro-Arabia in the early Paleogene, then dispersed to Europe, Asia, and North America. The clade includes *Hyainailouros*, one of the last hyaenodonts and one of the largest. Fragmentary material referred to *Hyainailouros* has been recovered from Miocene localities in Africa, Europe, and Asia, making the taxonomy and morphology of

this taxon important for interpreting biogeography and dispersals from Africa. Material from the most complete hyainailourine from sub-Saharan Africa was discovered several decades ago and was accessioned at the National Museums of Kenya. In this study, the material of this specimen is described and compared with other hyainailourine material from the Oligocene and Miocene. The specimen represents a relatively young adult with only light wear on its dentition, making it an important specimen for interpreting often more heavily abraded hyainailourine specimens. The canine is nearly 10 cm long with a distinct distal shearing cristid. P_4 is mesiodistally short with a tall, narrow protoconid and shear crista obliqua. M_3 is 6.3 cm long, larger than molars referred to *Hyainailouros sulzeri* from the Miocene of Europe and Africa, and it features a paraconid that is slightly shorter than the protoconid. There is no indication of the metaconid and the talonid is reduced to a small distal bump. The large upper molars have mesiodistally elongate metastyles, deep carnassial notches, and clear fusion of the taller paracones and shorter metacones into a single piercing cusp. In this study, postcranial material referred to the Meswa Bridge hyainailourine is compared with other large mammals known from the locality to evaluate the hypothesis that the specimen is a composite. Parsimony and Bayesian phylogenetic analyses, using cranial, dental, and postcranial characters, were conducted to examine the systematic relationships of the Meswa Bridge hyainailourine to other hyaenodonts. Results place it within a clade of Miocene hyainailourines that includes *Hyainailouros* and *Megistotherium*. Using the relationships within Hyainailourinae, we infer the biogeographic history of the clade, and reconstruct the evolution of gigantic body size in Afro-Arabian hyaenodonts.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

TEACHING CORE PHYLOGENETIC SYSTEMATIC CONCEPTS THROUGH PRACTICAL EXPERIENCE BUILDING A HOMININ FAMILY TREE

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Investigating the diversification of lineages through time is one of the central goals of paleontological research. To accomplish this, paleontologists draw upon an expanding toolkit of phylogenetic methods to analyze character-taxon matrices. The result is a phylogenetic tree that places the new taxa into relationship with other taxa. Teaching a wider public how to read these branching trees and interpret genetic or morphological input data is imperative as publicly funded research continues to explore the tree of life. An initial attempt to teach core phylogenetic concepts in a workshop setting was conducted as part of a human origins field school. The goal of the workshop was to introduce major concepts in phylogenetic systematics, including the phylogenetic species concept, and the challenges of resolving the tree of life with a fragmentary fossil record. Participants began with simple character building exercises based on cartoon characters to familiarize them with phylogenetic software. Then participants applied their character-building abilities to the fossil record of humans. Casts of hominin material are available in many museums and universities and models of hominin material are freely available from many online sources, making it easy to equip students with a representative sample of material from the clade. One advantage of hominin morphology is the general public can recognize the primary characters used by paleoanthropologists to investigate hominin evolution with relatively little direct instruction. Participants were assigned to groups responsible for generating characters and states for different regions of the skull and skeleton. With each group's characters and states, a large-scale character-taxon matrix was rapidly assembled and a consensus tree was calculated in real time. Participants immediately began discussing the taxa that were in expected or unexpected positions in the tree and began discussing the further resolution additional characters or fossil material might provide. Close examination of casts for character information also led to anatomical questions and discoveries. Ultimately, participants were able to interpret phylogenetic trees, and ask questions about the data supporting clades in other studies. This activity reinforces the necessity of the fossil record for inferring biological relationships and is appropriate for overnight, day camp, and extended classroom interactions. The materials used for this exercise are available for download and modification.

Grant Information:
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Technical Session XX (Saturday, August 26, 2017, 2:30 PM)

DIGITAL CRANIAL ENDOCAST OF THE GROUND SLOTH *GLOSSOTHERIUM ROBUSTUM* (OWEN, 1842) (XENARTHRA, PILOSA) FROM THE PLEISTOCENE OF ARGENTINA

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The species *Glossotherium robustum* (Owen, 1842) was one of the most widespread ground sloths during the Pleistocene of South America, and is one of the most well studied species of the family Mylodontidae. This species was discovered by Charles Darwin during his travels on the HMS Beagle, and subsequently studied by Richard Owen, becoming one of the most iconic taxa of the South American extinct megafauna. In recent times, studies focusing on this species have clarified many aspects of its paleobiology, such as its digging abilities, hearing capabilities, dietary preferences and food intake. However, anatomical studies of its neurocranial features are scanty and out of date. The studies of its external ear region are 20 to 50 years old, whereas the scarce information about the morphology of its brain cavity dates back to the latest 19th century. Novel techniques of CT scanning and digital reconstructions enable non-destructive access to the internal cranial features of both extinct and extant vertebrates, as well as improve our knowledge of anatomical features that had previously remained obscure. Therefore, we performed CT scans on a partial cranium of *G. robustum* from the Late Pleistocene of the Buenos Aires province (Argentina), and created a digital reconstruction of the endocast, which allowed us to document many previously unknown structures. These include not only the brain cavity itself, but also the paranasal sinuses, the inner ear anatomy and the trajectory of several cranial nerves and blood vessels. All these features have been compared with the extant representatives of the suborder Tardigrada (= Folivora, Phyllophaga): the two-toed sloth genus *Choloepus* and the three-toed sloth genus *Bradypus*. For many characteristics, especially those related to paranasal pneumaticity and the brain cavity, a close similarity between *Glossotherium* and *Choloepus* is observed, in accordance with the most widely accepted phylogenetic scenarios. Geometric morphometric analyses also reveal that the inner ear anatomy of *Glossotherium* more closely resembles that of the giant ground sloth *Megatherium*, extant anteaters and armadillos, than that of *Bradypus* and *Choloepus*, further demonstrating the striking morphological convergence between the two extant sloth genera. The current work represents the first exhaustive study of a digital endocast of a fossil ground sloth, and reveals the importance of the application of these new methodologies for elucidating the evolutionary history of this peculiar mammalian clade.

Technical Session XVIII (Saturday, August 26, 2017, 8:15 AM)

GROWTH PATTERNS OF LATE TRIASSIC PROZOSTRODONTIAN CYNODONTS FROM BRAZIL

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The Prozostrodontia was a group of Triassic eucynodonts, the derived members of which gave rise to the Mammaliaformes, in which Mammalia is nested. Analysing their growth patterns is thus important for understanding the evolution of mammalian life histories. Obtaining material for osteohistological analysis is difficult due to the rare and delicate nature of most of the prozostrodontian taxa much of which comprises only crania or sometimes even only teeth. Here we present a rare opportunity to observe the osteohistology of several postcranial elements of the basal prozostrodontid *Prozostrodon brasiliensis*, the tritheledontid *Irajatherium hernandezi*, and the brasilodontids *Brasilodon quadrangularis* and *Brasilitherium riograndensis* from the Late Triassic of Brazil (Santa Maria Supersequence). *Prozostrodon* and *Irajatherium* reveal similar growth patterns of rapid early growth with annual interruptions later in ontogeny. These interruptions are associated with wide zones of slow growing bone tissue. *Brasilodon* and *Brasilitherium* exhibit a mixture of woven-fibered bone tissue and slower growing lamellar bone. The slower growing bone tissues are present even during early ontogeny. The relatively slower growth in *Brasilodon* and *Brasilitherium* may be related to their small body size compared to *Prozostrodon* and *Irajatherium.* These brasilodontids also exhibit osteohistological similarities with the mammaliaform *Morganucodon.* This may be due to similar small body sizes, but may also reflect their close phylogenetic affinities as *Brasilodon* and *Brasilitherium* are the closest relatives to the Mammaliaformes.

Grant Information:
National Research Foundation
Centre of Excellence in Palaeosciences

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

VISUALIZING POTENTIAL SOUND PRODUCTION FROM THE ORNATE CRANIAL CRESTS OF *PARASAUROLOPHUS* AND *HYPACROSAURUS* (DINOSAURIA: ORNITHOPODA: HADROSAURIDAE)

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The elongated cranial crests of lambeosaurine hadrosaurs are hypothesized to have functioned in vocal enhancement, perhaps suggesting complex social systems in hadrosaurs. Support for this idea can be found in the convoluted internal structure of lambeosaurine crests, which are more complex that would be expected based on external crest morphology alone, particularly if these exaggerated structures functioned exclusively for visual display and respiration. Previous studies found that the elongated nasal passage of *Parasaurolophus* was capable of producing low-pitched resonant frequencies that were within the inferred audible range for the species based on reconstructions of cochlear function. However, these initial interpretations did not consider the effects of soft tissues on sound production within the crest. Using data from several new specimens of *Parasaurolophus*, we constructed a digital composite skull and used a computational aeroacoustic approach to simulate potential resonant frequencies within the elongated nasal passages. Our composite *Parasaurolophus* specimen had a nasal passage length of 2 m, which was smaller than previous specimens and resulted in the crest resonating at a first harmonic frequency of 88 Hz. This was higher than the 48 Hz previously proposed for *P. walkeri* or 75 Hz for *P. cyrtocristatus*. Soft-tissue correction did little to change the first harmonic frequency, but did affect subsequent harmonics, indicating that soft tissues would have noticeably affected sound timbre. We ran a similar analysis on *Hypacrosaurus altispinus,* which has a complicated nasal passage housed within a thin, blade-shaped crest. We found the nasal cavity to resonate at a fundamental frequency of approximately 121 Hz. Ambiguity of the potential soft-tissue anatomy within the common median chamber, and the more complicated lateral diverticulum in *H. altispinus*, resulted in greater frequency variation within this taxon. Regardless, both animals consistently produced sounds within the reconstructed audible range for each species, suggesting that species-specific vocalizations remain valid potential functions for these unique cranial structures.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A POSSIBLE NEW SPECIMEN OF THE OWENETIID *RUHUHUARIA REISZI* FROM THE MANDA BEDS OF SOUTHERN TANZANIA (MIDDLE TRIASSIC) AND ITS IMPLICATIONS FOR SMALL REPTILES DURING THE TRIASSIC PERIOD RECOVERY

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During the recovery from the end-Permian extinctions in the Middle Triassic, small reptiles (<50 cm) are exceptionally rare, and this gap in the fossil record inhibits our understanding of small reptile ecology and evolution during such a critical transition in Earth history. One of the biggest problems in assigning small reptiles to reptile clades is that most forms are only represented by partial or highly fragmented skeletons. Here, we fully describe two fossil fragments of the jaw of a single individual of a small reptile from the Middle Triassic Manda Beds of Tanzania, CAMZM T1162. CAMZM T1162 shares two diagnostic character states (labio-lingually expanded and anteriorly enlarged dentary teeth) with the recently described taxon, *Ruhuhuaria reiszi* (Procolophonoidea: Owenettidae), which was found at the same locality. From this, we tentatively assign CAMZM T1162 to *Ruhuhuaria reiszi.* CT scanning and SEM imaging were employed to fully examine the morphology of the new specimen and illuminate details of the teeth not available in the holotype. Though the new specimen is much less complete overall, the dentition of CAMZM T1162 is better preserved than that of the holotype and shows that 1) the more posterior teeth of the dentary of this animal were chisel-shaped rather than pointed, 2) at least some of the teeth were transversely expanded at the base, and 3) tooth implantation is acrodont in the posterior portion and pleurodont in the more anterior portion of the dentary. This combination of character states in the new specimen referred to *Ruhuhuaria reiszi* appears to be unique. Furthermore, this potential second specimen of *Ruhuhuaria reiszi* provides new information about the ecology of the taxon, such as its diet, and complicates the previous hypothesized relationships of the taxon by introducing still more ambiguous morphological characters with ambiguous or contradictory distributions among Triassic small reptiles. This new addition to the fossil record further illustrates the difficulties in assigning small reptiles to various clades in the Triassic during the recovery period. If CAMZM T1162 does represent another specimen of *Ruhuhuaria reiszi*, it clearly shows that small Triassic reptiles had more variation in their tooth implantation and tooth disparity than previously appreciated.

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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DIG LOCALLY, TEACH GLOBALLY: USING MASSIVE OPEN ONLINE COURSES TO MAKE PALAEONTOLOGY EDUCATION ACCESSIBLE WORLDWIDE

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The pedagogical benefits of Massive Open Online Courses (MOOCs) are numerous: the potential for flexible student learning, reduced stress on attention spans, and the removal of physical limitations such as classroom size or lack of local resources, are just some examples. Following the success of its pioneering, twelve lesson palaeontology MOOC 'Dino 101' (which has reached over 70,000 students worldwide), the University of Alberta created three four-lesson palaeontology mini-MOOCs: 'Ancient Marine Reptiles', 'Early Vertebrate Evolution', and 'Theropod Dinosaurs and the Origin of Birds'. Each mini-MOOC was intended to highlight a particular research strength in the University of Alberta's palaeontology community.

The aim of these MOOCs was to provide a) an outreach tool to bring palaeontology to the general public at no cost, and b) course material for three new online for-credit courses at the University of Alberta. The mini-MOOCs were built upon the same pedagogical strengths as Dino 101: high-quality video lectures frequently interspersed with formative feedback, such as in-video quizzes, and interactive components, such as puzzles. Several new interactive components were introduced, including taxonomic trading cards and an interactive phylogenetic tree, that linked species presented across all three mini-MOOCs. Full time instructors were hired to help build an online community of palaeontology enthusiasts and inspire cohort learning.

Beyond servicing University of Alberta students, these online courses were designed to be accessible to people outside of full-time education, in areas with no fossil collections, or who belong to groups, such as the elderly, for whom returning to a physical school setting may be impractical and potentially stigmatising. Course analytics suggest that these target audiences are being reached; 79% of all learners are not full-time students, and 53% are from outside of North America, and would not have access to many of the fossil sites, such as Miguasha, Quebec, which provide much of the course content. Further, men and women above 65 years-old are the highest demographic in all three courses, suggesting that MOOCs are an ideal medium to deliver education to lifelong learners.

So far, Ancient Marine Reptiles, Early Vertebrate Evolution, and Theropod Dinosaurs have reached over 38,000 people in six continents, and learner feedback data has been overwhelmingly positive.

Technical Session I (Wednesday, August 23, 2017, 11:00 AM)

HISTOLOGY AND INTERNAL ANATOMY OF AN ENTIRE HADROSAURID DENTAL BATTERY WITH EVIDENCE OF TOOTH MIGRATION

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The hadrosaurid dental battery is composed of multiple vertically stacked columns of teeth, or tooth families, which interlock to form a large grinding surface. Previous work initially interpreted this unique structure as a solid block of teeth that were cemented together, but a recent study concluded that soft tissues and ligaments held the battery together, giving it more mobility than previously thought. Properly assessing these competing hypotheses requires a histological analysis of the internal anatomy of complete batteries. For this study, the first histological thin-sections of an entire adult dental battery were prepared along the occlusal plane, as well as a nearly complete perinatal dental battery. Considering adults have approximately eight times more teeth than perinatal individuals, an ontogenetic approach was used to further test whether any shifts in these interactions changed through ontogeny.

The adult dental battery revealed signs of tooth migration. Extensive remodeling of the alveolar bone and the anteroposterior displacement of successive generations of teeth highlight the gradual migration of tooth generations within the battery. The four most posterior tooth families of the adult migrated posteriorly whereas the remaining tooth families had a progressively more pronounced anterior trajectory. This migration is pronounced enough in some areas to cause extensive resorption of neighboring teeth. In the perinatal individual, all of the alveoli are angled anteriorly suggesting that tooth migration is extensive early in ontogeny and that the most posterior tooth families migrate posteriorly later in ontogeny. Although the mechanisms behind tooth migration in the hadrosaurid dental battery require further investigation, accommodation of new tooth families during jaw development, or opposition of forces during mastication and occlusal wear may have had strong influences. Regardless of the reason, this amount of movement within the dental battery is only possible due to the ligamentous connections between the teeth and alveolar bone. The transverse thin sections through an entire battery confirm the presence of periodontal ligament connections between all teeth.

The first histological study of an entire hadrosaurid dental battery provides a better understanding of this complex structure. The presence of a periodontal ligament network holding all of the teeth together underscores the dynamic nature of one of the most unique and complex dental systems of any known herbivore.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE MICROVERTEBRATE FOSSIL ASSEMBLAGE OF THE UPPER CRETACEOUS (CAMPANIAN – MAASTRICHTIAN) WILLIAMS FORK FORMATION, WESTERN COLORADO

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The Williams Fork Formation is an understudied Upper Cretaceous unit in NW Colorado and NE Utah that offers important insights into the Judithian-Lancian transition. We collected approximately 50 kg of sediment from a channel sandstone at a previously described locality, the J&M Site, near Rangely, Colorado. Collected material was broken down and picked for microvertebrate fossils. The sandstone did not break down through traditional screenwashing with water, and freeze/thaw methods utilizing a vacuum were only moderately successful and appeared likely to result in damage to fossils. Soaking in heated (50° C) solutions of the chemical dimethyl-sulfoxide (DMSO) was reasonably effective (50% breakdown) and is the recommended method for fossil recovery from similar sites. No method has been discovered that breaks down the non fissile sandstone from the site. Counting bone fragments, 1000+ fossils were collected from the ~25 kg of sediment that did break down. A minority of the fossils exhibit extensive abrasion, consistent with an environment at least occasionally dominated by current processes, but most are well preserved. There are at least three genera of shark new to the Williams Fork Formation. Of the non batoid sharks, Chiloscyllium cf. C. missouriense teeth are the most common collected. Teeth of the hybodont Lonchidion sp. are present, but rare, with Cantioscyllium represented by a single tooth. Ray teeth assigned to Myledaphus are also abundant. Xiphodont osteichthyan teeth are abundant, and some of them are interpreted as belonging to amiids and lepisosteids. Bulbous teeth assigned to Paralbula are present but not as common. After the osteichthyans, crocodyliform teeth make up the majority of fossil teeth collected and include both xiphodont and crushing morphotypes. Most fossils (~80%) are shell and bone fragments. Large turtle shell fragments probably pertain to baenids and trionychids. Confirmed dinosaur remains include isolated hadrosaur teeth and a few teeth belonging to a pachycephalosaur or possibly, an ankylosaur. Mammal teeth from multiple taxa have been recovered, including a bicuspate multituberculate incisor, a probable Cimolodon P4, a Didelphodon DP3, and a possible molar of Cimolomys. Small pieces of amber lacking inclusions are among the rarest fossils collected. Previously reported vertebrates from the J&M site include the amiid Melvius, the turtles Adocus and Aspideretoides, small crocodyliforms, an indeterminate giant neosuchian, Pentaceratops, an indeterminate tyrannosaurid, and a hadrosaurid.

Grant Information:
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Technical Session XV (Friday, August 25, 2017, 3:00 PM)

EXPLORING THE EVOLUTION OF DUROPHAGY IN STAGODONTID METATHERIANS USING RELATIVE MANDIBULAR BENDING STRENGTH

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The Stagodontidae includes some of the largest metatherian mammals known from the Cretaceous of North America. Two genera, *Eodelphis* and *Didelphodon*, are indisputably assigned to this family. Among the two known species of *Eodelphis*, *E. cutleri* is larger, has a more robust jaw, more inflated premolars, and third premolars more specialized for crushing than those of *E. browni*. These dental differences led to the hypothesis that an *Eodelphis cutleri*-like ancestor gave rise to *Didelphodon*, another, mostly younger, stagodontid genus with more robust dental and mandibular morphology.

Previous analysis of the craniodental morphology of *Didelphodon* led to the interpretation that this taxon was a predator-scavenger with adaptations towards durophagy. If *Didelphodon* arose from an *E. cutleri*-like ancestor, then we might expect *E. cutleri* to exhibit adaptations toward durophagy relative to the condition in *E. browni*. To explore such possible trends within Stagodontidae beyond the dental evidence, we investigated mandibular bending strength using beam theory. We made estimates at six interdental gap locations along the jaws of seven *Didelphodon* specimens, four *E. cutleri* specimens, three *E. browni* specimens, and two *Eodelphis* sp. specimens, as well as various other metatherian taxa.

The mandibular bending strength profiles of *Eodelphis* differ from those of *Didelphodon*; dorsoventral and labiolingual bending strength increase linearly from the symphysis to below the ultimate molar, suggesting that the jaw of *Eodelphis* is better suited to handle those forces posteriorly than anteriorly. It is also about twice as deep as it is wide, indicating it is better suited to withstand dorsoventral loads than it is labiolingual loads. Dorsoventral loads generally reflect bite forces. In contrast, jaws of both *D. vorax* and *D. coyi* are relatively wider than those of *Eodelphis*, and their labiolingual bending strength varies little from the symphysis to below the ultimate molar. Higher labiolingual bending strength is associated with greater resistance to lateral movements of struggling prey or from torsional stresses induced by hard-object feeding. The low labiolingual bending strength values anteriorly in the jaw of *Eodelphis* suggest that, among the morphological changes associated with durophagy in stagodontids, the inflated premolar morphology evolved prior to the broad anterior mandibular morphology for large labiolingual loads.

Technical Session X (Friday, August 25, 2017, 9:15 AM)

NEW SILESAURID (ARCHOSAURIA: DINOSAURIFORMES) SPECIMENS FROM THE UPPER TRIASSIC CHINLE FORMATION OF NEW MEXICO AND THE PHYLOGENETIC RELATIONSHIPS OF *EUCOELOPHYSIS BALDWINI*

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The recent discovery of the dinosaurian sister taxon Silesauridae has revolutionized our understanding of the early evolution of dinosaurs and their closest relatives. Silesaurids were predominantly herbivorous and quadrupedal taxa that were geographically widespread during the Middle and Late Triassic. One silesaurid taxon, *Eucoelophysis baldwini,* was described from a single fragmentary postcranial skeleton in the Petrified Forest Member of the Upper Triassic Chinle Formation near Ghost Ranch in northern New Mexico, USA. This limited material has hampered the ability to properly diagnose *Eucoelophysis* and determine its phylogenetic relationships among silesaurids. However, since 2006, our team has recovered abundant silesaurid material at the nearby Hayden Quarry (HQ) from a similar stratigraphic level of the Petrified Forest Member as the *Eucoelophysis* holotype. This material includes a maxilla, dentaries, isolated teeth, humeri, and both associated and isolated pelvic and hindlimb material. Our examination of all available specimens indicates that the *Eucoelophysis* holotype and the HQ pelvic/hindlimb material share a unique combination of character states which distinguish them from all other silesaurids, including a reduction in the size of the fourth trochanter of the femur and an appressed surface along the lateral margin of the tibia. Although the isolated HQ cranial material cannot be directly compared to the holotype of *Eucoelophysis*, it does possess silesaurid synapomorphies (e.g., leaf-shaped teeth ankylosed with the jaw), and there is no evidence to suggest more than one silesaurid taxon in the HQ. Taken together, these data all support the referral of the HQ material to *Eucoelophysis*. Our parsimony phylogenetic analysis (294 characters, 35 taxa) recovers a monophyletic Silesauridae, with a polytomy of *Eucoelophysis* (including HQ specimens), *Diodorus*, *Lutungutali*, *Sacisaurus*, and *Silesaurus*. When *Lutungutali* is omitted as a wildcard taxon, *Eucoelophysis* is recovered as the sister taxon to a clade comprising (*Diodorus* + *Sacisaurus*) and *Silesaurus*. *Eucoelophysis* shares several features with those taxa, such as a Meckelian groove restricted to the ventral margin of the dentary, a Meckelian groove that extends anteriorly through the dentary symphysis, and an enlarged iliac brevis fossa which opens laterally. The results of our study indicate that the diversification of most Late Triassic silesaurid lineages occurred by the Carnian, which is approximately coincident with the initial radiation of dinosaurs.

Grant Information**:**

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

PRECISE 3D PHOTOGRAMMETRY REVEALS NEW INFORMATION ON PTEROSAUR ICHNOTAXONOMY AND TERRESTRIAL LOCOMOTION: REVISITING THE ICHNOHOLOTYPE OF *PTERAICHNUS SALTWASHENSIS*

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For all the prehistoric beasts, the terrestrial locomotion of pterosaurs may be themost complex, controversial, and least well understood. For 170 years followingthe discovery of the first pterosaur fossils in Germany's Solnhofen Limestone,the debate on pterosaur terrestrial locomotion relied solely on studies of theskeletal anatomy. This changed in 1952, when geologist William Lee Stokesdiscovered an enigmatic trackway in the Saltwash Member of the Upper JurassicMorrison Formation of northeastern Arizona. The footprints (preserved on afluvial sandbar) were careful documented, collected, examined, and comparedwith known fossil tracks at the time. Stokes realized that these traces werenot only new to science, but were the first direct evidence of pterosaurswalking on land. In 1957, he established the ichnotaxon *Pteraichnus saltwashensis* for these distinctive tridactyl manus and tetradactyl pes impressions. Sincethis discovery, thousands of similar traces have been found on nearly everycontinent; yet Stokes' description of the 9 consecutive pairs of quadrupedalmanus and pes prints has remained the "gold standard" for all pterosaur trackstudies. Reexamination of the original specimen with new digital documentationtechniques, allows errors from the 1957 paper to be noted and corrected in anobjective manner. Unfortunately, those initial errors have been propagatedthrough the literature, especially when researchers failed to make firsthandobservations on the original specimen. These inaccuracies, combined with thelack of standardized measurements and paucity of 3D digital comparisons, putmany locomotor and taxonomic studies in question. Recent photogrammetricdocumentation of the ichnoholotype at the University of Utah allows for thesubtle details of pterodactyloid locomotion and ichnotaxonomy to be teased outof this unique ichnite. GIS Raster analysis (e.g., exaggeration of the verticaland mapping of slope and curvature) assists in the visualization andquantification of the morphologic variation of this and other digitallydocumented specimens. In addition to ichnotaxonomic revisions, high resolutionanalyses allow for better insights into the kinetics of movements of pterosaurson land and in shallow water.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

INFERENCE OF FEEDING BEHAVIOUR IN A MORPHOLOGICALLY UNIQUE EXTINCT BIRD, THE DODO (*RAPHUS CUCULLATUS*)

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The dodo (Aves: Columbidae: *Raphus cucullatus*) is a striking example of island endemic evolution and secondary flightlessness in birds. Despite becoming extinct relatively recently (late 17th century), only a few, highly fragmentary osteological specimens exist. Compared to extant columbids, dodos have highly modified skeletal anatomy, including changes to the skull. This suggests a distinct ecology for the dodo, but historical observations of living dodos are variable in both their assertions and their quality. The dodo therefore remains an enigmatic creature, and is perhaps best treated as a paleontological taxon. If we are to understand its biology, it must be subjected to the same quantitative analysis as any other extinct animal. A remarkable feature of dodo anatomy is the uncommonly large beak, especially when compared to other pigeons, the family within which dodos are nested. Dodo jaws are deep and robust, with a long mandibular symphysis, suggesting that dodos were capable of strong bites. In contrast, most extant pigeons have particularly slender jaws and engage in very little biting, primarily using pecking and "throw-and-catch" methods to feed. It is therefore of interest to consider how dodos used their beaks to acquire and process food. Using high-resolution CT scanning and Finite Element Analysis (FEA), we compared the lower mandible of the dodo to that of its closest extant relative, the Nicobar pigeon (*Caloenas nicobarica*). We demonstrate that dodos experience lower and more evenly distributed mandibular feeding stresses than Nicobar pigeons, especially during unilateral biting. While this indicates that dodos were capable of forceful bites along the entire length of the jaw, stresses are particularly low when biting at the back of the jaw where lever mechanics dictate that bite forces will be highest. This suggests that dodos were well adapted for crushing, asymmetrical bites. Our results are therefore consistent with isotopic and palaeobotanical evidence that dodo diets comprised mostly fruit and large seeds.

Technical Session I (Wednesday, August 23, 2017, 10:45 AM)

MORPHOGENESIS OF THE EGG TOOTH IN THE LEOPARD GECKO AS A MODEL FOR THE DEVELOPMENT OF DENTAL SIZE VARIATION IN AMNIOTES

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Tooth size can vary along a tooth row in an individual organism, and can also change through ontogeny as the organism grows. However, little is known about the developmental controls regulating tooth size in amniotes. This lack of data makes a comprehensive understanding of the origin of tooth size differences within and among species difficult, and hampers interpretations of the acquisition of heterodonty over evolutionary timescales. In this study, we examine tooth development through embryonic growth in the leopard gecko *Eublepharis macularis* to understand the timing of tooth mineralization and its contribution to sizing differences in teeth. The embryonic leopard gecko has greatly enlarged egg teeth that are shed a few days after hatching, and show a dramatic phenotype for studying size variation. In this study, we aimed to: 1) quantify differences in tooth size at the very earliest stages of tooth development, 2) determine the timing of tooth development in the context of skull development, and 3) visualize the mineralization pattern in egg and marginal teeth in ovo. To do this, 40 specimens were fixed at different developmental stages: 14 days post-oviposition to hatching. Specimens were examined with microCT, histology, and immunofluorescence. Cells in developing tooth buds were counted as a proxy for the size of the tooth germ at all developmental stages. Results show that the cranial ossification pattern is not typical of squamates, as the neurocranium is the first to ossify rather than the dermatocranium. The egg teeth

begin mineralization prior to the ossification of the jaw elements, while the marginal teeth mineralize after ossification. The first initiating marginal teeth correspond to the areas of highest ossification on the maxilla and dentary. In addition to initiating one week earlier than the marginal teeth, the tooth germs for the egg teeth are larger than the marginal teeth at equivalent developmental stages. At hatching, the egg teeth are five times larger than the marginal teeth. This shows that the large size of the egg teeth is determined through earlier initiation as well as allocation of more cells to tooth germs. The differences in developmental time that create tooth size variation along a tooth row may be a key factor in the evolution of heterodont dentitions. These data will serve as a model as part of a larger framework addressing the relationships between tooth mineralization, tooth size, and tooth replacement rates in the evolution of heterodont dentitions in synapsid and diapsid lineages.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

MOLAR FUNCTION OF JURASSIC PSEUDOTRIBOSPHENIC DOCODONTS (MAMMALIAFORMES) AND TRIBOSPHENIC *MONODELPHIS* (DIDELPHIDAE) IS SIMILAR IN CRUSHING AND GRINDING EFFICIENCY

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Tribosphenic molars with a lower crushing basin (talonid) and an upper corresponding cusp (protocone), known since the Jurassic (*Juramaia*), are widely recognized as key innovations within the therian stem line. They perform an enhanced crushing and grinding function during mastication. The mammaliaform docodonts evolved independently from the therian stem lineage a derived molar dentition with crushing basins and interlocking cusps.

Molar function of the Late Jurassic docodont *Haldanodon* was compared with that of the extant insectivorous marsupial *Monodelphis*, which has retained a largely tribosphenic molar pattern. Molar function was studied by virtual reconstruction of the mastication cycles with the OFA software, using 3D-models of molars reconstructed from µCT data. Tracing the contact area for individual wear facets during the chewing stroke shows that grinding lasts longer and involves a relatively larger surface area in *Monodelphis* than in *Haldanodon*. Therefore, grinding is obviously more efficient in the tribosphenic *Monodelphis*. Other insectivorous docodontan taxa such as the tegotheriids developed an additional basin on the lower molars accompanied by an additional interlocking cusp Z on the upper molars. This provides additional surface area for grinding and makes the teeth functionally more similar to the tribosphenic molars of *Monodelphis* than those of *Haldanodon* are.

In tribosphenic molars crushing is the more important function compared to grinding. Although the basins of *Monodelphis* molars are relatively larger than those of the *Haldanodon* molars, crushing might actually be equally efficient in both taxa. Striations on *Haldanodon* molars indicate a two-phased power stroke. The first phase was an upward movement into centric occlusion. The second phase either was a downward movement following centric occlusion or an independent upward movement. At least in the case that *Haldanodon* indeed performed two separate upward movements of the lower molars into centric occlusion, crushing would have lasted significantly longer than it does in *Monodelphis*. This most probably compensated for the smaller basins. The tegotheriids with their additional lower basin most likely even surpassed the crushing ability of *Monodelphis*.

Although docodontan molars performed in a similar efficient way as tribosphenic molars, their thin enamel made them much more prone to abrasion and the concomitant loss of efficiency. Therefore, it is likely that the tribosphenic molars provided a longer-lasting functionality during lifetime.

Grant Information:
DFG FOR 771

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A RE-EXAMINATION OF *MILOSAURUS MCCORDI*, AND THE EVOLUTION OF BODY SIZE IN CARBONIFEROUS SYNAPSIDS

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Milosaurus mccordi was described in 1970 as a large pelycosaurian-grade synapsid from the late Carboniferous ofIllinois, but has since received little attention. Here the holotype and referred material of *Milosaurus* is re-examined and incorporated into a recent phylogenetic analysis. *Milosaurus*is found to be the sister to Sphenacomorpha, sharing with this clade the posterodorsally expanded ischiumand the calcaneum with a greater length than width, but the more plesiomorphicischium indicates it is an outgroup to the clade rather than within it. Most of the referred material shows very little overlap with the holotype, and so most was not included in the cladistic analysis. However, what was originally described as a dorsal rib is judged to be a femur, sharing a highly distinctive morphology with the holotype.

With an estimated body mass of 41 kg, *Milosaurus* represents one of the largest Carboniferous synapsids. Large size evolved at least twice independently in Sphenacomorpha during the Pennsylvanian: once in Sphenacodontidae and once in Edaphosauridae. Using comparative phylogenetic methods, we re-examined body size evolution in sphenacomorphs with *Milosaurus* included. *Milosaurus* is found to represent an independent evolution of large size, but with its trait evolution considerably slower than was observed in the other sphenacomorph clades, indistinguishable from evolution under Brownian Motion. Nevertheless, as one of the earliest appearances of large body size in the amniote fossil record and the outgroup to the most diverse Paleozoic synapsid lineages, *Milosaurus* represents a crucial taxon for understanding early terrestrial ecosystems.

Technical Session XIX (Saturday, August 26, 2017, 3:30 PM)

VERTEBRAL MORPHOMETRICS AND LUNG STRUCTURE IN NON-AVIAN DINOSAURS

BROCKLEHURST, Robert J., University of Manchester, Manchester, United Kingdom

Studies on the evolution of the respiratory system in dinosaurs have mostly focused on the presence and distribution of post-cranial pneumaticity as evidence of avian-style air sacs. However, this only provides indirect information about the structure of the lungs themselves. In extant sauropsids, the dorsal surface of the lungs adheres to the vertebral bodies and to the rib heads; as a result, axial morphology directly affects the gross morphology of the lung, and can be used as an osteological correlate of lung structure in fossil taxa. In extant birds, the costovertebral articulations are very separate- the parapophysis lies on the centrum while the diapophysis lies at the tip of the transverse process. The ribs are strongly forked, creating a furrowed thoracic ceiling, and the rigid lungs are incised by the proximal ribs. In crocodilians, the parapophysis migrates onto the transverse process towards the diapophysis. This reduces rib forking, and creates a smooth thoracic ceiling, associated with compliant lungs ventilated by the fore-aft motion of the "hepatic-piston" visceral pump.

To test potential similarities of dinosaurian lungs to extant archosaurs, vertebral morphology (as a proxy for lung structure) in birds, crocodilians and a wide range of dinosaurian taxa was quantified using a combination of linear and geometric morphometrics. Principal components analysis showed the first two PCs, which explained the majority of shape variation (>60%), were both strongly loaded by the positions of the costovertebral articulations (which directly relate to lung structure). Results of a Procrustes ANOVA show that whilst all dinosaur groups analysed had vertebrae more similar to birds than to crocodilians (lower Procrustes distance between mean shapes), fossil taxa still occupied distinct regions of morphospace, significantly different from either birds or crocodilians. These results suggest dinosaurs had heterogeneously partitioned lungs, differentiated to some degree, but not entirely separated into a lung-air sac system as in birds. As predicted, theropods and then sauropods were the most similar fossil groups to extant birds, and presumably had the most heterogeneous lung structure. Whilst ornithischian dinosaurs were the least similar to birds- even less so than deeper diverging dinosauromorphs- ornthisicans were also completely separate from crocodilians. Therefore, this analysis does not support the presence of a crocodilian-like visceral pumping mode of ventilation in Ornithiscia.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

EARLIEST EOCENE PERISSODACTYLS (MAMMALIA, LAURASIATHERIA) OF EUROPE: REVIEW AND NEW DISCOVERIES

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The Perissodactyla – the group that includes extant horses, tapirs and rhinos - are known from the Paleocene of Asia, but they appeared in Europe and North America during the Paleocene-Eocene transition. The phylogenetic position of perissodactyls among placental mammals is highly controversial with various conflicting hypotheses including possible affinities with South American native ungulates. New fossil data from the earliest Eocene locality Le Quesnoy (MP7 biohorizon, Paris Basin, France), and the revision of the fossils from Rians and Palette (MP7, Southern France) shed new light on the basal diversification of perissodactyls in Europe, and their phylogenetic relationships with taxa known from Asia and North America. Two new species documented by dental and postcranial elements have been recognized in Le Quesnoy. The first shows phylogenetic affinities with *Pliolophus* from the London Basin but it is clearly distinctive from species of Southern France. It displays a combination of primitive features that makes it the most primitive hippomorph known. The fossils from Southern France, first identified as belonging to *Cymbalophus*, are clearly distinctive from this genus and from all other genera from Northern Europe, thus confirming the hypothesis of a strong provincialism between Northern and Southern Europe during the early Eocene. The second species from Le Quesnoy shows closest affinities with the Asian ‘isectolophid’ such as *Cardiolophus* and *Chowliia*, and is therefore the oldest known Tapiromorpha from Europe. The new tapiromorph from Le Quesnoy suggests dispersals from Asia to Europe during the Paleocene-Eocene transition whereas the origin of earliest European hippomorphs remains controversial.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

TWO NEW THEROPODS DESCRIBED FROM ASSOCIATED MATERIAL FROM THE LOWER CRETACEOUS GRIMAN CREEK FORMATION OF LIGHTNING RIDGE, NSW, AUSTRALIA

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The fossil record of Australian theropods consists almost exclusively of isolated skeletal elements recovered predominantly from Cretaceous rocks of Queensland, New South Wales, and Victoria. Only two representatives of Australia's Cretaceous theropod diversity—both megaraptorid allosauroids—are known from associated material: *Australovenator wintonensis* from the Cenomanian–Turonian Winton Formation in central Queensland; and an unnamed taxon (LRF 100–106) from the Albian Griman Creek Formation in northern New South Wales. Examination of additional material recovered from the Griman Creek Formation near Lightning Ridge indicates the presence of non-megaraptorid theropod taxa.

Two associated, partially preserved caudal vertebrae are attributed to a medium to large-bodied theropod. The largest is presumed to be the anteriormost caudal and lacks pneumatic fossae on the centrum that characterise megaraptorids. A fossa on the neural arch near the base of the transverse process may be pneumatic, recalling similar features on the caudal vertebrae of *Acrocanthosaurus* and *Alioramus*. The posterior placement of the neural spine and postzygapophysis is reminiscent of large-bodied non-

maniraptoriform tetanutans, specifically carcharodontosaurids and tyrannosauroids. The smaller caudal centrum has a sharp ventral keel characteristic of carcharodontosaurids. These vertebrae are interpreted to belong to a non-maniraptoriform avetheropodan with possible carcharodontosaurian affinities. Another two vertebrae pertain to the dorsal region of a small-bodied theropod. The most complete of the two bears a pronounced ventral keel, a stout dorsolaterally-directed transverse process and a very large neural canal, approximately as large as the central articular facets. The last feature is common to many small-bodied tetrapods; however, the presence of laminae and apneumatic fossae on the transverse process indicates saurischian, and specifically theropod, affinities. The vertebra has no discernable avialan synapomorphies. In addition, a lack of neural arch pneumaticity and stalked parapophyses distinguishes it from the abelisauroid *Masiakasaurus* and alvarezsaurids respectively, both of which have relatively large neural canals. These vertebrae are attributed to an indeterminate maniraptoriform. Together, these finds increase the diversity of Cretaceous theropods known from Australia and denote Lightning Ridge as the second most diverse Cretaceous theropod locality in Australia behind the south coast of Victoria.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE PALEOBIOGEOGRAPHICAL AND PALEOENVIRONMENTAL IMPLICATIONS OF A WHATCHEERIID-LIKE TETRAPOD FEMUR FROM THE UPPER DEVONIAN CATSKILL FORMATION IN NORTHCENTRAL PENNSYLVANIA

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The Catskill Formation of northcentral Pennsylvania contains diverse assemblages of Late Devonian continental organisms. Several vertebrate fossil sites were recently discovered at roadcut exposures in northern Lycoming County. Identifiable vertebrate remains at these sites include at least four genera of placoderms (*Bothriolepis*, *Phyllolepis*, *Groenlandaspis*, and *Turrisaspis*), one genus of acanthodian (*Gyracanthus*), several genera of sarcopterygian fishes (*Holoptychius*, *Eusthenodon*, megalicthyid, rhizodontid), and an isolated left femur of a whatcheeriid-like tetrapod. These discoveries reinforce that early tetrapods were members of diverse vertebrate communities occupying Late Devonian alluvial plain depositional facies. Previously, early tetrapods from the Catskill Formation were limited to the Red Hill site in Clinton County, which is located approximately 30km west of the recently-discovered sites. Two species of early tetrapods have been described from Red Hill including *Hynerpeton basseti* and *Densignathus rowei*. Other cranial and post-cranial tetrapod elements from Red Hill compare favorably with whatcheeriids including an isolated left femur which bears a striking resemblance to the recently-discovered tetrapod femur from northern Lycoming County. The discovery of early tetrapod material from another site in the Catskill Formation indicates that tetrapods were more widespread in the Catskill alluvial plain than previously recognized. Coupled with recent discoveries of whatcheeriid tetrapod elements in Upper Devonian strata of Belgium, this discovery shows that whatcheeriid-like tetrapods were distributed widely across Euramerica in the Late Devonian and became more globally distributed during the early Carboniferous.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

OSTEOHISTOLOGICAL EVALUATION OF THE SQUAMOSAL IN *TRICERATOPS HORRIDUS*

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Ceratopsian dinosaurs are characterized by an array of cranial ornamentations including post-orbital horns and a frill composed of the parietal and squamosal. In *Triceratops horridus* the frill undergoes drastic morphological shifts throughout ontogeny, progressing from a thickened condition towards a thinner, variably fenestrated state in later stages of development. It follows that the ontogenetic stage of even fragmentary cranial material might be osteohistologically assessed. Previous osteohistological evaluation of *Triceratops* was limited to the parietal and documented a complex series of changes closely associated with ontogenetic stage; however, osteohistological patterns of the squamosal have yet to be documented. Newly recovered material from the squamosal of *T. horridus* (BCGM 10272) was histologically sampled and compared with previously published specimens for which age estimates were available. We also used measures of the occipital condyle as an independent metric of ontogenetic stage.

Morphological assessment of gross osteological characteristics (exclusion of the supraoccipital from participation in the foramen magnum; relative size and thickness of frill; reduction of the episquamosals) suggests that BCGM 10272 represents a sub-adult individual of *T. horridus*. Furthermore, the presence of relatively disorganized, fast-growth primary bone in concert with fully formed Haversian systems suggests that terminal growth had not been achieved in the sampled individual. Transverse histological sections of the squamosal reveal mineralized fibrous lineations longitudinally oriented along the lateral margin, and are interpreted as intratendinous metaplastic mineralization. Secondary osteons are abundant, frequently elongated and oriented along the lateral length of the squamosal. In summary, our results suggest that the osteohistological patterns observed in the squamosal and parietal of sub-adult to adult *T. horridus* are consistent with one another and with independent assessments of relative ontogenetic stage based on measures of the occipital condyle.

Technical Session XVI (Saturday, August 26, 2017, 12:00 PM)

NEW EXCEPTIONALLY PRESERVED NODOSAUR (ORNITHISCHIA: ANKYLOSAURIA) EXHIBITS EXTENSIVE EPIDERMAL SCALES, *IN SITU* OSTEODERMS, AND THEIR ASSOCIATED KERATINOUS SHEATHS, AND REVEALS STRONG POSITIVE ALLOMETRY IN THE BOTH BONY OSTEODERMS AND HORNY SHEATHS

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Research on extant animals has illustrated that secondary sexual characteristics often show strong positive allometric growth. As such, documenting patterns of relative growth in dinosaurs exhibiting bizarre and exaggerated structures has been a focus of many researchers. Strong positive allometry in putative display structures has been shown for a variety of dinosaurs, including the crests of Hadrosauridae, horns and frills of Ceratopsia, and domes of Pachycephalosauria. Despite the armoured thyreophorans (Stegosauria and Ankylosauria) possessing diverse and apomorphic osteoderms, the morphometrics and relative growth of these bony components of the dermis have rarely been investigated.

A new nodosaurid ankylosaur, from the Early Cretaceous of northern Alberta, preserves *in situ* osteoderms, and extensive epidermal structures (preserved as dark organic residues), across the head, neck, back, sides, forelimb and undersides of both fore and hind feet. Unlike previous ankylosaur specimens with *in situ* armour, here the organic epiosteodermal scales, often in the form of horn-like sheaths, are preserved capping and exaggerating nearly all bony osteoderms. This exceptionally preserved specimen allows for documenting the rarely preserved soft tissues forming the horny sheaths, and a study of osteoderm morphometrics and allometry.

A total of 172 axial osteoderms were measured for up to 4 linear metrics. Osteoderm spine length is positively allometric (slope=1.2, CI=1.1-1.3) with respect to basal length. Despite tight correlation amongst all other osteoderms, the large parascapular spines represent consistent outliers. Thickness and relative contribution of the keratinized epiosteodermal scales/sheaths varies greatly by region, making up only 1-5% of the overall height in posterior thoracics, increasing to 10-20% of the cervicals and ~33% for the parascapular spine. Relative to the bony cores, the horny portions of the spines are strongly positively allometric (slope=2.3, CI=1.8-2.8).

Although the original evolutionary drivers of nodosaur osteoderms may have been for predator defense, the strong allometric growth, species-specific morphology, and significant keratinous extension of the cervicoscapular spines is consistent with their elaboration being driven by socio-sexual selection. Previous studies of allometry in ornithischians were limited to bones, this marks the first time patterns of relative growth in soft tissues have been established.

Grant Information:
Royal Tyrrell Museum of Palaeontology, Royal Tyrrell Museum Cooperating Society, National Geographic Society

Preparators' Session (Thursday, August 24, 2017, 9:15 AM)

EIGHTY PERCENT FASTER AND GOOD ENOUGH? A MORE PRACTICAL PROCESS TO PRODUCE PHOTOGRAMMETRIC MODELS OF VERTEBRATE MICROFOSSILS IN THE 0.5-2 MM SIZE RANGE

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I have previously presented a protocol to produce research-quality photogrammetric 3D models of vertebrate microfossils using inexpensive equipment and readily available software. That process uses focus-stacked images to enhance depth of field at high magnification. While the method yields research-quality models, image capture is a laborious manual process that often requires 8 to 9 hours to adequately photograph a single rodent tooth. This makes it impractical for the digitization of large datasets. Alternatively, high depth-of-field can be achieved using a "pinhole" aperture. The downside of pinhole apertures is that they can produce significant diffraction effects that tend reduce overall image quality. When used in photogrammetric reconstruction this leads to reduced model quality relative to those produced with focus-stacked images.

Here I explore the addition of a pinhole aperture to my equipment and the results of several experiments designed to test whether the expected decrease in model quality is small enough to be a reasonable price to pay for the savings in image capture and processing time. I used the same upper second molar of a shrew (*Sorex sp.*) I used previously to test the quality of models generated using focus-stacked images. As in the earlier study, I developed rarefaction curves by plotting the number of photos randomly drawn from sets of 220 photographs against the Dirichlet Normal Energy (DNE) of the best surface model generated for that subset. For each photoset, I retained models with DNE values greater than the lower 95% confidence bound for the asymptote of its curve for further analysis. On average DNE values of the pinhole models are 45% lower than those of the focus-stacked models. 3D geometric morphometric analysis revealed clear differences between the focus-stacked and pinhole models. While the differences are clear, the overall magnitude appears to fall within the range of what would be expected within a single population, and not so large as to be interpreted as separate species. This suggests that with a little more development the pinhole method could provide a practical inexpensive means to generate large 3D datasets of very small specimens.

Technical Session XX (Saturday, August 26, 2017, 2:00 PM)

THE BRAINS AND SENSES OF EARLY PLACENTAL MAMMALS: NEW INSIGHT FROM CT AND NT SCANS OF PALEOCENE SPECIMENS FROM NEW MEXICO, USA

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Modern mammals have many features that set them apart from other vertebrates, including the proportionally largest brains relative to body size and a novel elaboration of the forebrain called the neocortex, which imparts heightened intelligence, memory, and senses. Recent studies of Mesozoic-aged fossils have started to clarify the early evolution of the mammalian brain, but much less work has focused on the brains and senses of the oldest placentals, making it difficult to understand how neurosensory systems may have affected the survivorship and subsequent radiation of mammals across the K-Pg extinction. We used high-resolution x-ray computed tomography (CT) and neutron computed tomography (NT), the latter of which has rarely been applied to vertebrate fossils, to reconstruct the brain endocast, inner ears, cranial nerves and vasculature of

several ‘archaic’ placentals from the Paleocene of New Mexico. These taxa—which include the taeniodont *Onychodectes*, the periptychid ‘condylarth’ *Carsioptychus*, the phenacodontid ‘condylarth’ *Tetraclaenodon*, the problematic ‘condylarth’ *Chriacus*, and other species—lived within the first few million years of the extinction and are either primitive placentals or early members of the major modern placental lineages. In general, these specimens show that early placentals had relatively smaller and simpler brains compared to most modern species, but often had their own unusual features. For example, *Onychodectes* had a small neocortex and an encephalization quotient (EQ) of ca. 0.10, which is much less than most modern mammals, but apomorphically enlarged olfactory bulbs that are among the largest (in proportion to cerebrum size) of any mammal known, which indicates a strong reliance on olfaction. *Carsioptychus* also has a proportionally small brain, small neocortex, and low EQ. However, its semicircular canals indicate that it was about as agile as extant boars, and its cochlear measurements suggest that it had a high range of hearing sensitivity, in line with that of modern terrestrial mammals. Coupled with information on other ‘archaic’ taxa (e.g., the recently described *Alcidedorbignya*), the new data present an ecological model for primitive placentals: they had smaller brains and likely simpler intelligence than extant placentals, but often had keen senses. It seems unlikely that high intelligence was a factor that helped placentals survive and radiate immediately after the K-Pg, but keen smell and hearing may have been key adaptations involved in the initial diversification of Placentalia.
Grant Information:
National Science Foundation (EAR 0207750, EAR 1325544, DEB-1654952), BLM, Marie Curie Actions (CIG 630652), Royal Society (RG130018), New Mexico Consortium.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

IS THE MAMMALIAN PRESTERNUM COMPOSITE? EVIDENCE FROM *PARAMYLODON HARLANI*

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The evolutionary remodeling of the mammalian forelimb from a laterally divergent to a parasagittal orientation was accompanied by a dramatic transformation of the shoulder girdle. A key feature of this transformation was the reduction of the number of girdle elements, likely the result of both element fusion and loss. Here we ask whether the presternum (typically identified in living mammals as the manubrium) of the giant ground sloth *Paramylodon harlani* is a single element and the presumed homolog of the manubrium of multituberculates and monotremes. Alternatively, it may represent a composite structure produced by fusion of the ancestral manubrium, interclavicle, and/or adjacent elements. *Paramylodon* is a useful taxon for examination of the eutherian sternum due to the potentially basal phylogenetic position of Xenarthra among placentals, large body size, and the availability of multiple specimens. Additionally, the scapular blade and (meta)coracoid are discrete elements in many extinct and extant pilosans, suggesting a delayed pattern of ossification. *P. harlani* presterna collected from the La Brea Tar Pits exhibit transitions in external bone texture indicative of composite organization. Internal structure was studied in four specimens using CT scans. Scan analysis indicates the presence of two major components differing in bone texture, density, and location. A more dense anterior and dorsal component comprises the area of clavicular articulation, while a less dense posterior component comprises areas that articulate with the first sternebra and the second rib. The boundary separating these components varies among individuals. Surprisingly, all four specimens also exhibit spatially discrete bilateral components of mixed histology that are restricted to the immediate area of articulation with the first rib. These lateral components, reminiscent of the short rib homologs that bridge the gap between the primaxial first sacral vertebra and the abaxial ilium in extant mammals, suggest a possible developmental mechanism for the integration of tissues of different mesodermal origins into a single bony element. These results strongly imply that the *P. harlani* presternum is a composite structure produced by evolutionary fusion of the interclavicle and the ancestral manubrium.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

CONGRUENCE BETWEEN TARSOMETATARSUS OSTEOLOGY AND TRACK MORPHOLOGY IN EXTANT SHOREBIRDS, AND IMPLICATIONS FOR CRETACEOUS BIRD TRACK ICHNOTAXONOMY AND PALEODIVERSITY

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Tracks are often the best record of the presence of Cretaceous shore- and wading bird analogs in many formations. While the diversity of Cretaceous bird tracks is growing, and our knowledge of natural variation in bird tracks is increasing, it is still unclear how the morphology of the pelvic skeleton (pelvic width, lengths of femora, tibiotarsi, tarsometatarsi) influences the morphology of avian tracks and trackways. Extant Charadriiformes provide a test group for determining the congruence between osteology and track morphology in Cretaceous shore- and wading bird analogs.

Separate sets of skeletal and track linear and angular data were analyzed using discriminant analyses and MANOVA. Analyses on tracks and trackways of extant shorebirds show that tracks Charadriidae and Scolopacidae are significantly different, and that tracks of *Charadrius* are significantly different from those of *Actitis*, *Tringa*, *Gallinago*, and *Recurvirostra*, but not *Calidris*. The variables along which taxa separated are digit divarication I–II, digit divarication II–III, and footprint rotation. In the skeletal analyses, linear and torsion data for tarsometatarsi trochlea for Charadriidae are significantly different from those of both short-legged and long-legged Scolopacidae. This difference is not observed when pelvic, femur, and tibia data are included in the analyses. At the generic and specific levels, the differences are more ambiguous, where genera and species of Charadriidae are significantly different from *Tringa* but not *Calidris*. The variables along which taxa separated were those related to the torsion and displacement of the trochlea of metatarsal II.

As in previous cladistic analyses using extant using extant avian osteology, a preliminary cladistic analysis using pelvic limb characters suggest a systematic signal in the morphology of the distal tarsometatarsus of extant shorebirds: the displacement and torsion of metatarsals II is a synapomorphy for examined species of Charadriidae. This synapomorphy, together with the significantly larger trochlear torsion in metatarsal II of Charadriidae and larger digit II-III divarication in the tracks of Charadriidae, indicates that track morphology has the potential to contain systematic signals, even in the morphologically conservative feet of small Charadriiformes. This has direct implications for known Cretaceous shorebird paleodiversity as known from tracks. Shorebird track morophology, as influenced by distal tarsometatarsus morphology, may contain systematic as well as ecological data.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

AN INVESTIGATION OF PATHOLOGICAL VERTEBRAE IN SAUROPOD DINOSAURS FROM THE UPPER CRETACEOUS MAEVARANO FORMATION OF MADAGASCAR

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A collection of disassociated caudal vertebrae of two titanosaurian sauropod taxa (*Rapetosaurus* and “Malagasy Taxon B”) from the Upper Cretaceous Maevarano Formation of Madagascar record unusual osteopathological erosive lesions. In a survey of 74 caudal vertebral centra from at least 30 individual sauropods, abnormalities were identified in over 60% of the vertebrae (n = 46) and were most common in Malagasy Taxon B. Lesions vary in shape and size, are found throughout the caudal series, and are present on both articular surfaces. In some specimens, multiple lesions occur on a single surface. Abnormalities are most common in the distal caudal centra, though they also occur in middle and proximal vertebrae. Pit-shaped lesions are most prevalent, with a 37% occurrence. Curvilinear and elliptical shapes each occur in ~ 20% of centra, while other node morphologies are less common. In some centra multiple node morphologies co-occur. Statistical tests indicate that there are significant relationships between node location, node morphology, and taxonomy. Similar pathologies have been described as Schmorl’s nodes/subchondral cysts, or the osteological signal of osteomyelitis. Schmorl’s nodes result from intervertebral disc herniations in mammals. Analagous structures in taxa with synovial intervertebral joints have been termed subchondral cysts and are the result of a ruptured articular cartilage combined with penetration of synovial fluid into subchondral spaces. These types of spinal pathology occur under bending or compressive loads, and often relate to the weakening of the vertebral column in senescent individuals. The structures in the Malagasy sauropods are also morphologically similar to draining sinuses formed in response to osteomyelitis, a bacterial infection. Lesions in *Rapetosaurus* and Malagasy Taxon B may be related to any of these processes. Their frequent occurrence in the juvenile titanosaur sample we report may reflect biomechanical loading in the caudal region, perhaps linked to an unknown behavior in young sauropods, or it may relate to regular osteomyelitis, perhaps in the context of malnutrition or immune-suppression in the drought-stressed ecosystem that typified the Maevarano Formation.
Grant Information:
Grants from the National Science Foundation supported this work (EAR-0955716 and EAR-1528273).

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

CERATOPSIAN BRAINCASE MORPHOLOGY AND PALAEONEUROLOGY THROUGH ONTOGENY

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Palaeoneurological studies have long been thought to provide insight into behaviour of extinct organisms and are relatively well represented in palaeontological literature. Analyses of patterns in neurological development through ontogeny, however, are much less common. The development of cognitive abilities throughout ontogeny is of particular interest for the Ceratopsia; a group of non-avian dinosaurs for which many behavioural theories have previously been posited. Regrettably, ceratopsian braincases are often neglected in contemporary palaeontological studies due to the high level of fusion and consequent obscurity of sutures, however characterising any major changes occurring in this area during growth may further inform theories of mental development.

Due to their basal evolutionary position, Asian ceratopsians represent an extremely important set of taxa within Ceratopsia. Here we use an ontogenetic series of *Psittacosaurus lujiatunensis* specimens as a basis for a study into morphological disparity levels with ceratopsian palaeoneurological architecture during growth. We find that the braincase alters significantly as ontogenesis progresses. For example, as *P. lujiatunensis* grows, the supraoccipital undergoes dramatic morphological changes and reduces in size to make way for the expanding parietal. We also explore semi-circular canal plasticity in relation to the posited postural change of this species during ontogeny. There appears to be some change in semi-circular canal morphology that might support previous postural shift theories. We might expect sutural boundaries to become increasingly obscured through growth, a common assumption in comparing juvenile and adult crania. However, unexpectedly, we see relatively low levels of sutural fusion, even in the adult.

This has been a rare opportunity to acquire detailed 3D information on numerous ontogenetic stages of a single dinosaur species, from hatchling through juvenile to adult, and to link the various allometric and morphometric deviations from isometry to wider function. In further work, these studies will provide an excellent basis for comparison with more derived neoceratopsians from North America and for exploration of ontogeny-phylogeny links.
Grant Information**:**
Geological Society of London - William George Fearnsides Fund

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SEM AND THIN SECTION ANALYSIS OF PREVIOUSLY UNIDENTIFIED EGGSHELL FROM EGG MOUNTAIN

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Recent excavations at Egg Mountain have yielded a wide variety of eggshell material. While much of this eggshell can be assigned to known species such as *Troodon,* or ootaxa such as *Continuoolithus*, some of it remains unidentified. This study examines some of this unidentified eggshell and compares it to other fossil eggshell as well as to the eggshells of extant species.

The material consists largely of small shell fragments, several clusters of eggshell pieces, and some larger fragments. Based on the curvature of the larger pieces, a complete egg would measure approximately 3 cm in diameter. The eggshell is relatively thin (0.3-0.4 mm) and entirely smooth.

Although these specimens all appear similar in hand sample, they belong to at least two different animals. Based on SEM and thin section data, some specimens are probably avian, while others are probably crocodilian.

Grant Information:
Presidential Emerging Scholars grant.

Technical Session XVII (Saturday, August 26, 2017, 8:15 AM)

ASSESSING THE PALEOBIOGEOGRAPHIC HISTORY OF *LEMMISCUS CURTATUS* (MAMMALIA, RODENTIA): SINGLE SPECIES OR SPECIES COMPLEX?

BURROUGHS, Robert W., University of Chicago, Chicago, IL, United States of America

The Sagebrush Vole, *Lemmiscus curtatus*, ranges across the northerwestern United States and southern Canada today. Its fossil record extends back two million years (2My) across the American southwest. This history contains a purported anagenetic transition: an increase in the number of closed enamel triangles of the lower first molar (m1). Because *L. curatus* can be identified from isolated m1s, it is a compelling system for the study of evolutionary processes. To do this it is important to understand the evolutionary relationships between populations in the present and the past. Here, I present a biogeographic analysis of *L. curtatus* populations over the last 2My. I measured the order and disorder of populations across the spatiotemporal distribution of *L. curtatus*. Measures of order/disorder investigate if population distributions across time and space represent a series of nested or disjunct populations. Greater disorder suggests increasingly isolated populations (lower nestedness) and a higher probability of extinction. The measure for disorder is matrix temperature, scaled between 0º and 100º, with 0º being complete order (nested) and 100º being complete disorder (no nestedness). I investigated the distribution of five different morphotypes (characterized by triangle number) across six spatially distinct *L. curtatus*-bearing localities.

I found that disorder increases for populations moving towards the present; from 0º in the oldest time bin to 37º in the youngest time bins. All null models of random distribution are rejected with high temperatures (average temperature of 100º). Temperature remains relatively low (below 12º) until the youngest time bin (10-7.5kya), where temperature increases to 37º, indicating increasing disorder. Two of the five morphotypes also go extinct in this bin. This suggests that there is strong nestedness amongst fossil populations of *L. curtatus* over the past two million years, but with increasing disorder moving towards the present. Increasing disorder could suggest increasing isolation amongst all populations of *L. curtatus* suggesting incipient speciation. But increasing disorder can also be reflective of differential extinction (which occurs here). Overall, this study provides evidence for the idea that the fossil localities represent populations of a single species. This justifies moving forward with a broad scale phylogeographic analysis of *L. curtatus* populations (past and present) which can be used to investigate evolutionary process over the 2My history of *L. curtatus*.

Technical Session V (Wednesday, August 23, 2017, 3:45 PM)

PATTERNS OF ALPHA DIVERSITY FOR PHANEROZOIC TERRESTRIAL VERTEBRATES

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Vertebrate life on land today is richly diverse, but there is intense debate as to how that diversity accumulated through geological time. This debate reflects two alternative views on how to interpret the fossil record. The 'literalist' view argues that global diversity curves based on raw fossil data are reliable and not significantly affected by heterogeneous sampling. This has been used to argue that terrestrial diversification was unconstrained, with a 10-fold increase in species richness over the last 100 million years. The alternative view is that uncorrected diversity curves are biased by major variation in sampling intensity, and sampling-standardised approaches generally support constrained diversification, likely governed at the regional level by diversity-dependent processes. We address this debate by using Paleobiology Database data to document patterns of uncorrected alpha diversity (=species sampled per fossil locality) for terrestrial, non-flying tetrapod species from the Carboniferous to the present. Alpha diversity is less susceptible to biases that afflict larger spatial scales; it has been examined in detail for the marine realm, but is remarkably understudied for terrestrial taxa. Alpha diversity patterns were calculated for global tetrapods, as well as for key subtaxa (e.g. mammals, dinosaurs, squamates) and geographic regions. An initial increase through the Carboniferous was followed by only small increases through the Permian and Mesozoic. A step-change occurs across the Cretaceous-Palaeogene boundary, with diversity at least doubling, followed by little further change through the Cenozoic. A Pliocene–Pleistocene spike in alpha diversity likely results from intensive bulk sampling of unlithified sediments, as well as an expansion in sampling of equatorial localities and cave deposits. Taken at face value, our results are consistent with richness at the local community level being constrained by diversity-dependence. However, estimates of temporal variation in beta diversity will be needed in future to establish how these alpha diversity patterns might scale up to global diversity curves.

Grant Information:
Funded by a European Research Council Starting Grant (grant agreement 637483)

Technical Session XVI (Saturday, August 26, 2017, 9:45 AM)

REACHING CONVERGENCE: BIOMECHANICAL ANALYSIS OF THE FEEDING APPARATUS INDICATES CONSERVED FUNCTIONAL PATHWAYS IN THE EVOLUTION OF SAURISCHIAN HERBIVORY

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Evolutionary convergence is a widely-cited biological phenomenon. Despite this, quantitative testing of hypothesized instances of convergence between clades through macroevolutionary time is rare. Saurischian dinosaurs exhibited multiple independent acquisitions of herbivory during the Mesozoic, making them an ideal case in which to test for convergence as a result of the evolution of specific ecologies. Gross anatomical similarities in the skull are observed between select herbivorous taxa, yet morphology alone can be a poor predictor of performance. By contrast, biomechanical studies have provided less support for functional convergence between herbivorous clades. However, these studies have been limited in phylogenetic scope: patterns of convergence may be unrecognizable outside of a robust phylogenetic framework. Consequently, the degree of constraint acting upon saurischian dietary evolution is presently equivocal.

To address this, a series of biomechanical characters, together describing the functional properties of the feeding apparatus, were measured from saurischian taxa. Sampling included all major Mesozoic herbivorous clades, as well as faunivorous sister-taxa. These data were mapped onto phylogenies to elucidate evolutionary trends, and phylogenetically-controlled comparisons were performed to quantitatively test for functional convergence between herbivorous lineages.

Results demonstrate that most carnivorous theropods were functionally conservative. By contrast, convergent trends towards more robust mandibles with greater leverage for the jaw adductor muscles are observed within non-neosauropod sauropodomorphs and oviraptorids. Interestingly, diplodocoid and titanosaur sauropods, as well as ornithomimosaurians, therizinosaurians and caenagnathoids show antithetical trends towards more gracile mandibles with reduced dentition and less efficient *adductor mandibulae externus* and *profundus* musculature.

These results demonstrate the conservation of functional pathways in the evolution of herbivory in independent saurischian clades. However, the resolution of strongly divergent trends between even phylogenetically proximate groups suggests that skull form remained relatively plastic within these taxa. Instead, the gut-processing physiology of saurischians may have resulted in lesser constraint on the feeding apparatus than in contemporary neornithischian herbivores.

Technical Session I (Wednesday, August 23, 2017, 11:45 AM)

OSTEOLOGICAL CORRELATES OF RHAMPHOTHECA MORPHOLOGY IN BIRDS: RAMIFICATIONS FOR SOFT TISSUE RECONSTRUCTION IN THEROPODS

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A wide variety of amniote clades evolved a keratinized rhamphotheca, including turtles, mammals, and archosauromorphs. Within the latter, beaks have been hypothesized as having independently arisen a minimum of 11 times, alluding to the ubiquitous adaptive significance of this structure in archosaur evolution. Within theropod dinosaurs alone, a rhamphotheca evolved at least five times, and has been linked to dietary diversification. Thus, to understand the success and paleoecology of theropod dinosaurs, the cornified rhamphotheca is a vital structure of interest.

It has previously been proposed that dense vascularization on the surface of the maxillae/premaxillae and dentaries of theropods are osteological correlates of a keratinous covering. However, despite the plethora of avian and non-avian dinosaurs exhibiting remarkable soft tissue preservation recovered from Lagerstätten in China and elsewhere, a comprehensive study correlating bone vascularization and keratin thickness in extant bird rostra has not yet been undertaken. Moreover, although edentulism alone has been assumed to evince the presence of a rostral rhamphotheca, the shape of the soft tissue beak is not always reflected by that of the underlying bone in extant taxa, rendering ambiguous reconstructions in extinct relatives.

To test whether rostral vascularization can be used to predict the extent, thickness, and shape of the rhamphotheca in theropods, we examined its relationship to premaxilla morphology in extant birds. We observed the surface textures of specimens with rhamphothecae removed to quantify the degree of rostral vascularization (defined as the summed areas of neurovascular foraminae per 5 mm transect along the premaxilla). We then took digital x-rays of specimens of the same species and sex with intact beaks, allowing us to differentiate the extent of soft tissue from that of the bone. We recover a significant difference in vascularity between areas of the avian premaxilla covered by the rhinotheca that can be used to predict the extent of this structure in extinct birds; however additional outgroup comparisons are needed to apply these relationships to non-avian theropods. We also performed a simple linear regression between premaxillary vascularization and both keratin thickness and rostral extent of the rhamphotheca, recovering a weak but statistically significant correlation between vascularity and keratin thickness. We found no significant linear relationship between vascularity and extent of the rhamphotheca beyond the premaxilla in birds.

Grant Information:
Project was funded by the Georgia Ornithological Society Bill Terrell Graduate Student Research Award.

Technical Session XIX (Saturday, August 26, 2017, 3:00 PM)

THE EVOLUTION OF CARNIVOROUS DINOSAURS IN RESPONSE TO CHANGING PREY BODY SIZE

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Paleoecological research into the interactions between predatory non-avian dinosaurs and their prey has broadened our understanding of Mesozoic ecosystems. While many of our interpretations of these interactions are built upon analogous comparisons with extant mammals, they still provide a meaningful basis to frame questions about predator diversity, prey acquisition, and competition for resources. There exists the potential that any changes in the composition of prey biota would result in an evolutionary response from the predators, given the energetic requirements of predation (e.g., large predators need to take large prey to sustain themselves) and factors associated with prey choice (e.g., larger prey deter attack). During the Late Jurassic and Early Cretaceous, it was not uncommon to find ecosystems abundant with gigantic herbivorous sauropods that dwarfed the largest predators. But by the Late Cretaceous, ecosystems dominated by ornithischian herbivores that were more equitable in size with the predators became more common. How non-avian carnivorous theropods adapted to these changing biotas is a central aspect that has not been fully resolved. Here, I assess whether they demonstrated an evolutionary response to changes in potential prey. Using a published database of body mass estimates for non-avian dinosaur genera, I compared changes in body mass for using a non-parametric Kruskal-Wallis test. Both herbivores ($p=0.005$) and carnivores ($p=0.04$) experienced a significant drop in body size across the Jurassic–Cretaceous boundary; however, only carnivores experienced a subsequent increase in body size between the Albian and Cenomanian ($p= 0.004$). In addition, the difference in body size between carnivores and herbivores were only significantly different between the Albian and Cenomanian ($p = 0.00$). To test for corresponding changes in morphologic diversity among the carnivores, I sampled 71 maxillae from all major non-avian theropod clades and subjected them to a 2D geometric morphometric analysis of shape. While morphologic diversity remained relatively constant and did not significantly vary until the Campanian and Maastrichtian, there were significant differences between carnivorous theropod faunas (PERMANOVA: $F = 3.716$, $p = 0.001$), especially in the earliest Jurassic and from the latest Jurassic into the Cretaceous, indicative of taxonomic turnover. Taken together, carnivorous dinosaurs did not morphologically adapt in response only to changing prey body size and likely evolved due to several factors.

Technical Session XI (Friday, August 25, 2017, 9:30 AM)

ARE BONES ENOUGH? USING GENOMIC EVIDENCE TO ASSESS HOOFED MAMMAL CRANIAL APPENDAGE HOMOLOGY

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New hypotheses of even-toed, hoofed mammal (Artiodactyla) relationships based on molecular data challenge prior views on the homology of cranial appendages—horns, antlers, ossicones, and pronghorns. These phylogenies even allow equally parsimonious reconstructions of the single and multiple origins of the seemingly disparate permanent horns of bovids and the yearly-replaced antlers of cervids. Homoplastic morphological characters prevent confident placement of fossil taxa without cranial appendages at the base of any extant family, thus the earliest recognized members of each family already possess their respective cranial appendage types. Despite fundamental questions about how they evolved, cranial appendages remain a useful character for assigning fossils to extant artiodactyl subclades. Gene expression homology in artiodactyl cranial appendages is currently untested, yet could show deep homology of cranial appendages if the different types develop by the same genetic pathways. To test gene expression homology for horns and antlers, the similarity, or lack thereof, of their gene expression must be established, thus this study tested the hypothesis that horns and antlers grow through similar gene expression. Genes transcribed in tissues responsible for horn growth were sequenced using next-generation sequencing technology to produce over 200 million sequences representing over 74,000 proteins sequences. Abundances of each protein were computed for horn tissues and published data for normal cattle skin and antler tissues. Statistical significance of differences in the genes expressed in horns and antlers but not skin was determined using Fisher's Exact test. Some gene functions were shared between the two types of appendages; however, the differences in prevalent gene ontologies suggests that although both horn growth and antler growth involve similar stages of intramembranous ossification, gene transcription in the stages sequenced here are broadly dissimilar. Whether this difference relates to entirely separate evolutions of horns and antlers or represents initial outgrowth homology with autapomorphic modifications to growth *after* the intramembranous stage in antlers requires further testing. Morphological variation among fossil taxa ultimately results from variation in gene expression; by integrating genomic and morphological inference, this research shows little support for a single origin of horns and antlers as whole structures, but may suggest parts of cranial appendages are in fact homologous.

Grant Information**:**

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Technical Session XII (Friday, August 25, 2017, 9:00 AM)

EMERGING HEAD FIRST: THE EARLY FOSSIL RECORD OF SNAKE CRANIAL EVOLUTION

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The morphological disparity and species diversity of Late Mesozoic snakes indicate that they diverged from their closest squamate sister taxa through the early acquisition of a series of unique cranial features. The oldest (mid Jurassic–Early Cretaceous) snake fossils are sparse, but include informative cranial specimens of the "*Parviraptor*-like" snakes/stem snakes from Upper Jurassic and Lowermost Cretaceous localities in Laurasia and the newly recognized braincase from the Lowermost Cretaceous of South Africa that shows a "*Dinilysia*-like" morphology. These specimens portend the origins of later Mesozoic snake cranial morphologies from at least the Cenomanian to the Maastrichtian and clearly demonstrate that the various clades of early snakes radiated around specializations of the chondrocranial skeleton (braincase) and dermatocranium (jaws and elements of the suspensorium). From the Early Cretaceous upward, two "groupings" of ancient snakes are recognizable from comparisons of braincase and suspensorial anatomy: 1) "*Dinilysia*-Anilioid" condition, and, 2) the "*Pachyrhachis*-Macrostomatan" condition. The "*Dinilysia*-Anilioid" condition is recognized from fossil skulls beginning in the Valanginian (Lw. Cret.) through to the Maastrichtian (U. Cret.) from widely separated localities that were once part of the Gondwanan southern continental massif. 2) The *Pachyrhachis*-Macrostomatan" condition is recognized from fossil skulls beginning in the Cenomanian through to the Maastrichtian in spatially disparate marine environments of the Tethys and globally distributed SupraTethys Seaway. These two cranial and suspensorial conditions have been retained in descendant sister taxa and remain recognizable amongst modern crown group snakes; these similarities are phylogenetic, not functional (i.e., not convergent), and are diagnosed by character concepts describing the organization of the crista circumfenestralis, quadrate and columella/extracolumellar anatomy, mandibular anatomy, and so on. It is increasingly clear, as illuminated by fossils from the earliest part of the snake fossil record, that the transition from the non-snake lizard common ancestor to the first true snake-lizard, was driven by the evolution of cranial anatomy.

Technical Session XVII (Saturday, August 26, 2017, 8:00 AM)

X-RAY MICRO-COMPUTED TOMOGRAPHY OF PREMOLARS INFORMS THE TAXONOMY OF THE MYLAGAULIDAE (MAMMALIA: RODENTIA)

CALEDE, Jonathan J., Bucknell University, Lewisburg, PA, United States of America; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States of America

The Mylagaulidae are an iconic member of the Miocene faunas of North America well known for their hypsodont teeth. These are worn through the individual's life revealing a complex occlusal morphology composed of enamel lakes. The teeth of mylagaulids are therefore highly variable among individuals and complicate taxonomic assignments in a group of rodents for which cranial and postcranial remains are rare. Such difficulties can be overcome with large samples of teeth, but the ultimate test of the diagnostic value of mylagaulid's dentition would be assessed by considering changes in morphology through wear within individuals. To this end, previous studies have sectioned the diagnostic fourth premolar throughout the crown height. Such destructive techniques have been limited to a few specimens.

We used X-ray micro-computed tomography of over 30 teeth to explore the changes in tooth morphology with wear in mylagaulids and test the reliability of the taxonomic framework of six different species spanning the Barstovian through Hemphillian North American Land Mammal Ages across Oregon and Montana. We tracked the number, size, and orientation of the enamel lakes. We also quantified the complexity of the shape of the enamel lakes using an undulation index developed for the study of plant cells.

Our results largely support the diagnostic values of the occlusal morphology of the mylagaulid fourth premolar, despite intense and variable wear within and across individuals. They also provide quantitative evidence for the taxonomic framework of mylagaulid species. Thus, the number of enamel lakes is significantly different across all three species of the genus *Hesperogaulus* as well as between the two species of the genus *Alphagaulus* studied (*A. pristinus* and *A.vetus*). There are also significantly more lakes in *Hesperogaulus* than *Alphagaulus*. The relative size of the lakes also differs significantly among species; they are larger and longer mesio-distally in younger species. The orientation of the enamel lakes is significantly different between the two species of *Alphagaulus* but not between the species of *Hesperogaulus*. The complexity of the shape of the lakes is consistently greater in upper premolars than in lower premolars. However, it varies little across taxa, except for one specimen of an unidentified, possibly new, species. The trends through time observed across species support the hypothesis that the evolution of tooth morphology in the Mylagaulidae could have been driven by changes in their habitat. Such a hypothesis remains to be rigorously tested.

Technical Session XVII (Saturday, August 26, 2017, 9:45 AM)

MORPHOLOGICAL CORRELATES OF INTERBREEDING IN PLEISTOCENE MAMMOTHS (*MAMMUTHUS*) FROM ALBERTA

CAMMIDGE, Tasha S., University of Calgary, Calgary, AB, Canada; BARRON-ORTIZ, Christina I., University of Calgary, Calgary, AB, Canada; JASS, Christopher N., Royal Alberta Museum, Edmonton, AB, Canada

Recent molecular research utilizing Quaternary mammoth remains suggested that two North American mammoth (*Mammuthus*) species interbred. However, morphological correlates of interbreeding are not well-defined. This discrepancy may stem, at least in part, from a lack of unbiased morphological analyses. Here we develop quantitative morphological criteria to distinguish woolly mammoth (*M. primigenius*) and Columbian mammoth (*M. columbi*), and use these criteria to hypothesize the morphological correlates of interbreeding. Morphological characteristics of molars traditionally thought to separate *M. primigenius* and *M. columbi* include the spacing between enamel bands and the thickness of the enamel. It is generally thought that *M. primigenius* has narrower spacing between individual enamel bands and thinner enamel than *M. columbi*. We collected data on the enamel band spacing (measured as lamellar band frequency), enamel thickness, and tooth width of tentatively identified or unidentified mammoth teeth from Alberta, a geographic area where interbreeding was likely to have occurred. Our data was compared to measurements of teeth from Alaska, which are characteristically only identified as *M. primigenius,* and specimens from California and other western United States localities, which are characteristically only identified as *M. columbi*. A principal component analysis revealed that specimens from Alaska and the western United States form distinct morphological groups. Most mammoth teeth from Alberta are more similar to *M. primigenius* molars from Alaska, with few teeth showing traits similar to *M. columbi*. We also identified a number of specimens showing intermediate morphologies that may be consistent with some degree of interbreeding between *M.*

primigenius and *M. columbi*. Radiocarbon dates for many Alberta mammoths are infinite in age, and, thus, we are currently unable to confirm geographic and temporal sympatry of *M. primigenius* and *M. columbi* in the province. Dating of additional specimens is needed to better understand patterns of temporal and geographic distribution of mammoths in Alberta, although possible evidence of interbreeding would suggest that both taxa co-occurred in Alberta during portions of the late Pleistocene.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A REMARKABLY WELL-PRESERVED ELASMOSAURID (SAUROPTERYGIA: PLESIOSAURIA) SPECIMEN FROM THE UPPER CRETACEOUS (CAMPANIAN) DINOSAUR PARK FORMATION OF SOUTHERN ALBERTA

CAMPBELL, James A., University of Calgary, Calgary, AB, Canada; MITCHELL, Mark T., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; ANDERSON, Jason S., University of Calgary, Calgary, AB, Canada

Plesiosaurs are an unusual group of Mesozoic aquatic reptiles known primarily from marine deposits, but have also been documented from non-marine units such as the fluvial to estuarine sediments of the Dinosaur Park Formation (DPF). These beds were deposited along the western margin of the Western Interior Seaway, and have yielded a stratigraphically extensive collection of elasmosaurid specimens. However, most specimens collected to date are fragmentary and non-diagnostic. This study reports on a specimen (TMP 2009.037.0068) recently collected from the upper DPF of southernmost Alberta, and which represents the most complete elasmosaurid yet known from this formation.

TMP 2009.037.0068 is a well-preserved partial skeleton, comprised of posterior cervical vertebrae, most of the trunk region and girdle elements, the anterior half of the caudal series, and a partial forelimb. The disarticulated remains of this specimen were found in a carbonaceous, brackish to marginal marine sandstone bed just above a coal seam, which marks the base of the Lethbridge Coal Zone. Other DPF specimens with overlapping anatomy are morphologically similar, but vary in size and likely ontogenetic stage, as suggested by the differing degree to which their external features are developed. This morphological similarity, especially amongst postcranial elements considered to be the most diagnostic in plesiosaurs (e.g., forelimb and girdle elements), suggests that at least some of these specimens may represent the same taxon.

Study of TMP 2009.037.0068 suggests that this individual was not fully osteologically mature at the time of death. This is supported by open neurocentral sutures in most of the vertebrae and by the relatively smooth surfaces of most elements, which typically become more rugose with age. However, a comparison between this specimen and some other DPF specimens whose elements are larger and exhibit ontogenetically more advanced features suggests that TMP 2009.037.0068 was approaching full maturity.

The total body length of TMP 2009.037.0068 is estimated to have been about three metres, which is unusually small given its near-adult status. However, its small size is consistent with other DPF specimens, the largest of which are still dwarfed by most Late Cretaceous elasmosaurids from marine units. This suggests that elasmosaurids inhabiting the fluvial to estuarine deposits of the DPF may have had greater constraints on body size than those inhabiting deeper marine settings.

Grant Information:
NSERC PGS-D (J.A.C.)

Technical Session XII (Friday, August 25, 2017, 8:15 AM)

THE POLYPHYLY OF MOSASAURS: RESULTS FROM AN EXPANSIVE PYTHONOMORPH PHYLOGENY AND IMPLICATIONS FOR MULTIPLE MARINE RADIATIONS AMONG CRETACEOUS SQUAMATES

CAMPBELL MEKARSKI, Michelle, University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

During the Cretaceous, terrestrial squamates exhibited a remarkable series of radiations into the waterways of the world. One group of particular interest–the Pythonomorpha–was responsible for at least three major marine radiations: the ophidians (including aquatic hind-limbed snakes), the dolichosaurs (elongate, semi-aquatic lizards), and the mosasauroids (including the giant, open-ocean, predatory mosasaurs). The Pythonomorpha has a long history of study dating back to the early 1800s, when early pioneers of paleontology and comparative anatomy such as Conybeare, Cope, Cuvier, Kornhuber, Kramberger, Mantell, Meyer, and Owen were recognizing and describing these fossils. Recent decades have seen a renewed interest in this group, resulting in an explosion in the number of species described and revised. These studies have prompted questions surrounding the origins and evolutionary trajectories of lineages within the Pythonomorpha: specifically regarding the independent evolution, coevolution, or convergence of specific traits. The investigation of these questions necessitates a well-resolved phylogeny; however, no phylogenetic study has specifically attempted to resolve the relationships within the whole of the Pythonomorpha. Instead, the focus has generally been to contextualize a single specimen, or to determine the internal relationships of the ophidians, the dolichosaurs, or the mosasauroids. Broader level comparisons have been coincidental, usually due to the choice of outgroups or ingroups. This study is the first to focus on the relationships at the base of the Pythonomorph lineage using a comprehensive selection of basal members. Parsimony- and model-based methods show strong support for multiple independent incursions into the marine environment. This indicates that many of the traits uniting all or most of this group (axial elongation, limb reduction, the development of paddles and flippers) were independent acquisitions showing similar–though slightly different–solutions to the problem of aquatic adaptation. Most notably, these results correspond with stratigraphic and anatomical evidence which support the hypothesis that mosasaurs are a polyphyletic group representing at least two independent incursions into the water.

Technical Session I (Wednesday, August 23, 2017, 9:30 AM)

COMPARING SCALING AND VOLUMETRIC METHODS FOR DINOSAUR BODY MASS ESTIMATION

CAMPIONE, Nicolás, Uppsala University, Uppsala, Sweden; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

Inferring the body masses of fossil taxa provides a powerful tool for interpreting physiology and ecology on a macroevolutionary scale. However, despite over a century of interest, estimating body masses of non-avian dinosaurs remains contentious. A large number of studies have advanced methods for estimating mass in dinosaurs, which can be categorized into two major approaches: volumetric-density (VD) and extant-scaling (ES). The former relies on generating full body reconstructions that can be attained through scale, mathematical, and virtual models. ES, which employs a relationship between bone dimensions and body mass in extant animals, is most commonly applied to extinct members of crown clades, but some equations have been utilized in non-avian dinosaurs.

Here we use of both approaches in non-avian dinosaurs and provide a simple quantitative framework within which they can be compared and, hopefully, corroborated. Results for any given sample indicate that almost 70% of VD-based mass estimates generated over the last 100 years (N=400) occur within the 95% prediction intervals of the ES model between stylopodial bone circumference and body mass in extant tetrapods. Inconsistencies are recovered in certain dinosaurian groups, most notably non-ankylosaurian thyreophorans (average residual [a.r] ≈ –0.39±0.31sd) and, except for several outliers, theropod estimates reveal the greatest consistency between methods (a.r ≈ –0.01±0.45sd). Overall, VD approaches generate lower body masses (a.r ≈ –0.09±0.36sd), and most proposed methods reveal much higher variation compared to the extant limb-scaling model (VD residual standard deviation = 0.36, Extant residual sd = 0.13). Encouragingly, recent VD models based on a minimum convex hull approach reveal the best level of consistency with the extant scaling model (a.o = –0.07±0.17sd).

VD and ES approaches are often viewed in opposition, but both have methodological strengths. Biomechanical and physiological studies benefit from the full-body reconstruction provided by VD models, whereas large-scale macroevolutionary and ecological studies require the larger datasets that are more easily generated through ES models. We propose this comparative approach as a protocol for validating VD mass estimates. Discrepancies between models (estimates notably outside the 95% prediction intervals) require either 1) ad hoc explanations as to why certain individuals over- or underbuilt their limbs, or 2) revision of the baseline assumptions incurred in the generation of the VD reconstruction.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

FIRST RECORD OF THE ICHNOSPECIES *LAMAICHNUM GUANICOE AFF.* (ARAMAYO AND BIANCO 1987) FROM CHILE

CAMPOS MEDINA, Jorge, Valdivia, Chile; MORENO, Karen, Valdivia, Chile

In 2016 Ricardo Alvarez and one of the authors (KM) discovered vertebrate traces on newly uncovered strata of the already known fossil forest site of Punta Pelluco. This site is actually a Natural Sanctuary located about 5 km east from the city of Puerto Montt, along the shoreline of the Reloncaví Bay. It presents tenth of trees in life position, mainly assigned to *Fitzroya cupressoides* dated between 49.370 and 49.780 ^{14}C years before present.

The material described here corresponds to a single trackway composed of ten footprints. The trackbed is a fine sandstone of grey color that has been recently exposed due to a tidal sand-clearing event. Measurements and morphological study was performed through high resolution photographs, which included a centimetric scale, of each of the footprints, as well as of the whole trackway. Images were analyzed through the software Inskape and ImagenJ.

Trackway total length is 695 cm. The first four set of footprints presents a spaced step length of 104±10 cm and the remaining six are 66 ± 8.5 cm.

Ichnites shows the impression of two fingers in mirror symmetry. Its lateral margins are gently curved toward the midline, the footprint midline preserves the anterior interclavular separation (a V-shaped space between the claws) and the posterior interphalangeal channel connecting lateral and medial toe impressions. The interdigital cleft was not observed, however, this feature is characteristic of soft substrate impressions and it is frequently absent in the footprint record attributable to camelids. No manus/pes differences were identified. Basic measurements are consistent throughout each pedal impression: Antero-posterior length is 9.9 ± 1.45 cm and latero-medial width is 10.1± 2.01 cm. All these characteristics are diagnostic of camelid footprints. Non-camel ruminant footprints clearly differ in presenting a relatively long and narrow, anteriorly-converging digit imprints that are completely separated by an interdigital sulcus.

Minimal speed estimation is within 7.8 and 8.5 km/h assuming a hip high in the 100-150 cm range (values estimated from modern artiodactyls).

Of the only three camelid ichnospecies known so far, *Lamaichnum guanicoe*, *L. macropodum* and *L. tulipesis,* only *the first* presents a size range (4 to 15 cm long) and anterior roundness seen in our material.Therefore, the Punta Pelluco footprints can be attributed to *L. guanicoe*. This is the first record of artiodactyl footprints in the country and adds up for the environmental reconstruction of this iconic paleontological site.

Grant Information:
Funding provided by the Transdisciplinary Center for Quaternary Research (TAQUACH), Universidad Austral de Chile.

Technical Session I (Wednesday, August 23, 2017, 8:45 AM)

PALEOHISTOLOGY OF A GRAVID OVIRAPTOROSAURIAN DINOSAUR FROM THE UPPER CRETACEOUS NANXIONG FORMATION, CHINA, WITH AN ENIGMATIC ENDOSTEAL TISSUE

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Understanding the stepwise evolution of the unique reproductive strategy of birds requires piecing together the reproductive paleobiology of other closely related maniraptorans. Oviraptorosaur and troodontid specimens have been recovered in association with eggs and/or clutches, presumably at or near the window of reproduction. Prior paleohistological studies revealed that some of these "brooding" individuals were skeletally immature; thus unlike extant birds, these animals may have reached sexual maturity before somatic maturity. More surprisingly given its presence in earlier diverging taxa (e.g. tyrannosauroids), these "brooding" individuals uniformly appear to lack medullary bone (MB). Three hypotheses are put forth to address the absence of MB in these individuals: i) males, rather than females, were the active brooding parents; ii) MB had been completely resorbed by the time of death; or iii) MB was secondarily lost in oviraptorosaurs and troodontids after they diverged from the lineage leading to birds. The discovery of two gravid, and thus unequivocally female oviraptorosaurs, allows testing of these hypotheses directly. No MB was observed in the limb bones of one of these specimens, supporting the third hypothesis.

Here, we investigate the paleohistology of another gravid oviraptorosaur (NMNS-VPDINO-2002-0901) from the Upper Cretaceous Nanxiong Formation of China, unique in presenting a pair of fully formed shelled-eggs in its pelvis. The femur and tibia exhibit similar microstructures. The periosteal bone is formed of a well-vascularized parallel-fibered tissue interrupted by seven irregularly spaced growth marks (GM). A clear decrease in bone vascularization, and thus growth rate, follows the last GM. A thick layer of endosteal lamellar bone, vascularized by large radial canals, borders the medullary cavity. Finally, an additional, irregular bone layer is present and differs in structure from the overlying endosteal lamellar bone. Our preliminary results reveal that this gravid individual was approaching adult body size, and support the hypothesis that oviraptorosaurs reached sexual prior to somatic maturity. We hypothesize that the bone layer underlying the endosteal lamellar bone may represent the remnants of MB after complete formation of eggshells. However, because extant birds display microstructural variation in MB, histology is insufficient to identify it as such. Chemical and elemental analyses will be conducted to better characterize the nature of this enigmatic bone layer.

Grant Information:
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Preparators' Session (Thursday, August 24, 2017, 9:30 AM)

ASSESSING AND REHOUSING THE DEPARTMENT OF VERTEBRATE PALEONTOLOGY'S TEACHING COLLECTION AT THE MUSEUM OF COMPARATIVE ZOOLOGY (MCZ), HARVARD UNIVERSITY: A CASE STUDY INTO THE IMPORTANCE OF PREPARATION RECORDS IN REMEDIAL CONSERVATION

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Housekeeping is considered a well-known and important part of museum best practices. As new materials and methods evolve with the field, museums must keep up with curating specimens to the highest possible standards to slow the inevitable deterioration over time. This is particularly important to museums with older collections, where many specimens were prepared over 50 years ago and have remained relatively untouched.

One particular specimen in the MCZ's Vertebrate Paleontology teaching collection, a partial articulated *Archeria* vertebral column, is an excellent and unfortunate example of 'curatorial stasis'. Based on the label, the specimen was mounted in its current state in 1939, and has undergone several reparations since then. The specimen was sunk into a type of hard putty to add stability to the individual bones, causing several to become firmly fixed to the putty and difficult to remove. This has resulted in several fractures occurring during conservation efforts. The putty also caused discolouration of the fossil bone in contact with its surface.

In addition to the physical housing causing specimen damage, poor handling and recordkeeping was evident. The specimen had several pleurocentra and intercentra missing as there were empty spaces in the putty where they would have resided. To make matters more difficult, the individual bones were labelled in an ineffective way, causing greater confusion when trying to mitigate the issue. The lack of photographic and written records with the specimen made the preparator unaware of the previous condition and what fragments were present/absent throughout the specimen's history, making conservation more difficult and time-consuming.

To mitigate this issue, all preparation and remedial conservation are photographed to document the conservation process. Preparation record sheets were created to track all work done on a specimen, documenting the materials and methods used to get the specimen to its current state. This information is archived to allow members of the curatorial staff to review the history of the specimen and properly assess and execute conservation measures. The next step in this project will be to design a template to store preparation/conservation records in our database, MCZbase, to increase access of information for each specimen to current and future curatorial staff.

Preparators' Session (Thursday, August 24, 2017, 8:45 AM)

THE MANY BENEFITS OF 3D XRAY IMAGING IN PALEONTOLOGY: PREPARATION OF A DELICATE FOSSIL CONTAINED INSIDE A PLASTER JACKET

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Traditionally the preparation of a fossil contained in a plaster jacket requires a great deal of guess, because often its detailed content is unknown. Therefore, the preparation can be greatly improved by the use of Xray imaging, such as Computed Tomography (CT), since it makes possible a preliminary observation.

Here we present our results on the preparation of three plaster jackets which contained bones of *Caraguatypotherium munozi*, a Mesotheriinae (Nothoungulate mammal, late Miocene) found in Northern Chile. The bedrock consisted on a semi consolidated fine grained sandstone with abundant diaclases. Also plant roots are usually squeezed into the fractures. All of these factors makes difficult the extraction. Thus, a plaster jacket was applied with minimal superficial preparation. At this stage, sediment removal was performed only to know the fossil boundaries. Hence, its precise content was left unexplored.

Once at the Laboratory of Paleontology, Universidad Austral de Chile (UACh), a CT scan was performed in a medical equipment (UACh), and images analyzed with Osirix® free software. Image treatment included the search for the appropriated density range (Houndfield units) to distinguish the fossil and then perform a 3D reconstruction.

The 3D reconstruction permitted to: 1) identify bones, their position, size and preservation status. 2) to prioritize the sediment removal on areas of interest, such as the area comprising the occipital, an unknown skull bone in previously collected materials of the species including the holotype. 3) to choose and adjust extraction and consolidation techniques, such as the use of dentistry wax for filling cracks, and Paraloid (B-72) at various concentrations.

The use of CT scan allowed the successful extraction of two complete skulls with their corresponding mandibles, a series of 5 cervical vertebrae, a semi articulated arm and a few other isolated bones in just 20 days.

It is important to note that fossils were extremely fragmented within the sediment matrix, being often cut through by numerous one-centimenter wide cracks disposed in different directions. Hence, if the fossils were collected by *in-situ* picking, there would have literally resulted in a bunch of little unidentifiable pieces. Similarly, if the laboratory preparation would have not used CT scan, it would have been a difficult task to identify the puzzle, multiplying its preparation time. In conclusion, as 3D reconstruction technology becomes more accessible, it is possible to use it to facilitate, speed up and improve the preparation results.

Grant Information:
The present work is funded by the FONDECYT Project 1150879 "Skeletal morpho-function of Caragua's Miocene Fauna" awarded to KM.

Technical Session I (Wednesday, August 23, 2017, 11:30 AM)

NO LIPS FOR *T. REX*: THE CROCODILE-LIKE FACIAL INTEGUMENT AND SENSORY SYSTEM OF TYRANNOSAURS

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Although tyrannosaurs are arguably the most popular dinosubjects for artistic depictions, their life appearance has not received rigorous scientific attention that takes into account the relevant osteological evidence. To better reconstruct tyrannosaur life appearance, we compared the osteological correlates of facial integument in amniotes (crocodylians, birds, and mammals), to the facial skeleton of a growth series of a new species of tyrannosaur from the late Campanian of Montana. We found that tyrannosaurs match the crocodylian morphotype, where the subcutaneous surface is coarse and penetrated by a high density of neurovascular foramina. This coarse texture, a correlate of flat scales, covers the entire face (from the postorbital bar forward), and extremely rough patches within the coarse zone are covered by small, wart-like bumps and spicules, correlating to armor-like skin. The armor-like skin is localized to the front and top of the snout and the sides of the lower jaws, suggesting a protective function against abrasion, whereas patches on the lacrimal- and jugal horns suggest a display function. The postorbital horn, and the surface of the postorbital bar below it are elevated beyond the side of the head, indicating a keratin sheath that suggests a display function. The coarse texture that bore flat scales extends nearly to the tooth row, separated only by a narrow band that was covered by gingiva, providing no space for other integumentary structures such as lips. The dense distribution of neurovascular foramina on the sides and top of the snout in tyrannosaurs matches that of crocodylians that have an integumentary sensory system. Crocodylian snouts are equipped with bump-like mechanoreceptors called Integumentary Sensory Organs (ISOs) that are innervated by the trigeminal nerve, and are as sensitive as human fingertips. Based on their similarity with crocodylians, we can infer that tyrannosaurs also had ISOs. If true, then tyrannosaurs had a highly sensitive facial tactile system that in crocodylians functions in prey capture, object identification and manipulation, detecting and maintaining nest temperature and materials, the harmless handling of eggs and nestlings, and social behavior that includes face rubbing as a vital part of pre-copulatory play.

Grant Information:
T.D.C.: Faculty Research & Development Grant from Carthage College.
J.C.S.: Dissertation Improvement Grant.
J.R.M.: Channel 4 production company.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

PRESERVATIONAL AND MORPHOLOGICAL VARIATION IN THE HALECOSTOM FISH *HULETTIA AMERICANA* FROM THE JURASSIC ELLIS GROUP OF SOUTHERN MONTANA

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Previous fieldwork conducted by the Museum of the Rockies has produced a large collection (n>180) of fossil fish from the Upper Jurassic Ellis Group of southern Montana. Specimens typically occur in friable clays which represent deposits of the epeiric Sundance Sea. Many individuals are preserved as complete or nearly complete compressed body fossils with scales intact and in place. However, in several specimens, the internal skeleton is completely absent while the scales remain in place. Most specimens also preserve dark coloration in the position of the orbits and in a consistent location posterior to the operculum. The preservation of these fish are consistent with calm anoxic sea floor conditions. The fish range in body length from 2 to 10.7 cm and exhibit rhomboidal scales, maxillae which extend beyond the posterior margin of the orbits, an interopercular bone, and basal and fringing fulcra on all fins. Based on the presence of these features, the specimens are here referred to the halecostom species *Hulettia americana*. Standard major axis regressions of linear skeletal measurements indicate that growth was primarily isometric in *H. americana*; however, positive allometry is noted in the skull. This suggests that *H. americana* may have exhibited ontogenetic niche partitioning. Thus far, *H. americana* is the only species of fish identified from this locality. These specimens reveal details of growth and variation in *H. americana* and offer insights into the paleoenvironment and paleoecology of the Jurassic Sundance Sea.

Romer Prize Session (Thursday, August 24, 2017, 9:45 AM)

SYSTEMATICS, BIOGEOGRAPHY, AND DIVERSITY OF SOUTH AMERICAN NATIVE UNGULATES: NEW RECORDS FROM THE NEOTROPICS AND THEIR IMPLICATIONS FOR THE GREAT AMERICAN BIOTIC INTERCHANGE

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South American Native Ungulates (SANUs) include several clades of ungulate-grade herbivorous mammals that dominated the continent until well into the Quaternary. Despite substantial, recent progress, their phylogenetic relationships remain enigmatic. SANUs are recorded throughout most of the Cenozoic and they were widely distributed. However, most the SANU fossil record comes from high latitudes. This sampling bias challenges the study of their diversity dynamics and biogeography during important tectonic and biotic events, such as the Great American Biotic Interchange, the faunal exchange between North and South America after the formation of the Isthmus of Panama. Notoungulata is one of the main clades of SANUs, and exhibit high taxonomic, morphologic and ecological diversity. I describe a very complete skeleton of *Thomashuxleya externa*, an early representative of the notoungulate radiation from the middle Eocene of Patagonia, Argentina. I combine the new anatomical data with amino acid sequences in a comprehensive dataset to examine the phylogenetic relationship of *Thomashuxleya* with other placentals. When constrained as monophyletic with the Pleistocene notoungulate *Toxodon* (known for collagen sequences), Notoungulata is reconstructed on the stem to Euungulata or as sister to Perissodactyla. In addition, I describe new SANU remains from the Neogene of the Cocinetas (northern Colombia) and Falcón (northwestern Venezuela) basins. These new data document a tropical provinciality during the middle Miocene, supporting the "tropics as museum" hypothesis for some SANU clades (e.g., Astrapotheria, Leontiniidae). The Pliocene tropical faunas from northern South America are characterized by the predominance of native taxa, despite its proximity to the Isthmus of Panama (which was fully emerged by that time). Only one North American ungulate herbivore immigrant is present (Camelidae). The Pliocene faunas document an important landscape change in the region and suggest that ecological processes and biotic interactions could have affected the diversity dynamics and biogeographic patterns of SANUs during the Great American Biotic Interchange.

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Technical Session X (Friday, August 25, 2017, 9:45 AM)

A NEW AZHDARCHID PTEROSAUR FROM THE KAIPAROWITS FORMATION (LATE CAMPANIAN) OF SOUTHERN UTAH, USA

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Although a prevailing interpretation holds that Azhdarchidae dominated pterosaur diversity in terrestrial habitats during the Late Cretaceous, unambiguous azhdarchid material remains quite scarce in North America. Many published records only feature isolated elements, and most cannot be constrained taxonomically beyond Azhdarchoidea. Here, we report a well preserved and relatively complete associated skeleton representing a new taxon of azhdarchid pterosaur from the late Campanian-aged Kaiparowits Formation of Grand Staircase-Escalante National Monument, southern Utah. RAM 18659 (Raymond M. Alf Museum of Paleontology) includes the right scapula, both coracoids, a right humerus, partial right ulna, partial radius, partial fourth metacarpals, both femora, and associated indeterminate elements. The tall and rectangular deltopectoral crest, deep coracoid flange, and overall limb proportions firmly place RAM 18659 within Azhdarchidae. RAM 18659 is distinct from all other known pterosaurs in its strongly hooked, proximally projecting dorsal and ventral condyles on metacarpal IV. The unfused scapulocoracoids and surface porosity of the bone suggest that this was not an osteologically mature individual.

The preservation and completeness of diagnostic postcranial elements in RAM 18659 allows for comparisons with less complete pterosaur remains from penecontemporaneous terrestrial depositional environments throughout western North America. Although there is no direct element overlap between RAM 18659 and *Navajodactylus boerei* from the Kirtland Formation (late Campanian) of New Mexico, the morphology of RAM 18659's metacarpal IV is not congruent with the hypothetical morphology of MC IV predicted by the articulation of *N. boerei*'s distal first wing phalanx. Currently the only North American azhdarchid genus represented by multiple associated elements is *Quetzalcoatlus*, a genus with a wide geographic and temporal distribution. RAM 18659, with an estimated wingspan of ~2.8 meters, differs from known *Quetzalcoatlus* specimens in size, morphology, and limb proportions. Although RAM 18659 is comparable in size to *Montanazhdarcho* from the Two Medicine Formation (late Campanian) of Montana, the latter is a non-azhdarchid azhdarchoid, and numerous morphological details distinguish the two. Overall, RAM 18659 establishes the presence of azhdarchids in the Kaiparowits Formation, expands the known diversity of this clade, and affirms the geographic range of azhdarchids on the Late Cretaceous landscape of North America.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

AGE OF THE ADAMANTINA FORMATION, UPPER BAURU GROUP, LATE CRETACEOUS, BRAZIL

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The Upper Bauru Group is composed of the Adamantina Formation, the Uberaba Formation and the overlying the Marília Formation. These Late Cretaceous units have produced a highly diverse vertebrate fauna of fish, frogs, snakes, a diversity of notosuchian crocodylians, enatiornithine birds, abelisauroid theropods and aelosaurine titanosaurs. However, the exact age of these formations have been debated as a Turonian–Santonian age has been proposed for the Adamantina Fm., with a depositional hiatus to the overlying Marília Fm. considered to be late Maastrichtian in age.

A number of stratigraphic relationships between the formations of the Upper Bauru Group exist at different locations within the Bauru Basin. The three formations grade into one another and in no case is there a significant depositional hiatus within the Upper Bauru Group as previously indicated.

Magnetostratigraphic data from the Uberaba and Marília units indicate that both had a reversed polarity, which means that their ages (and the Adamantina Fm.) would be younger than the normal polarity of the rocks formed during the "Cretaceous Quiet Zone" (CQZ; ca.125–83.5 Ma). Thus the Uberaba and Marília units (and the Adamantina Fm.) cannot be older than the beginning of the Campanian at 83.5Ma.

The biostratigraphic ranges of aelosaurine titanosaurs from latest Cretaceous deposits in Argentina and the Adamantina Fm. in Brazil are hypothesized to have significant correlations. Thus, the Adamantina Fm is a biostratigraphic equivalent to the Allen Fm., the Los Alamitos Fm., and the Loncoche Fm. of Argentina. These Argentine units overlie the Anacleto Fm. (Rio Colorado subgroup), which also exhibits a reversed polarity compared to the long normal polarity of the CQZ and so the Anacleto Fm. can be no older than 83.5 Ma. The three Argentine formations overlie the Huantraiquican unconformity. The Colipilli Volcanics are below this unconformity and have produced an Ar/Ar datum of 72.8 Ma. This means that the aelosaurine titanosaurs of the Allen, Loncoche and the Los Alamitos formations and by correlation the Adamantina Fm. can be no older than latest Campanian as the Campanian-Maastrichtian boundary is at 72.1 Ma.

Technical Session XIX (Saturday, August 26, 2017, 3:15 PM)

COMPLETENESS OF THE GLOBAL NON-AVIAN THEROPOD FOSSIL RECORD: DISENTANGLING BIOLOGICAL, GEOLOGICAL AND SAMPLING BIASES

CASHMORE, Daniel D., University of Birmingham, Birmingham, United Kingdom; CLOSE, Roger A., University of Birmingham, Birmingham, United Kingdom; BUTLER, Richard J., University of Birmingham, Birmingham, United Kingdom

Changes in the quality of the fossil record through time, space and phylogeny can bias our interpretations of diversity, ecology, biogeography and macroevolution. Variation in the completeness of fossil specimens has been previously quantified for several groups of tetrapods using several different metrics to assess fossil record biases. One such approach, the Skeletal Completeness Metric (SCM), quantifies the proportion of a complete skeleton that a specimen preserves. Here, we use the SCM to quantify the quality of the global non-avian theropod fossil record, in order to understand biological, geological, and sampling biases acting upon it.

Specimen-level SCM scores were collected from the literature for 270 non-avian theropod species, representing all known non-avian theropods that have been included in previous phylogenetic analyses. Completeness scores were estimated using relative body proportions for each individual bone of the skeleton, which were calculated by 2D modelling of skeletal reconstructions for 10 phylogenetically disparate species. A time series of the average skeletal completeness per geological stage was compared statistically to raw non-avian theropod species diversity, sampling proxies (e.g. counts of dinosaur-bearing formations) and sea level. Statistical comparisons were made between the range of theropod completeness scores and body mass estimates. Completeness scores were also compared between geographical continents and between the main taxonomic groups within Theropoda.

Results show that non-avian theropod completeness is at its highest in the Norian and lowest during the latest Triassic, has two peaks in the Early and Late Jurassic, and an Early Cretaceous peak is followed by a 'middle' Cretaceous low, and then a gradual increase in completeness in the Late Cretaceous. Theropod completeness was not significantly correlated with global diversity, sampling or sea level change through time. Of the major continents Asia and North America have the most complete theropod records, followed by Africa, South America and Europe. Oviraptorosaurs, ornithomimosaurs, and basal coelurosaurs have the highest completeness values while basal tetanurans and alvarezsaurs have the lowest. Theropod completeness does not correlate with body size. This result is surprising, given known taphonomic size biases,

and requires further examination to determine the roles of Lagerstätten and clade-specific taphonomic processes.
Grant Information:
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Technical Session XX (Saturday, August 26, 2017, 1:45 PM)

NEUROCRANIAL ANATOMY OF TWO UNUSUAL PLACODERMS REVEALED BY COMPUTED TOMOGRAPHY SCANNING, AND THEIR IMPLICATIONS FOR EARLY GNATHOSTOMES EVOLUTION

CASTIELLO, Marco, Imperial College London, Ascot, United Kingdom; BRAZEAU, Martin D., Imperial College London, Ascot, United Kingdom

Placoderms provide key evidence for the vertebrate anatomical conditions near the origin of jaws. However, competing views on placoderm monophyly imply radically different hypotheses about the origin of the gnathostome face and reproductive biology. Among placoderms, petalichthyids and "acanthothoracids" have taken a central position in the debate on placoderm paraphyly, owing to their similarities with the jawless outgroups of jawed vertebrates. Nevertheless, their endocranial anatomy is still poorly known, preventing a thorough comparative analysis with the other early gnathostomes. Here we present the neurocranial anatomy of two exceptionally preserved placoderms, the "acanthothoracid", *Kolymaspis*, and the petalichthyid, *Shearsbyaspis,* from the Early Devonian of Siberia and Australia, respectively. Using X-ray computed microtomography datasets, we generated three-dimensional reconstructions of their endocranial surfaces, orbital walls, and cranial endocavity. The anatomy of *Kolymaspis* is similar to that of most other placoderms, with a distinct rhinocapsular ossification and a pituitary vein traversing the endocranium. However, the neurocranial anatomy of *Kolymaspis* is intermediate between long- and short-nosed "acanthothoracids", such as *Brindabellaspis* and *Romundina* respectively. This suggests that placoderms with similar orbitonasal anatomy can represent a highly specialized morphology rather than being plesiomorphic for jawed gnathostomes. *Shearsbyaspis* instead exhibits a combination of both derived and plesiomorphic characters never observed before in a placoderm and possesses a parasphenoid—a feature otherwise not confidently observed in non-arthrodire placoderms. Some features of the skull of *Shearsbyaspis* are reported here for the first time in a jawed vertebrate and are otherwise present only in the jawless stem-gnathostomes. Our results reveal striking differences between petalichthyids and "acanthothoracid" neurocranial morphology, casting doubt on the assumption that these two groups shared the primitive condition for jawed vertebrates. As both group are crucial to placoderm character polarities and testing proposed placoderm synapomorphies, resolving their affinity will be key to establishing gnathostome plesiomorphic character states at the origin of jaws and illuminating the deep evolutionary history of endocranial morphology in gnathostomes.
Grant Information:
European Union's Seventh Framework Programme (FP/2007–2013)/ERC Grant Agreement number 311092

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

FROM BARE BONES TO TRIASSIC PARK: CREATING A LIFE RECONSTRUCTION OF THE AETOSAUR *GORGETOSUCHUS* WITH A MULTIDISCIPLINARY TEAM OF SCIENTISTS, ARTISTS, AND STUDENTS

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Paleoart, the depiction of prehistoric life based on scientific evidence, is widely used as a 'hook' to generate popular interest in paleontological research. However, the unique combination of science and artistry used to create paleoart provides additional opportunities for multidisciplinary education.

In 2016, the Geology and Art departments at Appalachian State University partnered to create a life-sized sculpture of the desmatosuchine aetosaur *Gorgetosuchus pekinensis*. We compared the known material of *G. pekinensis* to more complete remains of the desmatosuchines *Longosuchus* and *Desmatosuchus* to extrapolate a multiple-view skeletal reconstruction, muscle study and preliminary life restoration. These were provided to a team of advanced sculpture students. Taking measurements and data from the reconstructions, the students welded a steel armature for the sculpture and created a three dimensional digital model of the animal. Sections of the digital model were taken and measurements compared to the reconstructions and fossils to ensure accuracy. The sections were cut out of foam and applied to the armature to create the core structure for the sculpture. The student team added a layer of plasticene over the foam and sculpted the final details, referring to a modern crocodilian (*Palaeosuchus*) specimen for scale pattern and texture. Students had the chance to review their progress with paleontology, geology, and art professors at the University, and through videochats with a consulting paleoartist. All participants learned how different fields met their objectives using overlapping procedures and technologies, which reinforced the benefits of communication and collaboration across disciplines.

The final model of *Gorgetosuchus* is complete and ready to be molded and cast for display in Appalachian State University's Fred Webb Jr. Outdoor Geology Lab.The sculpture will be displayed in an "aetosaur habitat" with large (meter scale, 1000kg) local geological specimens from the Upper Triassic Pekin Formation and surrounded by flora with close relatives known from the Late Triassic. A three-dimensional scan has been taken of the finished model for the development of additional projects and outreach. This project has laid the groundwork for future partnerships between the Art and Geology departments at Appalachian State, and provides a model by which multiple fields of study and small, nontraditional museums may collaborate to expand exhibit and program offerings.
Grant Information**:**
University Research Council, Appalachian State University

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

PARTLY ARTICULATED SKELETON OF *OPHISAURUS* (SQUAMATA: ANGUIMORPHA) FROM THE MIDDLE MIOCENE OF EUROPE, WITH COMMENTS ON THE HISTORY OF ANGUID LIMB REDUCTION BASED ON THE ANATOMY OF THE PELVIC GIRDLE

ČERŇANSKÝ, Andrej, Comenius University in Bratislava, Bratislava, Slovakia; KLEMBARA, Jozef, Comenius University Bratislava, Bratislava, Slovakia

The subfamily Anguinae (family Anguidae) is a small clade of legless lizards nested in the large clade Anguimorpha, forming a sister group to the Gerrhonotinae. The first fossil find of a partially articulated specimen of *Ophisaurus* (Anguimorpha, Anguinae) is present here. It comes from a middle Miocene (MN 7) classical locality Öhningen in Germany. This popular locality also contains other herpetofaunal elements, such as the famous specimen of *Andrias scheuchzeri*. This is the first time that the preservation of a specimen of *Ophisaurus* allows cranial and postcranial elements to be allocated to the same species. High-resolution x-ray computed tomography reveals a completely preserved parietal identifying the specimen as belonging to the species *Ophisaurus holeci*. The specimen from Öhningen also preserves the right pelvic girdle, consisting of a well-preserved ilium and partially preserved, but well separated pubis and ischium. This is in sharp contrast with the fused puboischium of modern forms. A limb is not preserved. Within the fossil Anguinae, there is only one specimen of *Ophisaurus* in which a similarly preserved pelvic girdle is present. This specimen is from the middle Miocene of Slovakia and the morphology of its pelvic girdle is revised here. Well preserved functional acetabulum is present. The morphology of the pelvic girdles of both these Miocene specimens is very similar to that of *Ophisauriscus quadrupes*, a possible anguine from the middle Eocene of Germany, which retains small limbs. The anatomy of the pelvic girdles of all three fossil lizards and comparisons with those of extant limbed and legless lizards indicates that the two Miocene anguines studied here may have possessed small, but functional limbs.
Grant Information:
APVV-16-0180

Preparators' Session (Thursday, August 24, 2017, 8:30 AM)

A TECHNICAL ANALYSIS OF METHODS OF DEFLESHING SMALL MAMMAL MODERN COMPARATIVE SPECIMENS

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Modern skeletal collections are integral in modern taxonomic studies and are essential for comparative specimens for fossil collections. The need for efficient, high quality defleshing methods is essential to the further modern biological taxonomic studies, as well as being a vital comparative resource for morphology and taxonomy studies in the paleontological field. Small mammals (mass 500 grams or less) present a problem in the defleshing process because their small bones are fragile and easily lost or damaged, and existing published literature focuses mainly on large mammals. This study investigates seven methods of defleshing to determine the most efficient method, given a preparator's constraints: bleach and hydrogen peroxide soaks, maceration, dermestid beetles, cooking, horse manure, burial, and flies in open air. We also compare efficiency within two size groupings, 0-25 grams and 25-500 grams. Dermestid beetles and maceration are common procedures utilized to deflesh specimens; however, their efficiency and quality of bone production has yet to be analyzed compared to other known methods of defleshing in small mammals. We compare each method on the time it takes to fully deflesh and the texture and completeness of the bones. We also take into account the effort of each method, whether skinning and gutting is required, and whether required materials and location of defleshing make the method less effective. Our preliminary results reveal that the most appropriate method of small mammal defleshing for the average academic or scientific institution is bleach and hydrogen peroxide soaking, as it produces high quality bones, with minimal degradation or damage to bones, in a timely, cost efficient, and obtainable method. When we compare bleach and hydrogen peroxide soaking to maceration, though similar quality bones are produced, the time required to completely deflesh is exceptionally long. Further investigation into more small-mammal defleshing methods is necessary, and individual circumstances must be taken into account in order to encompass preference, time, and materials available to preparators.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW MOSASAURINE FROM THE UPPER CRETACEOUS (LOWER CONIACIAN) OF NORTH TEXAS DEMONSTRATES MOSAIC EVOLUTION IN EARLY MOSASAURS

CHAPMAN, Blake R., The University of Texas at Austin, Austin, TX, United States of America; LIVELY, Joshua R., The University of Texas at Austin, Round Rock, TX, United States of America

We describe a new mosasaurine squamate from Fannin County, in northeastern Texas. The specimen was discovered in the Savoy Pit, a site that was excavated in 1940 by the Works Progress Administration and The University of Texas Bureau of Economic Geology. The oldest known and earliest-diverging mosasaurine is *Dallasaurus turneri*, based on fragmentary material from the Turonian Eagle Ford Shale. Other early-diverging mosasaurines, traditionally referred to as the genus *Clidastes*, are known from the upper Coniacian - Campanian. By the middle Campanian, the clade diversified and included taxa such as *Mosasaurus*, *Prognathodon*, and *Globidens*. Based on the results of a preliminary phylogenetic analysis of North American mosasaurs, we hypothesize the specimen from the Savoy Pit is an early-diverging member of Mosasaurinae.

The new specimen shares some characters with Russellosaurina including a short premaxilla-maxilla suture extending to a location dorsal to the third maxillary tooth position, an absence of a prefrontal supraorbital process, pterygoid teeth arising from the main body of the element, a low coronoid buttress on the surangular, and relatively short atlantal synapophyses. Characters shared with early-diverging mosasaurines include

smooth maxillary teeth, 15 tooth positions, a quadrate with a striated tympanic ala and constricted suprastapedial process, and vertebral condyles that are not dorsoventrally compressed. Along with several vertebral characters, the new mosasaurine is similar to *Dallasaurus* in lacking a lingual parapet on the maxilla, with teeth that more closely resemble the pleurodont condition of other lizards.

Our phylogenetic analysis supports a hypothesis of the specimen from the Savoy Pit being an early-diverging member of Mosasaurinae. Characters that this mosasaurine shares with Russellosaurina could represent independent convergences with that clade. Many of those characters cannot be evaluated in published specimens of *Dallasaurus*. Owing to this, and the large number of characters not observed in other mosasaurines, we hypothesize that those character states represent the plesiomorphic conditions for Mosasaurinae. This demonstrates mosaic evolution within early mosasaurs, even within individual elements. Caution should be used when identifying isolated mosasaur elements from the Turonian and lower Coniacian, even to more inclusive clades traditionally considered to be at the sub-family level.

Technical Session II (Wednesday, August 23, 2017, 8:30 AM)

THE FIRST HARD EVIDENCE FOR THE "OUTSIDE-IN" THEORY OF THE ORIGIN OF TEETH: 3D SYNCHROTRON DENTAL HISTOLOGY OF THE SILURIAN STEM OSTEICHTHYAN *LOPHOSTEUS*

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Lophosteus superbus from the Late Silurian of Estonia is the phylogenetically most basal stem osteichthyan, with acanthothoracid-like ornaments and skull bones reminiscent of arthrodires and maxillate placoderms. Its marginal jaw bones comprise six categories that probably align along the length of jaws, instead of a conventional osteichthyan set of premaxilla, maxilla and dentary. The suite of dentigerous bones also includes dome-shaped "tooth cushions", which may represent the most primitive form of inner dental arcade, corresponding to the coronoid-dermopalatine series and the parasymphysial tooth whorls of crown osteichthyans. 3D reconstruction from propagation phase contrast synchrotron microtomography scans, on specimens of different ontogenetic stages, have been compared to infer the growth history. Buried structures, such as stacks of resorption surfaces, reveal that both the marginal jaw bones and tooth cushions carry cyclic shedding teeth replaced by basal resorption, an osteichthyan synapomorphy. But in the tooth cushions, the first-generation teeth may have been resorbed exclusively by odontoclasts differentiated within the pulp cavity, leaving the osteocyte-rich tooth base unaffected, which may illustrate the emergence of site-specific resorption. While the successive generations undergo true basal resorption, probably due to the supply of external osteoclasts from the vessels newly entrapped in the bone of attachment. In the marginal jaw bones, the first shedding teeth are added at tooth sites established by conical non-shedding odontodes, after the latter have been partly removed by apical resorption. These first-generation odontodes, which are organized in an alternate pattern and pre-pattern the shedding dentition, fuse into a multicuspid sheet on the facial lamina. The replacement cycle can be terminated by overgrowth of ornament, with new shedding tooth sites added lingually, and the number of replacement cycles of tooth sites in the same file varies considerably. A linguo-labial morphological gradient is exhibited from unicuspid teeth, via multicuspid ornament, to elaborate stellate ornament with crenulated ridges. Surprisingly, some of the shedding teeth bear tiny labial-side-cusps, resembling the ornaments, but real ornament odontodes can be distinguished by their infill of osteodentine. The dental development of *Lophosteus* may cast light on the possible origin of teeth from dermal odontodes, and on the evolutionary relationship between dentitions of stem- and crown-group gnathostomes.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW GENUS AND SPECIES OF ELLIMMICHTHYIFORMES (CLUPEOMORPHA) FROM THE OLIGOCENE OF SOUTH CHINA

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Ellimmichthyiformes is an extinct cosmopolitan clade of Clupeomorpha. Its oldest members so far known are from early Early Cretaceous and the youngest is found in Eocene deposit. We herein report a new genus and species of Ellimmichthyiformes. Materials of the new form were discovered recently from the Oligocene deposits of Ningming Basin, Guangxi Province, China, where cyprinids, catfish, and perciforms were also found. The new form is a middle-sized fish with its body depth about a quarter of its standard length. Its dorsal margin is smooth and rounded. The anal fin has 3 unbranded and 36 branched rays. The predorsal scutes series is complete, with about 55 ovoid, nearly same-sized scutes, carrying several longitudinal ridges on their dorsal surfaces. The dermal bones in the skull are smooth. Detected two supramaxillae, numerous small teeth on entopterygoid, and beryciform foramen in the anterior ceratohyal. The structure of the caudal skeleton resembles that in many ellimmichthyiforms, i.e., the first ural centrum is the same size as the first preural centrum, and fused with the second hypural but in contact with the first one. There are six hypurals, and no diastema between the second and the third one. The parhypural is fused with the first preural centrum. The first uroneural does not fuse with the first preural centrum. Comparing with known clupeomorphs, the new form from Ningming apparently differs from clupeiforms but resembles ellimmichthyiforms in having a beryciform foramen in anterior ceratohyal, the ornament pattern of the dorsal scutes, and the structure of the caudal skeleton. Among ellimmichthyiforms, the new form differs from Paraclupeidae in absence of a deep body, a marked angle at the dorsal fin insertion, and subrectangular predosal scutes; from Sorbinichthyidae in lacking an extremely elongated second dorsal-fin ray and second pectoral-fin ray, subrhomboid spiny predorsal scutes, and ornamentation on skull roof; from *Armigatus* in having a complete series predorsal scutes; and from *Diplomystus* in ovoid predorsal scutes instead of subrectangular ones in the latter. It resembles the only previously known ellimmichthyiform from the Paleocene of China, *Diplomystus shengliensis*, in many aspects: high number of predorsal scutes, long anal fin base, no diastema between the second and the third hypural, and the first uroneural not reaching the second preural centrum. The discovery of the new form from Guangxi indicates that Ellimmichthyiformes had a wider distribution range and a longer evolutional history than previously thought.

Grant Information**:**
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

NEW CRANIAL FEATURES OF THE OLIGOCENE FOSSIL FROG *MACROPELOBATES OSBORNI* (ANURA: PELOBATOIDEA) RECONSTRUCTED USING X-RAY CT SCANNING, AND A RE-ASSESSMENT OF THE BIOGEOGRAPHIC HISTORY OF SPADEFOOT TOADS

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Discovered during Roy Chapman's third Asiatic Expedition in the 1920s, *Macropelobates osborni* is the first fossil spadefoot toad (Pelobatoidea) described from the Oligocene of northern East Asia. A curious occurrence outside the current distribution of the clade, this taxon has stimulated different hypotheses on the evolution and biogeography of the Pelobatoidea. Opinions vary on the phylogenetic placement of *Macropelobates*: it grouped either with the North American Scaphiopodidae or with the European Pelobatidae in previous studies. Here we re-describe the holotype of *Macropelobates osborni* using high-resolution X-ray CT scanning. The frontoparietal, although appearing to be paired on its dorsal surface, is actually an azygous bone. The CT reconstruction also shows palatal and endocranial structures that were not exposed by mechanical preparations, including the vomer, parasphenoid and inner ear. We conducted a total-evidence phylogenetic analysis of the Pelobatoidea incorporating the new morphological information of *Macropelobates osborni*. The data matrix consists of nine gene loci and 97 morphological characters across 31 extant and extinct spadefoot toads. We analyzed the data matrix using maximum parsimony criterion using POY 5. The results confirm *Macropelobates* as a stem pelobatid rather than scaphiopodid, as the sister group of the crown clade *Pelobates* in Europe. Five synapomorphies support this relationship: azygous frontoparietal; dermal sculpture in a pitted pattern; butterfly-wing-shaped sacral diapophysis with a straight lateral edge; length of urostyle shorter than combined length of presacral vertebra; and prehallux scaphoid-shaped. Modern pelobatids are burrowing frogs. *Macropelobates osborni* has a robust skull, short hind limbs and an enlarged bony spade on its foot, all suggesting a burrowing behavior in this fossil taxon. The occurrence of a stem pelobatid in Asia shows that this clade had a wider distribution in the Oligocene than that of today, and the Asian clade most likely dispersed from Europe through the then passable Turgai Strait. Furthermore, *Macropelobates osborni* shows that the local extinction of spadefoot toads in East Asia occurred after the Oligocene, which corresponds with the timing of temperature cooling and aridification of Asian interior during the uplift of the Tibetan Plateau.

Grant Information:
NSF grant EAR 0959384

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

REVISITING THE FEEDING ECOLOGY OF *PTILODUS MONTANUS* (MAMMALIA: MUTITUBERCULATA) USING 3D MODELING

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Multituberculata, with the longest evolutionary history of any mammalian clade, represents an ideal group for studying the evolution of feeding ecology within non-therian mammals. Recent studies have challenged the historical view of non-therian mammals as primarily terrestrial generalists that fed on insects. Indeed, non-therian mammals show great morphological diversification, with a corresponding ecological diversity that could have resembled that of extant mammals. Feeding ecology, as one of important autecologies of extant mammals, could have played an important role in enabling non-therian mammals to thrive in the age of dinosaurs.

Here, we revisit the masticatory apparatus of the early Paleocene ptilodontoid multituberculate *Ptilodus montanus*. Upper and lower dentition models were reconstructed from CT scan-derived, 3D models of cranial materials of *P. montanus* from the Gidley Quarry, Montana. We used 3D modeling to animate jaw movements in order to investigate its feeding ecology. A virtual analysis of the occlusal power stroke between upper and lower dentitions was carried out in the Occlusal Fingerprint Analyser (OFA) software, according to three hypothesized masticatory activities (incision, slicing-crushing, and grinding). These simulated masticatory activities were guided by the orientations of wear striations and topographical features of cheek teeth. The occlusal trajectory path was recorded, and contact areas per time-step were visualized and quantified.

Our preliminary results confirmed that *P. montanus* had a distinct jaw movement from extant mammals. Upper and lower dentitions show an extensive match during masticatory activities, which were facilitated by well-developed masseter, pterygoid, and temporalis muscles. These results promote the idea that the versatility of masticatory behaviors in *P. montanus* (and most multituberculates) could enable different feeding strategies within an omnivorous diet during seasonal shifts.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ABSENCE OF EVIDENCE IS NOT EVIDENCE OF ABSENCE: THE EFFECT OF SPATIAL FOSSIL BIAS IN PALEODIVERSITY ESTIMATES IN THE LATEST CRETACEOUS OF NORTH AMERICA

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Diversity trends for dinosaurs during the latest Cretaceous are of pivotal importance for understanding the lead-up to the K-Pg extinction, but these are masked by geological and anthropogenic sampling biases. Here we outline a novel approach for evaluating the impact of environmental agents on the spatial distribution of the fossil record, using the latest Cretaceous (Campanian and Maastrichtian) dinosaur record of North America as a case study. Whereas western North America has a rich dinosaur record, fossils are relatively rare in the eastern half of the continent. We downloaded a comprehensive database (>4100) of latest Cretaceous dinosaur occurrences from the Paleobiology Database and combined this with a new high-resolution global atlas of digital elevation models. Raw counts of dinosaur diversity peak at 40° N and 55° N paleolatitudes, correlating with higher preservation suitability areas in North America, reflecting the distribution of the most productive dinosaur-bearing formations (DBFs). As climate is a powerful driver of sedimentation, we used climatic envelopes, together with paleo-basin drainage analysis, to produce predictive maps of lithofacies suitable for fossilization. A HadCM3 coupled global climatic model was run in order to provide model outputs of several physical parameters (e.g. temperature and precipitation) during these Cretaceous stages. The resulting models show high preservation suitability, compatible with field data on DBFs. These areas, characterized by high preservation potential, all show active tectonics, large accommodation space, and overall constant surface run-off throughout the year. We created a rank-index for taphofacies characterized by higher potential of preservation (0 = null; 10 = ideal) based on published interpretations of DBFs. Using this virtual habitat approach, we calculated total richness of each simulated taphofacies and then tested the effect of randomly subsampling total dinosaur diversity curves through time. Recovered dinosaur diversity was severely affected, with a two-fold reduction of γ-diversity. This approach highlights that much of eastern North America lacked the conditions necessary to preserve terrestrial vertebrate fossils, and thus dinosaur diversity here might be greatly underestimated. The impact of this data absence on estimates of dinosaur biodiversity emphasizes the difficulty in reconstructing diversity trends in deep time, highlighting the effect of spatial bias on our understanding of mass extinctions and other palaeodiversity dynamics.

Technical Session I (Wednesday, August 23, 2017, 9:15 AM)

EMPIRICAL TESTING OF DEVELOPMENTAL MASS EXTRAPOLATION FOR IMPROVED GROWTH CURVE RECONSTRUCTION

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Body mass-to-age growth curves can provide important insights into animal physiology and ecology and are of interest in paleobiology. The parameters of these growth curves, however, cannot be obtained directly in extinct animals, and rely on estimation of ages and body masses of an ontogenetic series of specimens. Recent studies have developed elaborate age retrocalculation methods to estimate the number of ontogenetically-obliterated growth marks in bone thin-sections, and accurate body mass estimation methods of adults from interspecific limb scaling patterns observed in extant tetrapods. However, previous studies have noted that intraspecific limb scaling patterns do not necessarily follow interspecific patterns, but may be better approximated using a geometric scaling pattern (length^3 ~ mass). Therefore, Developmental Mass Extrapolation (DME) was proposed as a method for estimating the body mass of juveniles by geometrically scaling down from the adult mass. This assumption of DME directly affects important parameters in reconstructed growth curves (i.e. slope at the inflection point), yet DME has not been rigorously tested in extant tetrapods.

In order to assess the accuracy of DME, growth series of eleven extant taxa, including three reptiles, six mammals, and two birds were sampled. Linear limb bone measurements (femur circumference and length) of an ontogenetic series of skeletal specimens with known body mass were recorded. The coefficient of the intraspecific limb scaling in each taxon was compared to the slope of the specific limb scaling and DME lines, and then mean percent prediction errors (PPEs) of DME-based body mass estimates and a null estimate based on an interspecific limb scaling equation of each sampled taxon are compared.

Results reveal that coefficients of intraspecific scalings are generally closer to the slope of a DME line (three) than the interspecific one in the dataset. Accordingly, DME generates lower overall PPE values than the huge PPE values (>100 %) obtained when using the interspecific equation, supporting the use of DME to estimate the body mass of juveniles across terrestrial amniotes. Notably, PPE show that using femoral circumference rather than the length attenuates systemic biases in DME. This study addresses the level of uncertainty surrounding growth curve reconstructions in extinct forms, and provides an improved methodological framework for assessing their growth patterns.

Technical Session I (Wednesday, August 23, 2017, 9:00 AM)

GROWTH DYNAMICS OF SAUROPODOMORPH DINOSAURS

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The Sauropodomorpha comprise of the more basal members, the non-sauropod sauropodomorphs, and the more derived members of the clade, the sauropod dinosaurs among which are the largest terrestrial vertebrates that ever lived. The basal sauropodomorph dinosaurs are reported to have cyclical growth dynamics (evidenced by the cyclical deposition of growth marks during ontogeny), while the sauropods, are considered to have uninterrupted rapid rates of growth (inferred from the lacks of growth marks in their long bones during ontogeny). These deductions pertaining to the growth dynamics of the Sauropodomorpha have largely been derived from histological studies of only a few basal taxa, and several more derived sauropod taxa (Neosauropoda).

Here we examine a comprehensive sample of the bone microstructure of thirteen femora of sauropodomorph dinosaurs, which includes seven basal non-sauropod sauropodomorphs (i.e., *Riojasaurus incertus*, *Coloradisaurus brevis*, *Massospondylus carinatus*, *Leyesaurus marayensis, Leonerasaurus taquetrensis*, *Mussaurus patagonicus* and *Adeopapposaurus mognai*), and a few sauropods (*Lessemsaurus sauropoides*, *Volkheimeria chubutensis* and *Patagosaurus fariasi*).

Although our results agree that the plesiomorphic condition for Sauropodomorpha is cyclical growth dynamics, we found that the hypothesized dichotomy between the growth patterns of basal and more derived sauropodomorphs is not supported. Our findings revealed that except for *Mussaurus*, growth marks occur throughout the cortex in all basal sauropodomorphs, but were also found to occur in the sauropod, *Lessemsaurus*. Additionally, a single growth mark was recorded in *Volkheimeria,* while several poorly defined annuli where observed in the outer cortex of *Patagosaurus*.

Thus, our results agree with the current consensus that the plesiomorphic condition for the sauropodomorpha is cyclical growth dynamics. However, our findings show that the uninterrupted and sustained rapid growth (the so called “sauropod pattern”) also occurred in the basal taxon, *Mussaurus*. We also found that the sauropod-like growth dynamics of uninterruptedand sustained rapid growth also occurred in some basal sauropodomorphs. Furthermore, we found that some basal sauropods retained the plesiomorphic cyclical growth patterns. Thus, our findings show that among the sauropodomorpha the basal taxa exploited different growth strategies, but the more derived Eusauropoda successfully utilize rapid, uninterrupted growth strategies.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

MULTITAXIC BONEBED OF TWO NEW ORNITHOMIMIDS (THEROPODA, ORNITHOMIMOSAURIA) FROM THE UPPER CRETACEOUS BAYANSHIREE FORMATION OF SOUTHEASTERN GOBI DESERT, MONGOLIA

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Theropod dinosaur bonebeds are rare in the world, and only three ornithomimosaur monotaxic bonebeds have been reported from Canada (*Ornithomimus* or *Struthiomimus*) and China (*Archaeornithomimus* and *Sinornithomimus*) so far. Mongolia is rich in dinosaur fossils from the Late Cretaceous, but no ornithomimosaur bonebed has been known yet. In 2010, an ornithomimosaur bonebed was discovered from the Upper Cretaceous Bayanshiree Formation (Cenomanian to Turonian) at Baishin Tsav locality in the southeastern part of the Gobi Desert in Mongolia during the Japan-Mongolia joint expedition. This formation has yielded various groups of theropod dinosaurs, including dromaeosaurids, therizinosaurids, and tyrannosauroid, but the deinocheirid *Garudimimus brevipes* is the only definitive ornithomimosaur taxon from the same locality.

This new bonebed consists different sizes of semi-articulated postcranial skeletons of at least four individuals based on the number of pubes, but no skull was recovered. Some elements are similar to *Garudimimus brevipes*, such as the ilium shorter than the pubis. At least one skeleton preserves arctometatarsalian condition in metatarsals (proximal end of metatarsal III covered by metatarsals II and IV in anterior view), which is a unique character of Ornithomimidae and indicates that this skeleton clearly differs from the non-arctometatarsus *Garudimimus*. The presence of the hand morphological structures, there are two morphotypes in the bonebed. Type I has a proximally positioned medial divergence of metacarpal I and nearly straight slender manual unguals with anteriorly positioned flexor tubercles. Type II has more distally positioned medial divergence of metacarpal I than Type I and ventrally curved robust manual unguals. Whether these morphotypes belong to *Garudimimus* is not clear because its holotype does not preserve hands. At any rate, this bonebed is important to understand the behavior of ornithomimosaurs because it is the first record of multitaxic ornithomimosaur bonebed, suggesting the co-existence of multiple groups of ornithomimosaurs in the same niche.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW MATERIAL OF AN UNUSUAL TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF CENTRAL AUSTRALIA

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The Middle Devonian (Givetian) Harajica Sandstone Member of the Parke Siltstone of Central Australia (Northern Territory) has yielded a well preserved freshwater fossil assemblage, comprising hundreds of fishes recovered as sandstone moulds. This represents the only central Australian Palaeozoic ichthyofauna based on complete body fossils. Collections by the Australian National University in the 1980s and 90s established the presence of five vertebrate taxa in the assemblage. They comprise an extremely abundant antiarch (*Bothriolepis* sp.) along with a phyllolepid (*Placolepis harajica*), a *Striacanthus*-like acanthodian and a dipnoan (*Harajicadipterus youngi*). The fifth, and in many ways most intriguing, taxon is a basal tetrapodomorph, whose material was comprised of several incomplete skulls and sections of postcranium. While much of this material has been presented by Dr. Tim Holland, formerly at Museums Victoria, the fish remains undescribed.

In August 2016, a joint Flinders University and Australian National University expedition to the Northern Territory successfully relocated the fish-bearing layers of the Harajica Sandstone Member and recovered a large quantity of new fossil specimens that will eventually be housed in the South Australian Museum. Of particular importance was the discovery of an exquisitely preserved, complete individual of the Harajica tetrapodomorph in dorsal view. The find firmly establishes that the previously known incomplete remains constitute a single new taxon and provides previously unknown

details of the postcranium. A rigorous full body reconstruction and life restoration of this fish is now possible.
The Gondwanan tetrapodomorph fossil record is notable in containing a mixture of regionally endemic and cosmopolitan lineages, with two endemic clades, the Canowindridae and the tristichopterid sub-group Mandageriinae, known previously from Devonian sites in Antarctica and south-eastern Australia. The Harajica fish possesses tiny eyes, an elongate parietal shield relative to the postparietals and extremely large spiracular openings. A phylogenetic analysis of the new taxon resolves it as the most basal of the canowindrids, extending the geographic range of this family to Central Australia.
Grant Information:
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Technical Session X (Friday, August 25, 2017, 11:45 AM)

A NEW COMPREHENSIVE PHYLOGENETIC ANALYSIS OF ALLIGATOROIDEA (CROCODYLOMORPHA, CROCODYLIA) AND ITS BIOGEOGRAPHIC AND PALEOECOLOGIC IMPLICATIONS

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Several phylogenetic analyses have been made focusing in one or more groups within Alligatoroidea, but few are the analyses that assessed the whole group. This work offers one of the most comprehensive phylogenetic analyses of Alligatoroidea, performed with 179 morphological characters and 96 operational taxonomic units, being 57 alligatoroids and having the non-Eusuchian *Bernissartia fagesii* as an outgroup, with 7000 replications and 20 trees saved per replication in the Tree Bissection Reconnection algorithm. The analysis obtained a strict consensus of 2681 trees, with 675 steps (CI=0,361 to 0,363; RI=0,797 to 0,798). Alligatoroidea was recovered as a monophyletic group, with *Leidyosuchus canadensis* as the basal-most taxon, followed by six species of *Diplocynodon* as a monophyletic group that is the sister-taxon to the remaining alligatoroids. More derived than *Diplocynodon*, the Asiatic forms *Krabisuchus* and the "Maoming crocodylian" appear as sister-taxa to Alligatoridae, within which three monophyletic groups were recovered (Alligatorinae, Caimaninae and a clade formed by the genera *Procaimoidea* and *Arambourgia*). Alligatorinae is formed by *Wannaganosuchus* as the sister-taxon of *Alligator*, a topology already recovered in many previous analyses. The topology within Caimaninae exhibits several significant changes compared to previous published phylogenies. One is the recovery of the clade formed by the genera *Brachychampsa*, *Stangerochampsa* and *Albertochampsa* as the basal-most in Caimaninae. Another is the recently described durophagous forms *Globidentosuchus*, *Gnatusuchus* and *Kuttanacaiman* all belonging to a basal clade within Caimaninae in which the first two taxa are more closely related to each other, while the last forms a clade with the three species of *Eocaiman*, a topology not recovered in previous analyses. The last one is *Purussaurus* being recovered as more closely related to Jacarea than to *Mourasuchus*, which is also not recovered in previous analyses. The biogeographic implications are that Alligatoroidea has a probable North American origin, with three dispersal events to Europe, two to Asia and one to South America, which originated the Caimaninae clade. Within Caimaninae, there are only two dispersal events towards North America. Paleoecologic implications include the perspective that the high level of specialization of durophagy in Caimaninae may have arisen only twice in the group, with the possibility that *Eocaiman* may have been a durphagous taxon as well, a perspective that is to be assessed in future studies.
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

AGE, SEDIMENTOLOGY AND PALEOECOLOGY OF KULINDA, AN EXCEPTIONAL MIDDLE JURASSIC DINOSAUR LOCALITY FROM SIBERIA

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Abundant remains from the neornithischian dinosaur *Kulindadromeus zabaikalicus* have been collected over the past five years at Kulinda, in southwest Siberia (Russia). Trenches have been opened in the southern slope of a hill and hundreds of isolated or partially-associated bones and exceptionally-preserved integumentary structures have been excavated from three monotaxic bone beds.
The Kulinda deposits are located in the lower part of the Ukureyskaya Formation, which consists of a mixture of igneous, volcaniclastic and sedimentary deposits. The age of the Kulinda locality can therefore be estimated on the basis of both K-Ar datings and palynological assemblages. Absolute dating was performed on zircons and monazites collected in two different layers, one at the base of the stratigraphical section and the other located close to the top. A third sample has been collected from a granitic intrusion cropping out on top of the hill. Radiochronological data constrain the maximum age for the deposits at 172.8 ± 1.5 Ma and 173.0 ± 1.6 Ma, and at 172.5 ± 1.6 Ma for the granitic intrusion. The palynological assemblage recovered from the main bone bed is consistent with the radiometric dating, also indicating a Middle Jurassic age for the deposits. Palynomorphs diversity is low at Kulinda. The assemblage is mostly dominated by conifers (*Podocarpidites*, *Piceapollenites*), ferns (*Cyathidites australis*), and bryophytes (*Stereisporites spp*.). The palynofacies assemblages at Kulinda vary throughout the three excavated sections, reflecting local differences in the transport and preservation.
Exquisitely-preserved soft tissues are abundant in one discrete silty layer at the base of trench 4, located on the lowest part of the slope, and are directly associated with *Kulindadromeus* articulated bones and 3D casts. The taphonomy of this bone bed indicates that the dinosaurs probably died *in situ*, close to pond-like water holes, where the dead corpses were protected from scavenging and further degradation processes. Preservation of soft tissues involves their very rapid mineralization. Here, scales and filamentous integuments have been epigenized into silicates and/or iron oxide-hydroxides, allowing their excellent morphological preservation. Bone beds located in the two other trenches, located upper up on the hill, have yielded recrystallized, disarticulated bones only, with rare integumentary structures, suggesting that dinosaur carcasses were disarticulated and degraded before their transport and deposition.
Grant Information:
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Technical Session VI (Thursday, August 24, 2017, 11:00 AM)

A PARAREPTILE FROM THE LOWER PERMIAN OF THE PARNAÍBA BASIN, NORTHEASTERN BRAZIL

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The aquatic mesosaurids, from the Paraná and Karoo basins in southern Gondwana, have long been the only parareptiles (and amniotes in general) known from the lower Permian of the southern hemisphere. Recent fieldwork in the Pedra de Fogo Formation (PdF), in the Parnaíba Basin of northeastern Brazil, has revealed a new tetrapod fauna dominated by temnospondyls, with amniotes represented by a single captorhinid. Collecting efforts in 2016 in the vicinity of Teresina, Piauí State, produced a second amniote from the PdF. The specimen, comprising a disarticulated cranium (~4 cm long) and a partially articulated postcranium, exhibits a number of features characteristic of the Parareptilia. These include an ornamented skull and jaw, a premaxilla bearing a thin arched dorsal process, a maxilla raised anterodorsally, bearing an enlarged anteriormost foramen, and vertebrae possessing swollen neural arches. A bone that borders the orbit, tentatively identified as the postorbital, bears a prominent tubercle. Circumorbital tubercles are characteristic of some parareptiles such as nycteroleters, lanthanosuchids and pareiasaurs. Some maxillary teeth bear weak striations, a feature known in parareptiles such as *Macroleter*, lanthanosuchoids and millerettids. A preliminary phylogenetic analysis suggests a sister group relationship with the genus *Colobomycter* from Oklahoma, USA, within the subclade Lanthanosuchoidea. Unlike all other PdF tetrapods found in the area, which were preserved in massive, silicified siltstones of lacustrine origin, the new parareptile was collected from an erosive-based fine-grained sandstone that suggests a fluvial flux bringing terrestrial material into the lake. The close affinities of the Piauí fossil with the Oklahoma parareptiles (which comprise the majority of known lanthanosuchoids) corroborates previous findings of PdF tetrapods (dvinosaurs, captorhinids) which are also close relatives to counterparts in the southwestern USA. Overall, this supports a model in which the characteristic Cisuralian continental fauna of North America was part of a biogeographic province that extended into the Gondwanan tropics.
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE AXONY CONCEPT IN TETRAPOD ICHNOLOGY

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In the ichnological literature, the concept of axony typically holds a multifaceted meaning when describing and characterizing tetrapod tracks. However, this plurality of meanings weakens the potential of constructive interpretations, especially if several sound implications (i.e. anatomical, biomechanical, behavioural) that the concept itself can convey in the context of track analysis and trackmaker identification are considered. A first meaning of the term relies on the trackmaker's biomechanical aspects related to the body weight, support and propulsive thrust. A second, currently the most frequently used, concerns axony as a purely geometric and dimensional descriptor. In both cases, a static view of the impression process is established, leading to the loss of (or inability to use) important information. Alternatively, a dynamic concept of track formation, and its direct application in the ichnological practice, implies the definition of several axony conditions in the light of the different phases of the locomotion cycle. This approach, presented here based on some perfectly preserved footprints referred to as *Ichniotherium* and *Dimetropus*, can positively impact track descriptions, ichnotaxa diagnoses and trackmaker identification, and allows restoring interconnections between track and trackmaker, thus re-establishing the biological significance of tetrapod footprints.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

LANDSCAPE DIVERSITY OF THE UPPER CRETACEOUS JUDITH RIVER FORMATION TRANSCRIPT

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From 2013-2015 we sampled 13 vertebrate microfossil bonebeds (VMBs) in the Judith River Formation (JRF; Campanian) type area of the Missouri Breaks, central Montana. The JRF was deposited along a swampy coastal floodplain that hosted numerous rivers and oxbow lakes. These VMBs were extensively surface sampled and screenwashed,

producing > 7,694 fossils. This project focuses on the taxonomic and ecological diversities and abundances of these VMB assemblages.
Fossils were identified to element type and taxon, using nested sets of categories. The most abundant taxa were gar, teleosts, salamanders, and ornithischian dinosaurs. By contrast, terrestrial taxa and omnivores had the highest diversities, primarily due to the greater precision associated with identifying lower-level mammalian taxa.
We used the *vegan*, *permute*, and *lattice* packages in R for statistical analyses. Rarefaction showed that most sites are well-sampled for major taxonomic groups. Overall, the environments represented by these sites were primarily aquatic with a significant secondary terrestrial input, as expected based on typical VMB formational processes. Across all sites, the most abundant taxa were small-bodied, aquatic and amphibious carnivores.
We calculated cluster dendrograms based on several different indices. Jaccard and Sørenson indices distinguished sites with high teleost diversity from those with high dinosaur diversity. Morisita's overlap index clustered sites based on high abundances of dinosaurs versus gar or salamanders. Non-metric multidimensional scaling generated two informative axes that separated large versus small taxa (NMDS 1), and terrestrial/amphibious versus aquatic taxa (NMDS 2).
None of these variations were clearly correlated with lithology or sedimentology. In light of our extensive sampling of these sites, we interpret these differences as signals of original variations across the JRF paleoenvironment. This further highlights the ability of VMBs to provide data relevant to landscape-level faunal studies.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NODOSAURID (ORNITHISCHIA, ANKYLOSAURIA) FROM THE LOWER EAGLE FORD GROUP OF NORTH CENTRAL TEXAS

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ABSTRACT— The Holland Farm nodosaurid (SMU 77100) was recovered from lower Eagle Ford Group marine sediments in Mansfield, Texas, and is among the most complete nodosaurid specimens known from the eastern half of North America. The lower Eagle Ford sediments in the area are earliest middle Cenomanian in age, correlated with the *Conlinoceras tarrantense* ammonite zone (95.73± 0.61 Ma), and consistent with a series of eight radiometric dates ranging from 97.838 ± 0.046 to 93.669 ± 0.094 Ma from intercalated ashes in the lower Eagle Ford of South Texas. The specimen preserves the cranium, partially articulated cervical, pectoral, and dorsal osteoderms, vertebrae, ribs, a partial right pectoral girdle, right humerus, right ulna, left femur, and manus elements. Complete first and partial second cervical half rings are preserved in articulated position. The osteoderms of the first half ring bear double keels. Preserved dorsal armor consists of strongly keeled sub-round to elliptical osteoderms and curved spines reaching lengths of 46.8 cm. The Holland Farm nodosaurid shares with *Pawpawsaurus* (late Albian), the geographically and temporally most proximal named nodosaurid, a prominent doming of the posterior skull table and lateral ridges on the squamosal horns. The Holland Farm nodosaurid differs from *Pawpawsaurus* in the possession of flattened and pitted cranial ornamentation with indistinct boundaries, a more prominent nuchal ridge demarcated by a distinct groove spanning the width of the skull, and wide, rounded squamosal horns. The skull of the Holland Farm nodosaurid is 45% larger than that of *Pawpawsaurus*.

Technical Session XI (Friday, August 25, 2017, 10:30 AM)

MORPHOLOGIC AND ISOTOPIC EVIDENCE OF THE DEVELOPMENTAL HISTORY OF AUDITORY BULLAE IN *DORUDON ATROX* AND *ZYGORHIZA KOCHII* (ORDER CETACEA, FAMILY BASILOSAURIDAE)

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Over the course of their land-to-sea transition, cetaceans modified their auditory systems to enable underwater hearing, a condition marked by the appearance of the involucrum, or thickened medial wall of the tympanic, in the early Eocene. Extant species are characterized by rapid mineralization of this structure early in development, shortly before or just after birth, which provides neonates the ability to hear and communicate with their mothers. Based on the significance of this structure to pair bonding between mothers and calves in extant species, we hypothesize that early mineralization of the tympanic during development would have been favored as soon as cetaceans severed all ties to land and were capable of giving birth in water. Here, we test this assumption by examining whether early pelagicetes (Family Basilosauridae) shared this derived condition of development with crown Cetacea.
To test our hypothesis, we employed a combined morphologic and isotopic approach that focused on two species of basilosaurids (*Dorudon atrox* and *Zygorhiza kochii)*. Tympanic bullae from multiple specimens of *D. atrox* representing different age classes were examined and measured to determine how bullae changed in size with age. These data were combined with carbon and oxygen isotopic data for tympanic bullae from one specimen of *Z. kochii* (USNM 16638), which were compared with isotopic data from the deciduous and adult dentition of this specimen. The dentition shows a decrease in $\delta^{13}C$ values for late erupting deciduous teeth (dP_1/dP^1) and early erupting adult teeth (M_1/M^1), marking the interval of nursing. Comparison of $\delta^{13}C$ values from tympanic bullae and dentition can constrain when these bones formed.
Measurements of tympanic bullae from *D. atrox* did not show a significant difference in length (L, $p = 0.107$) or width (W, $p = 0.847$) between age classes. Measurements for the youngest individual (UM 100139: L = 80.5 mm, W = 58.6 mm) did not differ significantly in size from those of the oldest individual (UM 101215: L = 79.9 mm, W = 59.1 mm). These data suggest that tympanic bullae reach almost adult size early in life. This timing can be refined further based on $\delta^{13}C$ values for tympanic bullae from USNM 16638 (left = -8.4‰, right = -8.9‰), which most closely match $\delta^{13}C$ values for teeth mineralizing during the nursing interval (~-9.0‰). Based on our combination of morphologic and isotopic data, we show that the tympanic bullae complete mineralization shortly after birth. Our findings are consistent with early mineralization of bullae in cetaceans evolving by the late Eocene.
Grant Information:
This project was supported by funds from the National Science Foundation (SGP EAR 0847413).

Technical Session II (Wednesday, August 23, 2017, 9:30 AM)

ARCHES AND ACTINOPTS: HYOID COMPOSITION AND RESOLVING THE BUSH AT THE BASE OF THE RAY-FIN TREE

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Hyoid arches are central to the structure of most fish heads: they contribute to jaw function and support, and link opercular, gill skeleton, and mandibular arch movements. In actinopterygians, the coupling between mandibular and hyoid arches involves a suite of components sandwiched between the hyomandibula and ceratohyal. These bones or cartilages are usually small, named as interhyal, symplectic and/or stylohyal, and are occasionally characterized as accessory elements despite their crucial role in cranial function. The terminological instability associated with these bones reflects uncertainty about the homologies of parts in different hyoid arch compositions, each characteristic of different clades. Part of the problem results from rarity of well-preserved examples in Palaeozoic fish, leading to uncertainty about early and likely primitive conditions. Here, for the first time, computed tomography (CT) reveals the entire, articulated hyoid arch of a 'palaeoniscid-grade' actinopterygian from the Early Pennsylvanian of Lancashire, UK. Importantly, the complete set of ossifications and their linkage network uniquely resembles the hyoid arch of living chondrosteans. Two accessory bones in series connect the hyomandibula to the ceratohyal. The uppermost accessory connects with the mandibular arch via the articular of the lower jaw, and the lowermost accessory bears the posterior member of the branchiostegal rays. Like neopterygian hyoid arches, this example includes five ossifications ventral to the hyomandibula, whereas chondrosteans have no more than four, and polypterids only three. These results exemplify the importance of CT methods for discovering small, fragile bones in-situ that retain their in-life connections to the rest of the skeleton, rather than reconstructing such patterns from mechanically prepared or chemically digested debris. These data hint at means of resolving the palaeoniscid problem: the vast array of Paleozoic actinopterygians that have yet to deliver a reliable signal of relationships to the primary divisions of the largest living vertebrate clade. Thus far, data matrices are dominated by morphological characters that are either too noisy (dermal skeletal) or too conservative (neurocranial). The wider range of data accessed by CT seem likely to resolve some of the nodes in question, and perhaps make sense of this inverse of the classic teleost problem: the bush at the base of the tree.
Grant Information:
NSF DEB-1541491: Fishlife

Technical Session IX (Thursday, August 24, 2017, 2:45 PM)

BIOMOLECULE PRESERVATION IN VERTEBRATE FOSSILS FROM DIFFERENT BURIAL ENVIRONMENTS

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Biomolecules have variable preservation potential and recent studies have found that proteins may preserve longer than expected in the fossil record, making the study of dinosaur biomolecules possible. However, studies have focused mainly on the detection of proteins and peptides and have not considered the taphonomy of the burial conditions, and have not definitively excluded the possibility of organic contamination from exogenous sources. To test the sources of proteins that can now be detected in fossils using high resolution mass spectrometry, we have analyzed two datasets: 1) a "shallow time" (~150 Ka) study on mammoth fossils from different burial environments (i.e., permafrost, a channel deposit, a sink hole and natural asphalt) and 2) a deep time study on Late Triassic fossils (~210 Ma) of different tissue types (i.e., bone, tooth and coprolite) from the same burial environment and post burial diagenesis. We used a series of analytical techniques to examine the molecular degradation of modern bone and compare that to what is preserved in the fossils. We used time-of-flight secondary ion mass spectrometry (TOF-SIMS) to detect amino acids and analyze the spatial distribution of the molecules within the bone. We incorporated maturation experiments as a proxy for bone degradation, lipid data to determine potential sources of contamination and Raman spectroscopy to establish how much degradation has occurred in the fossils. In our shallow time study we examine fossils within a time frame that protein preservation is likely and consider how amino acids degrade differently based on burial environment. The preservation of the lipids and amino acids in the mammoth fossils correspond with the amount of degradation seen in the bone. The permafrost sample retains the most lipid and amino acid information, followed by the channel deposit, with the least organic information preserved in the sink hole sample. But in our deep time study, based on the amino acid data, we found that the different types of tissues cannot be distinguished from the burial environment. The burial environment of the Triassic samples is most comparable to the channel deposit in the shallow time study and, when combined with greater degradation over millions of years, a clear loss of proteins is evident. Our results show that burial environment and analyzing multiple specimens or tissue types from the same burial environment is critical to further studies of molecular preservation in fossil record.
Grant Information:
Virginia Space Grant Consortium Graduate STEM Research Fellowship, GSA Graduate Student Research Grant, Palaeontological Association Stan Wood Award

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A POSSIBLE CARCHARODONTOSAURID THEROPOD RECORD FROM THE VALANGINIAN (EARLY CRETACEOUS) OF PATAGONIA, ARGENTINA

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Skeletal remains corresponding to an adult specimen of an allosauroid theropod (MLL-Pv-007) were collected in the sandstones of the Mulichinco Formation (Valanginian, Lower Cretaceous of the Neuquén Basin). The specimen includes the tip of the snout, some postdentary bones, vertebrae (cervicals, dorsals, sacrals and caudals), ribs, and fragments of the pelvic girdle. The cervico-dorsal section consists of five complete, articulated vertebrae (the three last cervicals and first two dorsals) with cervical ribs attached. Nine posterior dorsal vertebrae are represented by portions of the neural arches and centra, and are still attached to their ribs. The three preserved sacral vertebra are very pneumatic, and the four articulated caudals are from the middle to distal part of the tail. The hip elements are fragmentary but include the dorsal margin of the supracetabular blade, the pubic peduncle, and fragments of the pubis. The sculptured lateral surface of the maxilla, the moderately sized cervical epipophyses, the presence of sacral pleurocoels, and the well-developed prespinal laminae in the caudals form a combination of characters present in allosauroid theropods. A preliminary cladistical analysis links this specimen with carcharodontosaurid theropods by having a single unambiguous synapomorphy — a maxilla with a sculptured external surface. These are the first reported theropod remains from the formation, which is associated stratigraphically with dicraeosaurid sauropods and non-hadrosaurid ornithopods. The Bajada Colorada Fm partially overlaps the Mulichinco Formation temporally, and has yielded fragmentary and poorly preserved theropod remains assigned to abelisauroid and megalosaurid theropods. Thus, the Mulichinco specimen would represent the oldest carcharodontosaurid record from South America, and suggests that the evolutionary history of this clade in the continent is older than thought.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE RECORD OF *DEINOSUCHUS* EAST AND WEST OF THE WESTERN INTERIOR SEAWAY

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Deinosuchus is a giant (10+ m) Late Cretaceous crocodylian. It was the largest semiaquatic predator in its environment and is known to have fed on dinosaurs. Fossils have been found in units of Campanian age from Coahuila, northern Mexico to Montana in the west and Mississippi to New Jersey in the east. Three species have been named - *D. hatcheri* and *D. riograndensis* from the western interior and *D. rugosus* from the Atlantic coastal plain - and recent consensus has been that all three represent a single widely-ranging species. We studied newly-collected material from the Big Bend region of western Texas and increased sampling of the lineage from throughout North America to review species-level systematics of *Deinosuchus* and help refine its phylogenetic placement among crocodylians.

Deinosuchus from western and eastern North America can be consistently differentiated and represent different species. Western specimens have inflated, deeply ornamented osteoderms whose keels are largely obliterated whereas eastern specimens have pronounced keels and reduced ornamentation. Additional differences are manifest in the premaxilla. Eastern specimens have deep occlusal marks posterior to the junction of the first and second premaxillary teeth. Ontogenetic sequences show the development of this feature from a depression to a deep groove as the animal matures.

We conducted a phylogenetic study using Mesquite, Winclada and TNT. The matrix included 73 crocodylian taxa and 156 characters – the authors included new character states describing the unique osteoderm and skull table morphology of *Deinosuchus*. *Borealosuchus sternbergii* was used as an outgroup to root the trees. Eastern and western *Deinosuchus* are recovered as sister taxa in a basal polytomy with contemporaneous North American *Leidyosuchus canadensis* and more derived alligatoroids. Pruning the taxa to include only alligatoroids results in *Deinosuchus* being recovered one node crownward of *L. canadensis*. Homoplastic character states shared with crocodylians outside of Alligatoroidea are responsible for the modest difference in the placement of *Deinosuchus* between the analyses. This work reinforces the identity of the "terror crocodile" as an alligator.

Technical Session XVII (Saturday, August 26, 2017, 8:30 AM)

THE IMPORTANCE OF RATS: MURID RODENT FOSSILS FROM AUSTRALIA AND WHY THEY MATTER

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Murid rodents are an understudied component of the Australian fossil record, despite representing nearly 25% of the extant non-volant terrestrial mammal fauna. In particular, few extinct taxa have been described, and the palaeoecology of many fossil species are poorly known. Murids appear to have arrived in Australia during the early Pliocene, but their fossil record is patchy at least until the early Pleistocene. By that time several major lineages were already established, and molecular phylogenies suggest that those modern taxa not yet represented by fossils had also diverged. The majority of fossil murids from the middle to late Pleistocene have been assigned to modern species, so the discovery of a diverse assemblage of new taxa from the middle Pleistocene of eastern tropical Queensland is surprising. The main study sites are limestone cave fills in the Mount Etna area in central eastern Queensland, which together contain a record of faunal and environmental change from >500 ka to the present day. The oldest deposits contain faunal assemblages indicative of a rainforest palaeoenvironment, whereas those <280 ka predominantly contain fauna adapted to xeric habitats. The sites in the Mount Etna area thus document the collapse of a diverse rainforest palaeoenvironment during the middle Pleistocene. A similar event is recorded in cave sites in the Broken River area in northeast Queensland. Although Broken River and Mt Etna have many faunal similarities to suggest continuous rainforest coverage over a large area of eastern Queensland, the loss of rainforests was asysnchronous, with the northern fauna experiencing turnover prior to that in central Queensland. Several marsupial taxa from middle Pleistocene sites also show similarities to species otherwise known only from New Guinea, and this has suggested to some workers that rainforests were continuous with faunal exhanges between the two landmasses at that time. 12 extinct murid species are associated with sites interpreted as rainforest palaeoenvironments. This includes taxa with similarities to both extant north Queensland/New Guinean rainforest taxa as well as fossil assemblages from the Early Pleistocene. However, the absence of several distinctive New Guinean murid lineages from the study sites suggests that large-scale faunal exchange could only have occurred prior to the arrival and diversification of murids. It would thus appear that the extensive area of rainforest in central Queensland during the middle Pleistocene was already isolated from that to the north prior to its destruction.

Podium Symposium (Wednesday, August 23, 2017, 11:30 AM)

PATTERNS OF LIMB ELONGATION IN ENDEMIC SOUTH AMERICAN UNGULATES (NOTOUNGULATA AND LITOPTERNA) AS MEASURED BY METATARSAL/FEMUR RATIO

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The early appearance of hypsodont mammals in South America has spurred a variety of investigations of habitat change and mammalian paleobiology spanning the middle to late Cenozoic. Nevertheless, few such studies have focused on mammal limb morphology and potential correlations with vegetation structure. I compiled genus-level occurrences of notoungulates and litopterns, the predominant South American endemic ungulates, for late Oligocene to Pleistocene South American Land Mammal Ages (SALMAs; Deseadan to Lujanian) and calculated a measure of distal limb elongation, metatarsal/femur ratio (MT/F), to quantify and compare limb morphology across this interval. Litopterns have highest MT/Fs as a group, followed by typothere and toxodont notoungulates (mean = 0.45, 0.37, and 0.24, respectively; $p < 0.05$, Wilcoxon test). Few subclades are sufficiently represented to permit within-group trends to be assessed except: (1) mesothere notoungulates, with decreasing MT/Fs, possibly related to fossoriality; (2) pachyrukhine notoungulates, with increasing MT/Fs, possibly linked to habitat; and (3) macraucheniid litopterns, with diverging MT/Fs, possibly correlated with body mass. No endemic ungulate has MT/F > 0.65, the lower limit for modern "cursorial" ungulates (camelids, pecoran ruminants, equids). Only two ungulates have MT/F > 0.50: the early Miocene monodactyl proterotheriid litoptern *Thoatherium* (0.59) and an undescribed, relatively small-bodied macraucheniid litoptern from the middle Miocene of Quebrada Honda, Bolivia (0.53). Surprisingly, the middle Miocene interatheriid notoungulate *Miocochilius*, which shows greater lateral digit reduction than any other notoungulate, does not have appreciably longer distal limbs than other typotheres of similar size: its MT/F (0.40) is approximately equal to that of the early Miocene interatheriid *Protypotherium* (0.42) as well as the contemporaneous hegetotheriid *Hemihegetotherium* (0.41). Although only a small proportion of native ungulates could be included in this study due to limited postcranial material, there is no evidence for concordant distal limb elongation in multiple groups of endemic ungulates during this interval as has been documented for North American ungulates. This supports a recent hypothesis based on astragalus morphology that the most significant change in endemic ungulate limb morphology during the middle to late Cenozoic took place during the late Eocene or early Oligocene, concordant with the evolution of hypsodonty and development of more open habitats.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

IDENTIFICATION OF SCIURIDS (RODENTIA:SCIURIDAE) FROM TWO LATE CENOZOIC LOCALITIES IN THE EASTERN U.S.

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Sciurids are one of the most diverse mammalian species worldwide, yet this is not reflected in the fossil record, particularly in North America. Few non-marmotine sciurid records occur in North America before the Pleistocene; east of the Mississippi River there are only three pre-Pleistocene sciurid records: two marmotine squirrels from Pipe Creek, Indiana, and a pteromyine flying squirrel from the Palmetto Fauna of Bone Valley, Florida. Described are sciurids from two more late Miocene-early Pliocene localities—the Gray Fossil Site, Tennessee, and Tyner Farm, Florida. Three Sciuridae taxa comprised of four ecomorphs are described from the late Miocene-early Pliocene Gray Fossil site; these are the chipmunk, either *Eutamias* or *Neotamias*, the flying squirrel, *Glaucomys*, and two tree squirrels, one large and one small, identified as cf. *Sciurus*. From the late Miocene site Tyner Farm two ground squirrel ecomorphs were identified: a chipmunk, identified to the subtribe Tamiina, and a marmotine ground squirrel, identified to the tribe Martmotini. The presence of the three arboreal ecomorphs at GFS confirm the paleoenivronment was densely forested, consistent with previous studies. Two ground squirrel ecomorphs at Tyner Farm suggest a more open grassland type environment; the presence of both browsers and grazers suggest a wooded savannah ecosystem, thus the inferences based on the sciurids are consistent with the paleoenvironment as suggested by the presence of both grazing and browsing ungulates. The identification of sciurids from these two sites expands the sciurid record of North America, adding to the greatly lacking record of non-marmotine squirrels and providing insights into the evolution of the family through time.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE SKULL OF *CONCAVENATOR CORCOVATUS* (DINOSAURIA; THEROPODA) FROM LAS HOYAS (EARLY CRETACEOUS, SPAIN): OSTEOLOGY AND 3D RECONSTRUCTION

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Concavenator corcovatus is a carcharodontosaurid dinosaur known from only an almost complete and articulated skeleton, MCCM-LH 6666, from 'Las Hoyas' fossil site (Early Cretaceous, Spain). The fossil is embedded in fine laminated limestone, with only the right elements of the skull visible in lateral view. The skull of *Concavenator* is almost complete, except for the anteriormost and posteriormost regions, which are broken. Therefore, several posterior skull bones are missing.

Here, a review of the cranial anatomy of *Concavenator* has been carried out in order to further test its phylogenetic relationships. This included a detailed osteological description of the skull and comparing its features with those of other allosauroids. This description has provided a wide revision of the cranial anatomy of carcharodontosaurids, relevant to their general phylogenetic relationships.

This review shows the skull of *Concavenator* shares several allosauroid and carcharodontosaurid synapomorphies. *Concavenator* has, as other allosauroids, i) a low and longitudinal lateral ridged on the dorsolateral rim of the nasal, ii) a low, broad and rugose lacrimal horn, iii) several foramina on lateral surface of the lacrimal, iv) pneumatic recess on the palatine, and v) two posterior foramina on the surangular. *Concavenator* shares numerous apomorphies with other carcharodontosaurids: i) a lacrimal-postorbital contact, ii) a well-developed postorbital boss, iii) anteroventrally oriented postorbital ventral process, iv) an intraorbital process in the postorbital, v) rostrally projected roughness in the dorsal surface of the postorbital, vi) a notch in the ascending ramus of the maxilla, vii) a sulcus on the anterior margin of the lacrimal ventral ramus, viii) curved dorsal surface of lacrimal, and ix) frontal-parietal fused contact. Finally, *Concavenator* has two cranial autapomorphies: i) connection between the recess on the lateral surface of the nasal and ii) a rounded morphology of the ventral surface of the postorbital boss.

In addition, anatomical comparison mostly with *Allosaurus* and *Acrocanthosaurus*, as well as other carcharodontosaurids, has enabled to reconstruct the missing regions of the skull. Here, we propose the first complete 3D reconstruction of the skull of *Concavenator*, based on the integration of the anatomical data of the clade. The skull model was generated from a superficial photogrammetric scan with the missing information sculpted with CAD software.

Grant Information:
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Technical Session V (Wednesday, August 23, 2017, 3:00 PM)

STABLE ISOTOPE ANALYSIS OF AN EXTANT VERTEBRATE COMMUNITY USING PALEONTOLOGICAL SAMPLING CONSTRAINTS REVEALS LOW ECOLOGICAL RESOLUTION IN A C_3 FLOODPLAIN SYSTEM

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Stable isotopes are powerful tracers for elucidating patterns of diet, trophic interactions, and community structure in extant and Cenozoic terrestrial mammalian communities. These methods have been particularly useful in distinguishing browsing and grazing mammalian herbivores that inhabit primarily open landscapes, and are less commonly applied to closed forest or floodplain communities. This absence of comparative data is potentially problematic in stable isotope studies of Mesozoic terrestrial vertebrate communities. These systems are dinosaur-dominated, closed forest or fluvial environments with considerable marine input, and lack significant C_4 plant components. As a result, interpretation of stable isotope data from Mesozoic communities is challenging. Therefore, we sampled an extant terrestrial vertebrate community from the Atchafalaya Basin of Louisiana, an environmental analogue to the coastal floodplains of the Cretaceous of Western North America. Nineteen taxa were analyzed for stable carbon, oxygen, and nitrogen isotope ratios from bioapatite (teeth and/or bone) and keratin (claw and/or hair) in order to test the degree of ecological resolution that can be determined in a known system with similar conditions, and using similar methodological and informational constraints, as those in a Cretaceous sample. This dataset includes crocodilians, holostean fish, and both metatherian and eutherian mammals, and thus represents a range of diets and habitat preferences.

Nitrogen isotope data were effective at differentiating trophic relationships, whereas carbon isotope distributions sampled from both bioapatite and keratin overlap broadly among taxa and are consistent with a primarily C_3 plant community. Results from $O_{carbonate+phosphate}$ and $O_{keratin}$ isotope data suggest that the organisms shared local water resources, except for ^{18}O-enrichment in large herbivores, which is consistent with obtaining water from foliage. No obvious canopy effects or other habitat preferences were detectable in the carbon isotope data for keratin or bioapatite structural carbonate, despite known differences in habitat preferences and feeding styles from observational data among the sampled taxa. These results have implications for framing predictions of data from Mesozoic communities. Variation in isotopic results here are consistent with those recovered from the Late Cretaceous, but highlight that ecological interpretation in a C_3 system can be very difficult, particularly when sources of variation are unconstrained.

Grant Information:
Natural Sciences and Engineering Research Council of Canada (T.M.C, F.J.L., D.C.E.)

Technical Session I (Wednesday, August 23, 2017, 8:15 AM)

COMPARATIVE BONE HISTOLOGY IN THE ISCHIGUALASTO FORMATION (UPPER TRIASSIC): SHEDDING LIGHT ON EARLY DINOSAUR GROWTH PATTERNS

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The Upper Triassic (Carnian-Norian) Ischigualasto Formation preserves basal members of the three dinosaurian subgroups (Ornithischia, Theropoda, and Sauropodomorpha). The formation also yields a suite of non-dinosaurian tetrapods (archosauromorphs, crurotarsans, non-mammalian cynodonts) that overlap with or differ from the earliest dinosaurs in body size, diet, and habitat. The taxonomic and ecological diversity of Ischigualasto vertebrates, combined with the relatively short temporal span of the formation (~ 6 my) and its well-documented paleoenvironmental setting provide an ideal framework for investigating growth dynamics. We employed bone histology to test the following hypotheses: (1) the evolution of elevated growth rates evolved in archosauromorphs before the divergence of distinctive groups (e.g., Crurotarsi); and (2) early dinosaurs exhibited growth strategies distinct from those of contemporaneous non-dinosaurian taxa. We sampled mid-diaphyseal femoral cross-sections from terrestrial Archosauromorpha (*Scaphonyx),* aquatic Archosauriformes (*Proterochampsa, Chanaresuchus*), terrestrial Crurotarsi (*Sillosuchus, Saurosuchus*, *Trialestes*), terrestrial, potentially omnivorous (*Eoraptor*) and carnivorous (*Herrerasaurus, Sanjuansaurus, Eodromaeus)* dinosaurs, and terrestrial, herbivorous Cynodontia (*Exaeretodon*). Our results suggest that fibrolamellar bone is common to a diversity of non-dinosaur and early dinosaur taxa (this finding is consistent with the reconstructions of other authors). Interestingly, in taxa with more organized primary bone tissue (e.g., *Exaeretodon)*, vascularity is dense and interwoven. Mid-cortical Lines of Arrested Growth are absent in the archosaur sample. Finally, two "modes" of bone remodeling are developed, and these only rarely co-occur in our sample: some taxa (e.g., *Eoraptor, Exaeretodon*) exhibit occasional secondary osteons, while others (e.g., *Trialestes, Sanjuansaurus)* exhibit focused endosteal remodeling. Our results suggest that there may be only a few aspects of early dinosaur growth that are truly distinctive from most of their non-dinosaurian contemporaries.

Grant Information:
The work was supported by a National Science Foundation grant to KCR (EAR-0955716).

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

GONE FROM THE SOUTHERN PLAINS: A PLEISTOCENE *HELODERMA* IN A NEW LOCAL FAUNA FROM A KARSTIC FILLING IN SOUTHWESTERN OKLAHOMA

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Karstic fissure fillings in Ordovician limestones are well known in southwestern Oklahoma for producing the world's preeminent fossil record of early Permian tetrapods. Until this study, however, no fauna from paleokarstic fillings of any other age has been reported from the area. Herein, we present the first evidence of a new karstic filling containing Quaternary fossils of a diversity of vertebrates, named the Apache local fauna, from an active limestone quarry in the Slick Hills northwest of Apache, Oklahoma. The Apache local fauna is dominated by microvertebrates including pit viper, nonvenomous snakes, lizards, woodrat, and prairie dog, with less common members including fish, frog/toad, salamander, perching bird, turtle, rabbits, additional rodents, bat, shrews, ringtail, and skunks. One of the shrews represents an apparently extinct species of *Cryptotis* larger than *C. parva*. Other extinct mammalian taxa are represented by extremely fragmentary teeth and bones of larger mammals; they include canid, ?felid, *Equus*, *Platygonus*, a probable *Capromeryx,* and a larger pronghorn. To date, a single osteoderm has been recovered that is diagnostic of the Helodermatidae (beaded lizards), genus *Heloderma*. This is the first record of Helodermatidae in Oklahoma. The fauna is assigned to the Pleistocene based on the megafaunal mammals; recovery of a small sample of flowstone could provide a basis for radiometric dating by Uranium-series. The fauna appears to reflect an interstadial or relatively warm period not radically different from the late Holocene, and a relatively open habitat, dominated by prairie elements but including the unusual subtropical element of the beaded lizard. The occurrence of the *Heloderma* has potential implications for its conservation in the face of continuing climate change.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

QUANTITATIVE HETERODONTY IN CROCODYLIA: ASSESSING FUNDAMENTAL NICHE IN EXTINCT TAXA

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Dental morphology may reveal a wealth of information concerning tooth function and feeding ecology, but has been rarely investigated quantitatively in Crocodylia. A thorough understanding of modern crocodylian heterodonty should elaborate upon fundamental niche in their extinct counterparts. This study compares the tooth morphometrics of crocodylians, and elaborates upon potential trophic characteristics. In situ teeth from 14 extant and 7 extinct crocodylian species were analyzed, resulting in 1,150 teeth total. Each tooth was photographed individually, the tooth margin was converted to semilandmarks, and was analyzed using geometric morphometrics. Modern species were grouped based on phylogeny and snout shape characteristics. Results suggest that tooth size and shape are developmentally decoupled in crocodylians. In each species, the majority of teeth fall within a limited size range with several large outliers,

presumably used for initial prey acquisition. This results in an oscillating trend in tooth size. Concerning shape, the majority of the variance (>90%) involves tooth structuring ranging from narrow and caniniform, to robust and molariform. Contrary to size, shape change along the tooth row is linear in extant alligatorids and crocodylids; teeth gradually transition from caniniform to molariform as they progress posterior. Both size and shape heterodonty were highly variable between species, but were lowest in slender-snouted taxa. These crocodylians possess significantly smaller, and more caniniform, teeth than all other snout morphotypes, which may be linked to the compliant nature of fish and/or small-vertebrate prey. Broad-snouted and generalized crocodylians showed no significant size or shape differences in dentition. Within these, *Osteolaemus tetraspis* has most molariform posterior teeth in the sample, followed by *Alligator* species and *Crocodylus siamensis*: suggesting heightened durophagy. These species also show an enlargement of these teeth, whereas posterior teeth in all other taxa are among the smallest. Concerning extinct taxa, several species fall with ranges of modern generalists, such as *Borealosuchus*. *Crocodylus affinis* and *Boverisuchus vorax* have posterior teeth consistent with the most molariform extant taxa, and *Allognathosuchus* and *Brachychampsa* possess a more extreme molariform condition than any extant taxa when position is considered. This suggests these crocodylians may have had mechanical demands put on their teeth that equal and/or exceed those of modern durophages.

Technical Session I (Wednesday, August 23, 2017, 8:00 AM)

DEVELOPMENT AND STRUCTURE OF EARLY TETRAPOD VERTEBRAL CENTRA: A PALEOHISTOLOGICAL APPROACH

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In the past, early tetrapods were often classified on the basis of their wide spectrum of different types of vertebral centra. In the majority of early tetrapods, the vertebral centrum is multipartite and is composed of inter- and pleurocentrum, whereas the monospondylous centrum of most lepospondyls solely consists of the pleurocentrum. To determine possible contrasting growth patterns between inter- and pleurocentra, centrum bone histology of different early tetrapod lineages was examined. In all investigated early tetrapods, comprising representatives of stem-tetrapods, temnospondyls, seymouriamorphs, anthracosaurs, chroniosuchians, and lepospondyls, the vertebral centra, regardless of being intercentrum or pleurocentrum, display a common ossification pattern in which the elements were first ossified endochondrally and subsequently, periosteal bone was deposited on their outer surface. The microstructural organization and growth of inter- and pleurocentrum of early tetrapods indicate a low intraspecific but a high interspecific variability. Therefore, histology does not allow to distinguish between the two elements, and centrum homologies between different early tetrapods groups cannot be established. However, it can be shown that inter- and pleurocentrum developed differently during ontogeny. In all investigated early tetrapod groups, the typical, crescentic intercentrum evolved from paired, ventrally located ossification centers which fuse ventromedially during further growth. In stem-tetrapods and temnospondyls, the presacral pleurocentrum arises from two dorsally located ossification centers which may fuse to a dorsal crescent in some stem-tetrapods or even ossify to a ring-shaped element like in some dvinosaurian temnospondyls. An almost identical but mirror-inverted developmental pattern is observed in stem-amniotes (anthracosaurs, chroniosuchians, seymouriamorphs, and lepospondyls). In these groups, the pleurocentrum developed from two ventrally located ossification centers whereby the ring-shaped pleurocentrum of the seymouriamorph *Discosauriscus* ossified from ventral to dorsal. It can also be assumed that the ossified portions of inter- and pleurocentrum continued in cartilaginous rings or discs that surrounded the notochord in the living animals.

Technical Session XI (Friday, August 25, 2017, 9:15 AM)

ASSESSING THE PALEO-SPECIES-AREA RELATIONSHIP WITH NEOGENE FOSSIL MAMMALS FROM NORTH AMERICA

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Modern organisms show an exponential relationship between species richness and area sampled with well constrained coefficients, but fossil organisms, while having the expected relationship, have not shown matching fit values. We investigated the effect of sample-standardization on the species-area slope, comparing raw richness to that obtained by classical rarefaction and Shareholder Quorum Subsampling (SQS) on occurrences. We used the MIOMAP and FAUNMAP databases of published mammalian fossil occurrences from the Arikareean to Rancholabrean of the United States, as well as a database of modern mammal occurrences from iDigBio, VertNet, and GBIF. We find that within most of the individual North American Land Mammal Age (NALMA) subdivisions, fossil mammals do not have significant species-area relationships with any richness metric, with the exception of raw richness for the early Barstovian (R^2=0.50, p=0.03), early Arikareean (R^2=0.75, p=0.005), late Barstovian (R^2=0.48, p=0.04), and late Hemingfordian (R^2=0.65, p=0.03). Only the early Arikareean was significant for rarefied richness (R^2=0.74, p=0.03) and SQS richness (R^2 =0.73, p=0.03). However, analyzing all data across regional and time subdivisions together produces a significant species-area relationship for all three metrics (for SQS, R^2=0.43, p<0.0001). The species-area relationship in these data has enough noise that the small sample size afforded within a NALMA subdivision is not large enough to detect a signal. By fitting a single function to the grouped fossil data, we can characterize the offset from the general species-area relationship for each time interval, providing a sampling- and area-standardized metric for richness through time. We also find that the SQS richness fits tend to match the raw richness fits, with the rarefaction richness slopes much lower, supporting the assertion that SQS better retains relative richness information through fair subsampling. Finally, the modern mammal data show a surprising negative species-area relationship. The modern record is so well sampled that at the scale of our study we have passed the point of saturation on the collecting curve, so additional areas cannot add species. In the end, the species-area relationship is present in fossil mammal faunal assemblages, but the natural sampling regime is not adequate to diagnose the relationship within individual time bins. Instead, an overall species-area relationship can be used to create a richness index that accounts for both intensity of sampling and area sampled through time.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW LATE CRETACEOUS (EARLY CAMPANIAN) MICROFOSSIL FISH ASSEMBLAGE FROM THE UPPER CRETACEOUS ALLISON MEMBER OF THE MENEFEE FORMATION OF NEW MEXICO

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The marine deposits of the Cretaceous western interior seaway in New Mexico preserve abundant fish, especially chondrichthyans, of Early Cretaceous-Campanian age. Here we provide information on an assemblage that bridges the gap between these largely marine older assemblages and the nonmarine assemblages of the younger Fruitland and Kirtland formations. We report an updated list of microfossil fish remains, both osteichthyan and chondrichthyan, from the Menefee Formation based on an exceptionally rich microvertebrate assemblage. The majority of the fish fossils come from an intraformational clay-pebble conglomerate lag that is locally bone-bearing. This microvertebrate site is in the Allison Member, which is the middle member of the Menefee Formation and of Aquilan (early Campanian) age. Chondrichthyans are represented by hundreds, if not thousands, of teeth and include numerous batoid and non-batoid taxa. Batoid (ray and skate) taxa recovered include members of the families Rhinobatidae (*Cristomylus, Myledaphus, Protoplatyrhina, Pseudohypolophus,* and *Pseudomyledaphus),* Rhombodontidae (*Rhombodus*), Sclerohynchidae (*Ischyrhiza*), and Dasyatidae (*Dasyatis*). Non-batoid chondrichthyans include the hybodont *Lonchidion,* the odontaspidid *Carcharias,* the mitsukurinid *Scapanorhynchus,* and the cretoxyrhinid *Cretodus*. Of the chondrichthyans, *Cristomylus, Lonchidion, Myledaphus, Pseudohypolophus,* and *Psueudomyledaphus* are most abundant, with individual teeth numbering in the hundreds. Osteichthyans are represented by numerous teeth and scales. We assign bulbous, crushing teeth to the phyllodontid *Paralbula*. Additional ziphodont osteichthyan teeth can be assigned to Lepisosteidae, Pycnodontidae, and Amiidae, but are not identifiable to the genus level. The Menefee locality these fossils were collected from is primarily composed of sandstone, with some strata containing lignite or siderite nodules. Close to 85% of the microfossils by quantity recovered from the site pertain to fish, of which 75% of specimens are typically considered freshwater forms, while 25% are associated with salt water settings. We interpret this to indicate deposition in an alluvial floodplain with a nearby estuarine influence. At the same horizon nearby is a log riddled with *Teredolites* ("shipworm burrows"), further supporting our inference of marine influence. The presence of so many fish, especially chondrichthyans, greatly increases the known diversity of the Menefee Formation.

Grant Information:
Funding will be sought from the Office of Student research and the Department of Geology.

Technical Session II (Wednesday, August 23, 2017, 9:00 AM)

THE EARLIEST THREE-DIMENSIONALLY PRESERVED CHONDRICHTHYAN BRANCHIAL SKELETON IN THE EARLY DEVONIAN ACANTHODIAN *PTOMACANTHUS ANGLICUS*

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Branchial arches are a rich source of comparative morphological characters with which to understand the early evolution of gnathostomes (jawed vertebrates) during the Paleozoic. However, taphonomic processes only rarely leave the delicate branchial arches with their spatial relationships intact, and our sampling is restricted almost entirely to early members of the two internal gnathostome crown-groups - the cartilaginous (chondrichthyan) and bony (osteichthyan) fishes. Recent efforts to widen this sampling with the putative stem-chondrichthyan *Ozarcus* have led to the interpretation of the plesiomorphic gnathostome gill skeleton as being osteichthyan-like, with paired hypohyals and a ventral chain of unpaired basibranchial elements. However, this conflicts with certain reconstructions of the stem-chondrichthyan *Acanthodes* as lacking hypohyals with a single basihyal – itself problematic due to several conflicting interpretations of the fossil material. This uncertainty combined with the possibility that *Ozarcus* is in fact a crown-group chondrichthyan makes our sampling of the chondrichthyan stem-group indecisive. Here we use computed tomography scanning to image the pharyngeal skeleton of the Early Devonian stem-chondrichthyan *Ptomacanthus anglicus*. The data reveal an articulated three-dimensionally preserved branchial skeleton – the earliest known in a crown-gnathostome. The branchial skeleton of *Ptomacanthus* possesses a basihyal articulating directly with the ceratohyals and the first branchial arch. This is consistent with some reconstructions of *Acanthodes* and is a feature shared with other early and modern jawed vertebrates. In contrast with the condition in the stem-gnathostome *Paraplesiobatis* and some sarcopterygians wherein they contact one another, the posteriormost two arches of the branchial skeleton are separated ventrally. This unambiguous branchial architecture in a stem-chondrichthyan suggests that the gnathostomes plesiomorphically had a single basihyal and no separate hypohyals, and that ventrally separate posterior branchial arches may constitute a chondrichthyan synapomorphy.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SIGNIFICANT MESOZOIC VERTEBRATE FOSSIL LOCALITIES DISCOVERED DURING PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING ON BUREAU OF LAND MANAGEMENT LAND IN THE WESTERN BLANDING BASIN, SOUTHEASTERN UTAH

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Through a systematic program of paleontological resource inventory and monitoring, the Bureau of Land Management (BLM) in Utah has been compiling baseline data of paleontological resources on land that they manage. In 2016, the Utah Geological Survey (UGS) partnered with the BLM to conduct a paleontological inventory of a portion of an area west of Blanding, UT that was slated to be included within a proposed new Bears Ears National Monument. The Bears Ears National Monument was established in December 2016, in part, to protect sensitive antiquities including fossil resources. This area was chosen for survey because the State Paleontological Database, managed by the UGS, indicated that few sites had been recorded in this area. Geologic maps showed that fossiliferous rocks of Late Jurassic Morrison Formation (MF) crop out in this region. The MF in this region is critical for understanding Upper Jurassic stratigraphy across the southern Colorado Plateau because it is the type area for several important stratigraphic units including the Bluff Sandstone, and Recapture, Westwater, and Brushy Basin Members and authors disagree about stratigraphic nomenclature and correlation of the units. During ten days of field work, UGS personnel recorded several dozen new localities. Some sites having dinosaur bone were found in the Recapture Member indicating potential for significant sites in this unit. The Brushy Basin Member is well-known for containing abundant vertebrate fossils and many localities were discovered. Many sites contained isolated sauropod bones and one site had many bones eroding out over a small area that warrants additional exploration. Several sites have potential to produce vertebrate microsfossils. One site is a multi-meter-thick plant debris bed, likely representing a marsh setting, that has numerous compressional plant fossils and petrified wood, in addition to bones and bone fragments. This site is quite unusual for the MF and resembles deposits better known in the upper Cretaceous of the western U.S. and Canada. One laterally extensive organic mudstone near the top of the MF preserves a 10-cm volcanic ash that was sampled for palynology and radiometric dating. Although one site found by the BLM had been vandalized by unauthorized excavation, there appears to be less vandalism to MF localities in this region than in other areas of the state.

Technical Session XXI (Saturday, August 26, 2017, 3:15 PM)

A QUANTITATIVE METHOD TO RECONSTRUCT THE FLIPPER SOFT TISSUE MARGIN OF PLESIOSAURS AND ICHTHYOSAURS FROM THE FLIPPERS OF EXTANT MARINE TETRAPODS

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Hydrofoil-shaped limbs ('flippers') convergently evolved in several lineages of marine tetrapods and function in propulsion, steering, and stabilization. Shape is critical to the hydrodynamic properties of hydrofoils and part of what forms this shape is soft tissue, which is lost during fossil preservation. Thus, improperly accounting for flipper soft tissue could lead to misleading interpretations. Studies on locomotion and flipper functional morphology of fossil marine tetrapods have assumed that the soft tissue closely surrounds the bones even though this is not the case in the flippers of many extant taxa whereas descriptive studies arbitrarily delineate the extent of the soft tissue. In this study we present a new, quantitative method to reconstruct the soft tissue margin surrounding the limb skeleton of extinct marine tetrapods. We compiled radiographs of the forelimbs of odontocetes, otariids, cheloniids, and spheniscids encompassing >50% of extant genera for each group. Then using a custom MATLAB script, we measured the distances around the flipper between the soft tissue margin and the limb skeleton relative to a reference chord. Finally, we used Gaussian processes (GPs) to predict the soft-tissue margin based on a specific taxonomic library or combination thereof. The method accurately predicted the soft tissue margin of extant taxa using their respective libraries (odontocetes: root mean squared error (RMSE) = 0.040, otariids: RMSE = 0.059, cheloniids: RMSE = 0.051, spheniscids: RMSE = 0.073). To test the validity of the method in marine tetrapod groups that are known only from fossils, we applied it to selected flippers of plesiosaurs and ichthyosaurs whose fossils preserve both the soft-tissue outline and the bony skeleton. We combined the data libraries from the four extant marine tetrapod groups because it is unknown which of the four may best approximate the outlines in the extinct clades. The method predicted the soft-tissue outline for plesiosaurs and ichthyosaurs with only a small RMSE (0.142 and 0.130, respectively, relative to a reference chord). This is the first method to quantitatively reconstruct the flipper soft tissue margins in extinct marine tetrapods based on the flippers of extant taxa. It provides accurate and repeatable shape reconstructions that can be used for rigorous quantitative studies of flipper functional morphology.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

GENES FROM A STONE: USING BIOINFORMATICS TO UNCOVER THE GENETIC DRIVERS FOR LIMB DIVERSITY AMONG NON-AVIAN THEROPOD DINOSAURS

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Identifying and understanding the patterns of theropod forelimb evolution has been the focus of intense research in the field of evo-devo. Recently, it has been recognized that allometric trends, rather than absolute values or ratios, offer a more informative metric for determining patterns of limb size variation among lineages. Yet, while this method investigates patterns of tempo and mode of limb evolution, it does not get at the underlying causes, both proximate and ultimate, behind those trends. One method used to investigate the underlying causes responsible for phenotypic variation is by linking developmental phenotypes seen in the model organism's systems with their associated genes using ontology based reasoning software. This allows for the identification of potential candidate genes and gene pathways linked to morphological changes seen in the fossil record. Here, we use allometric investigations to identify regions of interest integrated with the Phenoscape Knowledgebase to identify possible genetic drivers for the patterns. As the Knowledgebase captures multiple different axes of information (size, shape, position etc.), a gene's candidacy can be assessed, not only on shifts in limb size, but also on pleiotropic effects on the overall morphology of the limb in question. As patterns of inter and intra-limb variation can have different developmental signals, we ran both overall level of limb reduction against several body size proxies, and within module variation. To account for evolutionary history, we undertook both phylogenetic informed (n=110) and non-informed (n=150) RMA analysis, the latter permits the inclusion of multiple specimens per taxon to view how ontogenetic pathways compare to the overall theropod trend. As there is uncertainty in the placement of major lineages, such as the Megaraptoridae and the Troodontidae, permutations were undertaken to account for the major topological reconstructions. This allowed us to identify several candidate genes responsible for major deviations from the non-avian theropod forelimb bauplan. In addition, we were able to address the different genetic underpinnings of superficially similar events, such as the reduction of the forelimbs in both tyrannosaurs and abelisaurs. This work helps to establish a pipeline between traditional paleontological investigatory techniques and leading edge bioinformatics to address long-standing questions in theropod paleobiology and gives paleontologists another tool to investigate patterns of macroevolution.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW OCCURRENCES OF UPPER TRIASSIC (ADAMANIAN—REVUELTIAN?) FOSSILS FROM THE LOWER CHINLE GROUP NEAR WINGATE MESA, SOUTHEASTERN UTAH: EXPANDING UTAH'S LATE TRIASSIC FOSSIL RECORD

DELGADO, Yanelis, Appalachian State University, Boone, NC, United States of America; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States of America; FOSTER, John R., Moab, UT, United States of America

Prospecting poorly studied outcrops of the Upper Triassic Chinle Group in southeastern Utah led to the discovery of 14 sites yielding a tetrapod fossil assemblage similar to that of lower Chinle Group (Adamanian) strata in Texas, New Mexico, and Arizona. Coprolites and body fossils were recovered from 11 sites in the Monitor Butte Fm, characterized primarily by blue-gray to dark gray mudstone, while the remaining sites are from the stratigraphically higher Petrified Forest Fm, composed primarily of "red-bed" mudstone with thin conglomeratic sandstone beds. Body fossils from these localities included phytosaur teeth and bones, including all or parts of osteoderms, a quadrate, a jaw fragment, and an ilium, as well as a lungfish toothplate and metoposaur fossils, including skull and pectoral bone fragments.

Approximately 600 coprolites were recovered from several sites low in the Monitor Butte Fm. These were cleaned and examined with microscopes, and 35-40 percent of them contained microvertebrates. The most common fossils in the coprolites were osteichthyan scales, bones, tooth plates, and mandibles. Other microvertebrates include what may be part of an amphibian skull and three articulated phalanges. Almost 90 percent of the coprolites, including all of those with microfossil remains, have a spiral shape that is diagnostic of *Heteropolacopros*, usually attributed to a xenacanth shark or a lungfish based on its spiral morphology, although we have reservations on this assignment based on size. The other 10 percent of coprolites are larger than *Heteropolacopros* and lack both the heteropolar morphology and microfossils. Their morphology suggests that they are best assigned to *Dicynocopros*, which is only found in strata of Adamanian age and thought to be perpetrated by dicynodonts. Most of the fish scales in the coprolites are rhomboidal with concentric lines and thus similar to redfieldiid osteichthyans. The second most abundant scales are similar to palaeoniscid scales and possess a rhomboidal shape with ridges and grooves on their surface. Lastly, the least abundant scales bear similarities to coelacanth scales with 4–6 elongate ridges. Three conchostracans found in the *Heteropolacopros* sample have radial lirae that are similar to *Anyuanestheria lucasi,* but are too fragmentary to be classified to the genus level. Our detailed examination of coprolites thus greatly increases the known vertebrate assemblage by revealing the presence of xenacanths and/or lungfish, diverse osteichthyans, and, possibly, dicynodonts.

Grant Information:
Department of Geology; Office of Student Research

Preparators' Session (Thursday, August 24, 2017, 8:15 AM)

RETRODEFORMATION AND RECONSTRUCTION OF A CERVICAL SERIES OF *GALEAMOPUS* (SAUROPODA: DIPLODOCIDAE)

DEMUTH, Oliver E., Zurich University of the Arts, Zurich, Switzerland; MALLISON, Heinrich, Palaeo3D, Pöttmes, Germany; LAUTENSCHLAGER, Stephan, University of Birmingham, Birmingham, United Kingdom; TSCHOPP, Emanuel, Università di Torino, Torino, Italy

Diplodocid necks are peculiar in their extreme elongation, in terms of element number and vertebrae elongation, as well as pneumatization. Due to their light-weight structure, these vertebrae are also easily deformed diagenetically, often hindering a reasonable interpretation of shape changes along the neck, and even influencing taxonomic identifications. We applied digital reconstruction and retrodeformation to the cervical

vertebrae of a new specimen of *Galeamopus*. The cervical series was found partially articulated and consists of 13 vertebrae; atlas to cervical vertebra 10, and the three posterior-most elements, all heavily deformed. The anterior and posterior cervical vertebrae are compressed transversely, the mid-cervical elements dorsoventrally. The neural arches in the mid-cervical vertebrae were not fused to their centra and disarticulated during burial. In addition to the vertical compression, these mid-cervical neural arches are strongly sheared. Due to instability, the five posterior-most cervicals were not fully prepared and remain partially embedded in the original matrix, which caused additional problems in the reconstruction process. We digitized the vertebrae using photogrammetry and created 3D-models for further processing. The vertebrae models were then simplified and minor taphonomic alterations such as cracks and smaller holes were removed. The broken pieces were placed at their supposed original position and missing or hidden elements (in the partly embedded vertebrae) were mirrored from the opposite side. The vertebrae were then imported into Landmark for general retrodeformation. Problematic elements, which could not be resolved through Landmark's symmetricalization, e.g. uniaxially compressed vertebrae, were further retrodeformed using the lattice tool in Maya and through manual sculpting in zBrush, based on better-preserved material of related taxa. Finally, the missing cervical vertebra 11 was interpolated based on the adjacent vertebrae and was adjusted in comparison with known material of related taxa to obtain the complete cervical series of *Galeamopus*. The reconstructed vertebrae were then compared with the original scan data to obtain a visual representation of the deformation. Our approach allows a more precise characterisation of the morphology and builds a new base for future research and comparison between different taxa. The reconstructed cervical series was 3D-printed at full scale and presented as part of the bachelor exhibition at the Zurich University of the Arts.

Technical Session XVII (Saturday, August 26, 2017, 11:45 AM)

PALEO-ALTIMETRY RECONSTRUCTIONS OF THE TIBETAN PLATEAU BASED ON VERTEBRATE FOSSILS

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The Tibetan Plateau is the youngest and highest plateau on Earth, and its paleo-altimetry reconstructions are crucial to interpret its geodynamic evolution and to understand the climatic changes in Asia. Uplift histories of the Tibetan Plateau based on different proxies differ considerably, and two viewpoints are pointedly opposing on the paleo-altimetry estimations of the Tibetan Plateau. One viewpoint is that the Tibetan Plateau did not strongly uplift to reach its modern elevation until the Late Miocene, but another one, mainly based on stable isotopes, argues that the Tibetan Plateau formed early during the Indo-Asian collision and reached its modern elevation in the Paleogene or by the Middle Miocene. In 1839, Hugh Falconer firstly reported some rhinocerotid fossils collected from the Zanda Basin in Tibet, China and indicated that the Himalayas have uplifted by more than 2,000 m since several million years ago. A century later, quantitative estimations for the Tibetan Plateau uplift were made again based on plant and mammalian fossils in the 1970s. In recent years, the vertebrate fossils discovered from the Tibetan Plateau and its surrounding areas implied a high plateau since the late Early Miocene. During the Oligocene, giant rhinos lived in northwestern China to the north of the Tibetan Plateau, while they were also distributed in the Indo-Pakistan subcontinent to the south of this plateau, which indicates that the elevation of the Tibetan Plateau was not too high to prevent exchanges of large mammals; giant rhinos, the rhinocerotid *Aprotodon*, and chalicotheres still dispersed north and south of "Tibetan Plateau", and a tropical-subtropical lowland fish fauna was also present in the central part of this plateau. In contrast, during the Middle Miocene, the shovel-tusked elephant *Platybelodon* was found from many localities north of the Tibetan Plateau, while its trace was absent in the Siwaliks of the subcontinent, which implies that the Tibetan Plateau had uplifted high enough to obstruct the exchange of mammals in the Middle Miocene. The Pliocene mammalian fauna of the Zanda Basin showed initiation of cold-adapted lineages that predate Ice Age megafauna, which implied that the Tibetan Plateau reached its modern elevation.

Grant Information:
Strategic Priority Research Program of the Chinese Academy of Sciences (XDB03020104) and National Natural Science Foundation of China (41430102)

Technical Session II (Wednesday, August 23, 2017, 9:15 AM)

BASAL CHONDRICHTHYAN PHYLOGENY AND A NEW AFFINITY FOR *DOLIODUS PROBLEMATICUS* SUGGEST A COMPLEX PATTERN OF PECTORAL EVOLUTION SPANNING THE ACANTHODIAN-CHONDRICHTHYAN TRANSITION

DENTON, John S., American Museum of Natural History, New York, NY, United States of America; PRADEL, Alan, Muséum National d'Histoire Naturelle, Paris, France; BRONSON, Allison, American Museum of Natural History, New York, NY, United States of America; MILLER, Randall, New Brunswick Museum, Saint John, NB, Canada; BURROW, Carole, Queensland Museum, Hendra, Australia; JANVIER, Philippe, Muséum National d'Histoire Naturelle, Paris, France; MAISEY, John, American Museum of Natural History, New York, NY, United States of America

Despite the growing consensus of an acanthodian-chondrichthyan relationship derived from studies on gnathostome evolution, comparatively little attention has been paid to the acanthodian-chondrichthyan transition. Two taxa, *Pucapampella* and *Doliodus*, are generally considered basal members of 'conventionally defined chondrichthyans' (i.e., above the 'acanthodian' part of the chondrichthyan stem), but this placement has been based on fragmentary character data, obscuring a more comprehensive understanding of the morphological underpinnings of this evolutionary transition. We present new anatomical data on both of these taxa, and define a Family (Pucapampellidae) for both *Pucapampella* and a newly recognized genus from South Africa. We present character data for the *Doliodus* pectoral endoskeleton, which includes shark-like expanded paired coracoids, but also an 'acanthodian-like' array of dermal spines. Phylogenetic analysis, incorporating new character data, finds the placement of pucapampellids highly problematic within stem chondrichthyans, while *Doliodus* is resolved as a member of a previously unrecognized clade that also contains some, but not all 'acanthodian' taxa. The implications of this placement for understanding of the acanthodian-chondrichthyan transition are discussed.

Grant Information**:**
George Frederic Matthew Research Grant (JGM)

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW TRACK SITES ON ISLE OF SKYE (SCOTLAND, UK) INDICATE POSSIBLE ENVIRONMENTAL PARTITIONING AMONG DINOSAURS

DEPOLO, Paige E., University of Edinburgh, Edinburgh, United Kingdom; BRUSATTE, Stephen, University of Edinburgh, Edinburgh, United Kingdom; CHALLANDS, Thomas, University of Edinburgh, Edinburgh, United Kingdom; FOFFA, Davide, University of Edinburgh, Edinburgh, United Kingdom; WILKINSON, Mark, University of Edinburgh, Edinburgh, United Kingdom; ROSS, Dugald, Staffin, United Kingdom

Although the Middle Jurassic (ca. 174-164 Ma) marks a pivotal time of diversification for multiple dinosaur lineages, the global record of dinosaur body fossils from this time period is sparse. Dinosaur footprints supplement the body fossil record and offer insights into both behavior and community ecology. We report two new extensive dinosaur track sites in coastal exposures of the Great Estuarine Group (Bathonian) near Brother's Point on the Isle of Skye (Scotland, United Kingdom). Each site represents a distinct depositional environment in which the dinosaurs walked. The first, located in the Lonfearn Member of the Lealt Shale Formation, is a dark gray shale with thin laminations and in-filled desiccation cracks that represents a subaerial mudflat. The tracks at this site are a mixture of tridactyl track morphotypes and small (~15 cm along the long axis) oval tracks from a quadrupedal trackmaker. The small tracks may represent the first thyreophoran tracks known from Skye. The tridactyl tracks at this site can be divided into two main morphotypes: one with elongate toes and the second with short, blunt toes and a broad heel. The second track site is found in a calcarenite located stratigraphically lower in the Lealt Shale Formation. This composition is indicative of a nearshore lagoonal environment similar to that observed in the younger Duntulm Formation in which the first reported sauropod tracks from Skye were discovered. The second Brother's Point track site is dominated by large (~50 cm width) sauropod footprints but also contains several, isolated large long-toed tridactyl footprints. These two track sites, in conjunction with previously discovered localities on Skye, demonstrate an apparent preference for different substrates among different dinosaur groups. Thus far on Skye, sauropod footprints have been observed only in nearshore lagoonal deposits. A more diverse assemblage of smaller theropod and ornithischian (ornithopod and possible thyreophoran) footprints is found in the mudflats. These track sites supplement the fragmentary record of dinosaur body fossils from the Isle of Skye and indicate that a diverse fauna of dinosaurs, which may have partitioned environments, was present in Scotland during the Middle Jurassic.

Grant Information:
This project is supported by the National Geographic Society, the Edinburgh Geological Society, the Edinburgh Zoo, and the Association of Women Geoscientists

Technical Session XIV (Friday, August 25, 2017, 3:15 PM)

DIETARY ECOLOGY OF THE SCIMITAR-TOOTHED CAT *HOMOTHERIUM SERUM* FROM FRIESENHAHN CAVE AS INFERRED FROM STABLE ISOTOPES AND DENTAL MICROWEAR: A CHEETAH-LIKE PREDATOR

DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States of America; KOCH, Paul L., University of California Santa Cruz, Santa Cruz, CA, United States of America

The scimitar-toothed cat *Homotherium* was distributed across the globe, including throughout Eurasia, Africa, and the Americas - going extinct less than 30 thousand years ago. Friesenhahn Cave (Bexar County, Texas) contains some of the best preserved specimens of *Homotherium serum* along with a diverse fauna, including an abundance of juvenile mammoths some have argued were preferentially hunted by *H. serum*. To date, little is known about the paleoecology of these felids, including why they went extinct. Here, we use a multi-proxy approach to examine the dietary ecology of *Homotherium* as compared to a diversity of extinct and extant feliforms, including those with and without elongated canines. Dental microwear texture analysis reveals that *H. serum* had significantly lower complexity values (high complexity is associated with increased durophagy in extant carnivorans) than extant lions and hyenas and the extinct sabertoothed cats *Smilodon fatalis* and *Smilodon gracilis*. *H. serum* is indistinguishable in complexity from the primarily flesh-consuming extant cheetah *Acinonyx jubatus* (and the extinct American lion *Panthera atrox*), suggesting that *H. serum* was cheetah-like in its hunting and feeding behavior. Stable carbon isotope values, which range from -4.4 to -2.3‰ (converted to prey values by adding 1.3‰ to raw values), demonstrate a clear preference for C_4 grazers including mammoths (juvenile *Mammuthus* values average -2.7‰), while bison and horses may have also been prey. In contrast, primarily C_3 consumers (i.e. *Mammut, Mylohyus, Odocoileus, Platygonus,* and *Tapirus*) were unlikely to have been a significant component of *H. serum* diets. Unlike *P. atrox* and *S. fatalis* which consumed prey in denser C_3 vegetation or *S. gracilis* which also had a preference for C_3 consumers), *H. serum* had the greatest preference for open-country C_4 grazers of all extinct felids examined in North America. Our isotopic data support inferences from its more gracile anatomy that *H. serum* preferred open country prey - as cheetahs do today. Similarly, low durophagy as inferred from dental microwear also suggests that *H. serum* was cheetah-like, primarily consuming soft organs and tough flesh.

Grant Information:
Funding was provided by NSF 1053839.

Technical Session XI (Friday, August 25, 2017, 12:00 PM)

NEW MATERIAL OF *AUSTRALOPHOCA* (CARNIVORA, PHOCIDAE) FROM THE LATE MIOCENE OF PERU SUGGESTS SEXUAL DIMORPHISM IN THE SMALLEST, EARLY-BRANCHING MONACHINE SEAL

DEWAELE, Leonard, Ghent University, Ghent, Belgium; LAMBERT, Olivier, Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium; DE MUIZON, Christian, Muséum National d'Histoire Naturelle, Paris, France; LOUWYE, Stephen, Ghent University, Ghent, Belgium

Over the last decades, late Neogene deposits from the Pisco and Sacaco basins in Peru proved to be rich in fossil marine mammal faunas, yielding numerous odontocete and mysticete cetaceans taxa, marine sloths, and pinnipeds, essentially Phocidae (true seals). Contrasting with the globally very scarce fossil record of Phocidae, the Pisco Formation yielded taxa that are known from skulls associated to postcranial material. These include *Acrophoca longirostris*, *Hadrokirus martini*, and *Piscophoca pacifica*. However, the most recently described true seal from this region, the tiny *Australophoca changorum*, is currently only known from very fragmentary and poorly preserved postcranial elements.

The collection of the Muséum National d'Histoire Naturelle, Paris, France, contain several partial skeletons and multiple disarticulated specimens, including two skulls, of a diminutive seal from the Pisco Formation. These undescribed specimens can be referred to *A. changorum* and complete our knowledge of this species, fine tuning the geological age, completing the diagnosis, and permitting a first phylogenetic analysis. The new specimens recently assigned to *Australophoca,* have been recovered from the type horizon, the Aguada de Lomas vertebrate level, but also from the overlying Sacaco and Sud-Sacaco levels, expanding the age range from the late Tortonian to the late Messinian. The sample shows two morphotypes, both found in the different vertebrate levels and bearing few differences apart from size. This points towards sexual size dimorphism for the species.

Australophoca is separated from other monachine seals by a number of plesiomorphies. Some, such as a little reduced trochanteric fossa on the femur, were mentioned in the original publication. Newly observed plesiomorphic features include the mediolateral orientation of the glenoid fossa on the skull, the distally pointed ulna, and the tibia and fibula that are articulated proximally. The newly described material allows for the first time to implement *Australophoca* in a phylogenetic analysis, which places the taxon as an early-branching stem monachine.

Podium Symposium (Wednesday, August 23, 2017, 10:30 AM)

QUANTITATIVE ASSESSMENT OF 3D HUMERUS MORPHOLOGY ACROSS THE TETRAPOD WATER-LAND TRANSITION

DICKSON, Blake V., Harvard University, Cambridge, MA, United States of America; PIERCE, Stephanie E., Harvard University, Cambridge, MA, United States of America

The water to land transition in tetrapods is one of the greatest transitional leaps in evolutionary history. In the Late Devonian, the sarcopterygian fishes started their journey towards terrestrialization, a process that kick-started a new era of vertebrate evolution. Many features of the tetrapod body plan would arise during this transition, but perhaps the most distinctive are the four robust limbs that enable locomotion on land. Of all the elements of the tetrapod limb, it is the humerus that has been the most valuable in furthering our understanding of early tetrapod evolution. However, beyond phylogenetic approaches, there has been no quantitative assessment of morphological change in the humerus across the water-land transition, or how broad changes in morphology impacted functional performance. Here we produce the first whole bone 3D geometric morphometric analysis of the tetrapod humerus – from the tetrapodomorph fish *Sauripterus* to the stem amniote *Diadectes*. We utilised a psuedolandmark approach to identify 512 surface points that were aligned using generalized Procrustes analysis (GPA). Principal component analysis (PCA) was used to generate a morphospace into which a composite phylogeny was mapped. GPA coordinates were assessed for allometric signal using a Procrustes linear model and phylogenetic signal using the multivariate K statistic. Further, a multi-optima Ornstein-Uhlenbeck (OU) model of evolution was tested on univariate PC coordinates. Our morphospace shows a clear morphological transition from Devonian tetrapodomorph fish to Permo-Carboniferous temnospondyls and stem amniotes, with an intermediate clustering of stem tetrapods possessing the characteristic 'L' shaped humerus. We find significant phylogenetic signal in humerus shape data ($p<0.001$), reflected by a clear phylogenetic trajectory moving through morphospace from aquatic fish to later terrestrial tetrapods. This pattern conforms to a Brownian model of evolution ($K=0.96$), with only weak support for a single ($p=0.28$) or two ($p=0.22$) shift OU model. No significant allometric shape signal is present in our sample ($p=0.23$), suggesting that early tetrapod humerus morphology was not strongly constrained by size but perhaps instead by phylogeny or ecology. This work lays the groundwork for investigating functional performance of the humerus across the water-land transition and for uncovering tetrapod locomotor ecology at a critical juncture in vertebrate evolution.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

VALLEY OF THE MASTODONS: CASE STUDY OF AN INTEGRATIVE APPROACH TO RESEARCH COLLABORATION, OUTREACH, AND EXHIBITS

DOOLEY, Alton C., Western Science Center, Hemet, CA, United States of America; SMITH, Kathlyn M., Georgia Southern University, Statesboro, GA, United States of America; STONEBURG, Brittney E., Western Science Center, Hemet, CA, United States of America; RADFORD, Darla, Western Science Center, Hemet, CA, United States of America; OZOLINS, Margaret, Western Science Center, Hemet, CA, United States of America; DROUAULT, Krystle, Western Science Center, Hemet, CA, United States of America; DOOLEY, Brett S., Patrick Henry Community College, Martinsville, VA, United States of America

Increases in both the availability and speed of dissemination of information over the last 20 years arguably have had both positive and negative effects on science communication. Current debates around concepts such as open data, crowdsourcing, and citizen science demonstrate some of the avenues that are available to researchers in communicating with the public, and invite examination of new ways to communicate the processes and results of research.

Through the Valley of the Mastodons project, we are exploring ways in which the process of paleontological research can be incorporated directly and rapidly into exhibits and outreach programs. This project is centered on the large and understudied collection of Late Pleistocene mastodon (*Mammut americanum*) remains recovered during the construction of Diamond Valley Lake reservoir in Riverside County, California and housed at the Western Science Center (WSC). There are several parallel components of the project: 1) a 3-day invitational workshop at WSC involving several researchers, students, and science writers, to include presentations, discussions, and examination of previously unstudied specimens and new data; 2) public access during much of the workshop proceedings, including presentations and some data collection; 3) ongoing media contact during the workshop, as well as continuous use of social media to describe workshop activities; and 4) opening an exhibit displaying the examined specimens, with the majority of the exhibit information based on observations made during the workshop. Key objectives of the project are to encourage an open, collaborative atmosphere among researchers, and to provide open and rapid means for researchers to demonstrate to the public how science works.

Technical Session XI (Friday, August 25, 2017, 9:00 AM)

THE ECOLOGY AND EVOLUTION OF BODY MASS OF NORTH AMERICAN UNGULATES IN RELATION TO ENVIRONMENTAL CHANGE

DOUGHTY, Evan M., University of Illinois, Urbana, IL, United States of America; MARCOT, Jonathan D., University of Illinois, Champaign, IL, United States of America

Body mass is intertwined with organismal physiology, morphology, life history, and both microevolutionary (i.e. decreased energy requirements, predation deterrent, thermoregulation, etc.) and macroevolutionary (i.e. species persistence, biodiversity, etc.) dynamics. Previous studies document the distribution of the well-sampled North American ungulate (Artiodactyla and Perissodactyla) body mass separately for the Paleogene and Neogene.

Here, we statistically detect shifts in the ungulate body mass distribution, and changes in dynamics of body mass evolution throughout the Cenozoic (55 to 2 Ma). We estimate body mass from the lengths and widths of the upper and lower dentition of nearly every North American ungulate species (n=807). We statistically tested for shifts in taxonomic and body mass distributions between intervals of stasis (i.e., statistically indistinguishable distributions) throughout the Cenozoic to determine whether shifts in body mass distribution were correlated with taxonomic turnover, and how these related to global climate change. We also used phylogenetic analyses to identify shifts in models of body mass evolution over time.

Our results corroborate previous findings demonstrating a persistent increase in both the median and lower bound of body mass throughout the Cenozoic. The upper bound remains relatively stable between 2500 and 5000kg. The apparent trend of median body mass increase is driven by the proliferation of medium-bodied species (25 to 500 kg), and the extinction of the smallest ungulates after the Eocene/Oligocene boundary (E/O). These observations reject a strict interpretation of Depéret's (=Cope's) Rule, which predicts either increasing maximal body mass or greater numbers of species with large body mass (>500 kg). Nevertheless, trends toward larger body mass throughout the Cenozoic are apparent in several ungulate subclades. We found seven distinct shifts in body mass distribution, and four shifts in taxonomic distribution. Some of these shifts are not coincident with global climatic changes, but some are, including shifts in both taxonomic and body mass distributions at or immediately following the E/O. Phylogenetic analyses indicate a marked shift in macroevolutionary dynamics at the global cooling event at the E/O, which led to lower rates of body mass evolution afterwards. These results point to a reorganization of ungulate ecological and evolutionary dynamics following this global climatic event.

Grant Information:
NSF EAR-1252123

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

COMPARATIVE TAPHONOMY OF TWO JUVENILE *EOLAMBIA CAROLJONESA* (HADROSAURIA) BONEBEDS FROM THE CEDAR MOUNTAIN FORMATION OF UTAH

DRIEBERGEN, Julie, Tinley Park, IL, United States of America; CIFELLI, Richard, University of Oklahoma, Norman, OK, United States of America; ZANNO, Lindsay, North Carolina Museum of Natural Sciences, Raleigh, NC, United States of America; PRIETO-MARQUEZ, Albert, Field Museum of Natural History, Chicago, IL, United States of America; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL, United States of America

Eolambia caroljonesa is the most abundant dinosaur in the Cenomanian Mussentuchit Member of the Cedar Mountain Formation (MM-CMF) of Utah and is known from numerous specimens representing a wide range of growth stages. Larger specimens are typically collected as solitary finds, whereas juvenile material derives from several paucispecific bonebeds including the "Cifelli 2 Bonebed" collected in part by teams from the Oklahoma Museum of Natural History (OMNH). The Field Museum of Natural History (FMNH) excavated a juvenile *Eolambia* dominated bonebed at the base of the MM-CMF from 2014-2015. These two bonebeds are well sampled (>500 bones each), contain bones from throughout the skeleton, and exhibit excellent preservation with only minor evidence of crushing, cracking or weathering. Transport was likely minimal as both sites preserve maxillae with in situ teeth.

Both sites represent comparable samples with Minimum Number of Individuals (MNI) of 5 and 8 for the FMNH and OMNH sites, respectively. Proportions of skull, girdle, and axial elements are similar at both sites, although they differ significantly in the number of sampled limb elements. Commensurate with this overall similarity, both sites can be categorized as Voorhies Group 1. Size frequency plots for select limb bones from both sites exhibit broad overlap in sizes classes. Femoral lengths (a proxy for body size) range from 217 mm to 433 mm in the OMNH sample and 97 mm to ~480 mm in the FMNH sample. Comparison to size frequency plots of other hadrosaurids shows that both

Eolambia samples cover a size range interpreted as late hatchling stages to young juveniles less than a year old. All are larger than embryonic bones assigned to *Hypacrosaurus stebingeri*, but smaller than *Maiasaura* leg bones that exhibit annual growth marks.
Based on our taphonomic observations, we interpret both sites as parautochthonous catastrophic death assemblages that experienced only short fluvial transport and rapid burial. The lack of adult *Eolambia* at either site is therefore likely an accurate biological signal rather than a taphonomic one, and further supports previous studies, which concluded that juvenile hadrosaurids formed herds distinct from sub-adult and adult animals in the first year of life. Such concentrations of hatchling to juvenile sized animals have been interpreted as nesting grounds, but we found no evidence of eggshells at either site despite frequent eggshell preservation in the MM-CMF.

Technical Session X (Friday, August 25, 2017, 11:00 AM)

HOW MANY SKULLS DOES IT TAKE TO MAKE A CROC? THE FOSSIL RECORD OF MESOZOIC MARINE CROCODILES IS BIASED BY FOSSIL COMPLETENESS

DRISCOLL, Daniel, University of Bristol, Pueblo, CO, United States of America; STUBBS, Thomas L., University of Bristol, Bristol, United Kingdom; DUNHILL, Alexander M., University of Leeds, Leeds, United Kingdom; BENTON, Michael J., university of Bristol, Bristol, United Kingdom

Thalattosuchians, which include the Jurassic to Early Cretaceous teleosaurs and metriorhynchids, have been receiving increasing attention in recent years. Their fossil record is dominated by finds from classic European localities, but a few newer specimens have been described from the Americas and Africa. Understanding the macroevolutionary record of these organisms depends on an adequate fossil record. Using methods that have previously been applied to ichthyosaurs and mosasaurs, we have quantitatively scored the fossil completeness of 879 specimens of thalattosuchians using the taphonomic completeness metric (TCM). Both literature-based and museum collections visits were used to create a database for analysis. Generic and species richness were measured at the stage level and compared to completeness and average sea level using only specimens directly assignable to the specific stage. Time series were correlated after generalized differencing and then compared. Results indicate that neither generic nor species richness correlates with sea level. TCM does not correlate with sea level. In most time bins, European Lagerstätten influence both the number of specimens and the mean completeness. The Holzmaden Shale and Oxford Clay have the highest average completeness and contain almost 50% of the total specimens, with an incredible 52% and 67% skull specimens in these collections. Both species richness and species completeness highly correlate with the number of specimens, indicating that some time bins are not well-represented. Fossil completeness scores of teleosaurs and metriorhynchids show significant correlations with species richness (TCM vs. richness, Spearman: $p < .01$; rho= 0.85 and 0.71, respectively). The correlation is even greater when non-European specimens are left out. The number of skull specimens correlates strongly with total species richness (Spearman: p=0.01, rho=0.75). Unlike some marine reptiles, sea level does not drive the diversity or the completeness of specimens. However, the fossil record of thalattosuchians is biased by preservation, leaving marine reptile taxonomists digging for more skulls.

Technical Session X (Friday, August 25, 2017, 10:30 AM)

NEW CARNIAN TAXON FROM NORTH CAROLINA (USA) CLARIFIES EARLY CROCODYLOMORPH ANATOMY AND ALLOWS FOR EXPANDED CHARACTER SAMPLING IN THE CLADE

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Phylogenetic relationships among early diverging crocodylomorphs remain contentious despite a recent increase in both the number of species described and the skeletal representation of newly discovered fossil materials. Lack of a well-resolved, well-supported phylogeny is preventing a synthetic understanding of broader evolutionary trends, including paleoecological changes characterizing the early diversification of the clade. To increase resolution in crocodylomorph phylogeny, we critically re-evaluated the anatomy of early taxa, based on comparison with a spectacularly preserved, articulated, small-bodied crocodylomorph specimen (NCSM 21722) from the Carnian (Late Triassic) of North Carolina. NCSM 21722 is nearly complete and undistorted, missing only the rostralmost skull and distalmost portion of the tail.
Additional detailed preparation of the specimen and visualization of internal anatomy via computed tomography reveals intricate features of the braincase and the postcranial skeleton that were previously obscured and allows for the development of new phylogenetic characters as well as reconsideration of existing traits. New details of the braincase include the presence of an enlarged, fully combined foramen for CNV and the middle cerebral vein and a short, slender cultriform process. NCSM 21722 demonstrates that an elongate radiale and ulnare appeared at the origin of Crocodylomorpha, and that the loss of the intermedium, fusion of distal carpals 3 and 4, and appearance of a pisiform in the carpus occurred later in the evolution of the clade. A prominent medial process on the proximal radius first observed in NCSM 21722 is newly recognized as a synapomorphy shared with other early crocodylomorphs. Finally, based on outstanding preservation of NCSM 21722, we are able to more clearly interpret the anatomy of other crocodylomorph specimens and improve trait scoring in our dataset. Our new phylogenetic analysis recovers NCSM 21722 near the origin of crocodylomorpha with *Dromicosuchus* and *Hesperosuchus*, although an earlier radiation of large-bodied crocodylomorphs represented by *Redondavenator* and *Carnufex* remains supported and suggests complex body size trends early in the evolutionary history of the clade.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

HISTOLOGY REVEALS TIMING OF CREST DEVELOPMENT IN *PROSAUROLOPHUS MAXIMUS* (HADROSAURIDAE: SAUROLOPHINAE): IMPLICATIONS FOR SEXUAL DISPLAY AND MATURITY

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Ontogenetic changes in cranial ornamentation are well documented in lambeosaurine hadrosaurs, but are poorly understood in saurolophine hadrosaurs due to the limited number of ontogenetic series known in this sub-family. Current hypotheses related to crest function in hadrosaurs suggest that this feature was used for sexual display due to its positive allometric growth relative to the skull. If these hypotheses are correct, then the crest should be fully formed before the animal reached sexual maturity. Sexual maturity in dinosaurs is inferred to coincide with the initial decrease in growth rate as interpreted from histological studies. However, crest morphology has yet to be linked to biological age and age of sexual maturity even though several ontogenetic series are known for hadrosaurs. Here we study an ontogenetic series of *Prosaurolophus maximus*, a saurolophine hadrosaur with a small nasal crest, to evaluate the timing of changes in crest morphology. Crest morphology was examined in four specimens curated at the Royal Tyrrell Museum of Palaeontology (TMP), including three juveniles (TMP 1983.64.3, TMP 1998.50.1, and TMP 2016.37.1) and one large individual (TMP 1984.1.1). Histologic thin sections, taken from the tibial mid-shaft of each specimen, were used to count growth lines (indicated by changes in bone tissue type) to estimate biological age. Our results indicate that development of the crest in *P. maximus* is minimal at two years of age (TMP 1983.64.3). By three years of age (TMP 1998.50.1 and TMP 2016.37.1), the crest has adopted the distinctive crest shape of *P. maximus* although it is not as robust as in adults, and the circumnarial depression is not as deeply excavated as in large specimens. The crest has achieved the morphology observed in the largest *P. maximus* specimens by five years of age (TMP 1984.1.1). Despite its large size (skull length =101 cm) comparable to the largest known specimen of the species (USNM 12712), TMP 1984.1.1 had not yet reached skeletal maturity and was still undergoing rapid growth at the time of death. As such, our results demonstrate that the crest of *P. maximus* reached full development at a young age, in individuals that are still undergoing rapid growth. The early onset of crest development in *P. maximus*, which occurs well before the initial slowdown in growth, is consistent with the previous hypotheses stating that the crest was a sexual display structure.

Grant Information:
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Technical Session VI (Thursday, August 24, 2017, 8:00 AM)

TERRESTRIAL TETRAPOD DIVERSITY AND BIOGEOGRAPHY ACROSS THE CARBONIFEROUS/PERMIAN BOUNDARY

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The Carboniferous and Permian periods (359-252 million years ago) witnessed the establishment of the first terrestrial tetrapod ecosystems against a backdrop of major environmental change. However, there continues to be widespread disagreement surrounding the major patterns of tetrapod diversity change across this interval, stemming from the ongoing debate on the importance of spatial and temporal sampling biases in the fossil record.
Previous estimates of tetrapod diversity across the Carboniferous/Permian boundary have suggested that tetrapod evolution was significantly affected by the late Carboniferous collapse of the tropical rainforest biome (the Carboniferous Rainforest Collapse). However, these previous studies failed to account for temporal and spatial variations in sampling. To facilitate more robust investigations, a new global species-level dataset (>400 species from 520 unique localities) has been created within the Paleobiology Database. These raw data suggest a rise in global species richness and alpha diversity from the Carboniferous to early Permian punctuated by a decrease in diversity during the latest Carboniferous and earliest Permian (Kasimovian-Sakmarian), a pattern distinct from previous estimates showing a continuous rise in taxonomic diversity across this interval. Subsequent analyses that attempt to correct for sampling (Shareholder Quorum Subsampling and residuals from linear models of diversity as a function of sampling proxies) indicate that sampling biases strongly affect our ability to decipher genuine patterns of diversity change during this interval, particularly in the Carboniferous.
To further examine the effect of the Carboniferous Rainforest Collapse on terrestrial tetrapod communities, we used a newly-devised biogeographical network method, which uses phylogenetic data to quantify biogeographic connectivity between distinct geographic regions. We built an informal supertree of early tetrapods including 312 species, and estimated changes in connectivity during the late Carboniferous and early Permian. Our results do not support a previous hypothesis that habitat fragmentation following the Carboniferous Rainforest Collapse drove increased tetrapod endemism; instead cosmopolitanism increased markedly across the Carboniferous/Permian boundary. Our analyses highlight the caveats associated with estimating Paleozoic terrestrial tetrapod diversity and serves as a cautionary tale on the impact of sampling for future analyses during this interval.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW INSIGHTS INTO A MAASTRICHTIAN MAMMALIAN FAUNA FROM THE NORTH SLOPE OF ALASKA

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The terrestrial vertebrate fauna from Upper Cretaceous (early Maastrichtian) strata of the Prince Creek Formation (PCF) cropping out along the Colville River on Alaska's North Slope (70°N. lat.; 67 – 82°N paleolat. based on studies by others) is best known for its diverse dinosaur fauna, including several new species. Until recently, the mammalian fauna comprised a small assemblage of isolated teeth and fragments. Renewed field research in the Prince Creek Formation has resulted in the discovery of dozens more mammal fossils, including dentaries, that suggest a higher diversity than initially estimated. By far the most abundant mammal fossils are from a new species of pediomyid marsupial that is represented by a maxillary fragment, dentaries, and 50+ isolated molars and premolars. Our preliminary phylogenetic analysis of the pediomyid suggests that it is morphologically similar to, although 20 – 30% smaller than, *Pediomys elegans* from Lancian mid-latitude North American localities. In most characters of its dentition, the PCF pediomyid is more primitive than *P. elegans*, which is consistent with its earlier age (ca. 69 Ma, based on radiometric dating of the fossil vertebrate-bearing strata of the PCF by others). Additionally, there are at least three species of multituberculate from the PCF, based on differences in size and p4 morphology; thus far, they cannot be easily placed into known North American taxa. To date, the sole eutherian from the PCF, known only from a few isolated teeth, is morphologically similar to, though noticeably smaller than, *Gypsonictops hypoconus* from the Lance Formation. Notably, the PCF mammalian fauna likely lived well above the Arctic Circle and consequently experienced months of winter darkness and probably subfreezing temperatures. It is intriguing, then, that all of the PCF mammals, with the possible exception of *Gypsonictops*, are members of lineages that did not survive the K-Pg mass extinction.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

COMPOSITE STRATIGRAPHY AND SEDIMENTOLOGIC EVOLUTION OF THE DINOSAUR-RICH BARUUNGOYOT-NEMEGT SUCCESSION (UPPER CRETACEOUS), NEMEGT BASIN, SOUTHERN MONGOLIA

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Portions of the dinosaur-rich Upper Cretaceous Baruungoyot-Nemegt succession are exposed in four geographic areas of the Nemegt Basin, Mongolia: Nemegt, Altan Ula, Bugin Tsav, and Kheermen Tsav. Nemegt, Altan Ula, and Bugin Tsav form a 100-km-long, east-west transect along the northern margin of the basin, and collectively expose 185 meters of section. In contrast, the Khermeen Tsav section is a single geographic outlier southwest of the northern transect. Lithostratigraphic correlations between areas were accomplished by tracing unique lithofacies and matching non-random stratigraphic patterns of (1) grain-size variation and (2) paleoenvironmental indicators. From east to west the northern transect exposes successively higher portions of the section, extending from the uppermost Baruungoyot Formation and encompassing an almost complete section of the Nemegt Formation. Along the transect, the contact between the Baruungoyot and Nemegt formations is well exposed only in the Nemegt area, where it exhibits a well-exposed interfingering contact between the underlying Baruungoyot and overlying Nemegt beds. The uppermost portion of the transect section is well exposed to the west at Bugin Tsav, where a variety of facies occur, including alluvial, lacustrine/paludal, and sheet flood deposits with reworked eolian grains. The uppermost ~25 meters of the 135-meter-thick Khermeen Tsav section correlates with the lowest ~25 meters of the exposed section at Nemegt, and exhibits an interfingering contact between the Baruungoyot and Nemegt formations. The remaining (and lower) 110 meters of the exposed section at Khermeen Tsav is dominated by alluvial facies that are tentatively assigned to the Baruungoyot Formation. Correlation of all sections suggests a minimum thickness of ~295 meters for the Baruungoyot-Nemegt succession in southern Mongolia. The distributions of facies and facies assemblages through the composite section record changes in paleoenvironmental conditions, rates and styles of sedimentation, and biostratigraphic and fossil preservation patterns across this region during the Late Cretaceous, and suggest the presence of discrete paleoecological and dinosaur-assemblage zones through time.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW HYPERCARNIVOROUS HYAENODONT (MAMMALIA) FROM THE MIDDLE EOCENE PONDAUNG FORMATION OF MYANMAR AND ITS INFLUENCE TO THE BIOGEOGRAPHIC ORIGIN HYPOTHESES OF THE PONDAUNG HYAENODONTS

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Five genera of hyaenodonts (Hyaenodonta, formerly placed in the order Creodonta) have been known from the Middle Eocene Pondaung Formation of Myanmar. Four of them, represented by *Kyawdawia lupina*, are endemic to the formation, and the other, *Orienspterodon dahkoensis*, is known also from southern and central China. This study reports a new genus from the Pondaung Formation, and examines paleobiogeographic hypotheses of the Pondaung hyaenodont assemblage.

The new genus is known from a mandibular fragment with m/2-3. It shows hypercarnivorous features such as loss of the metaconids, buccolingually narrow trigonids, and rudimentary talonids. It differs from other hypercarnivorous hyaenodont lineages in its small size (body mass estimated as approximately 1 kg), retention of small talonids surrounded by three cuspids, and the paraconid as large as the protoconid. First members of other hypercarnivorous lineages appear during the Middle Eocene, and the new genus with unknown phylogenetic affinity is highly specialized to hypercarnivory as a middle Eocene taxon.

Among the previously reported Pondaung hyaenodonts, *Kyawdawia* and its relatives have been suggested to be related to *Paratritemnodon* and *Indohyaenodon* (Indohyaenodontinae) from the Eocene of Indo-Pakistan. These taxa are characterized by a horizontal wear of cheek teeth and broad talonids, lacking hypercarnivorous adaptations. *Oriens*pterodon is a gigantic animal with reduced metaconid and talonid. Systematic position of *Oriens*pterodon has been suggested as a primitive hyainailourine or a specialized indohyaenodontine. The later classification implied a single immigration event of a hyaenodont to the Eocene of Southeast Asia; however, the discovery of the new genus denies the single-immigration-event hypotheses, because the new genus distantly related to the previously known Pondaung hyaenodonts. It is suggested that the Pondaung hyaenodont assemblage was formed by three immigration events: an immigration of a indohyaenodontine affinity from South Asia and subsequent endemic diversification, an immigration of a small-sized form specialized to hypercarnivory, and an immigration of a stem hyainailourine from Africa.

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Technical Session II (Wednesday, August 23, 2017, 11:30 AM)

NEW LATE CRETACEOUS (SANTONIAN-CAMPANIAN) GENUS OF LAMNIFORM SHARK FROM THE MOOREVILLE CHALK OF ALABAMA, USA

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The Late Cretaceous lamniform taxon *Cretalamna appendiculata* has been reported from marine deposits worldwide. Historically, most Late Cretaceous shark teeth with a triangular crown and single pair of lateral cusplets were referred to *C. appendiculata,* despite an extremely wide range of morphological variation. Because the taxonomy of *Cretalamna* was over-simplified when originally described, the genus has become a 'waste-basket' taxon. Although some differences between these teeth can be attributed to heterodonty, ontogeny, individual, temporal, and geographic variation, recent work has helped clarify the taxonomy of *Cretalamna* through the creation of new genera and species.

In Alabama, teeth referred to *C. appendiculata* have been recorded from outcrops ranging in age from the Santonian to Maastrictian. A close examination of large samples of these teeth has identified distinctive morphologies with apparent apomorphic characteristics. These teeth were compared to those of recently described *Cretalamna* taxa, as well as *Dwardius*, *Serratolamna* and *Cardabiodon* and show there is at least one, previously undescribed form present in the Late Cretaceous of Alabama. Here we describe a new genus and species of lamniform shark from the Mooreville Chalk (Campanian) of Alabama and review the taxonomy of morphologically similar shark taxa such as *Cretalamna aschersoni Cretalamna biauriculata, Cretalamna marrocana* and *Serratolamna serrata*. This new genus demonstrates a suite of characters including a crown that is significantly recurved, two sets of cusplets that are angled lingually, and a large lingual protuberance.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW CATFISH (SILURIFORMES) REMAINS FROM THE UPPER EOCENE BIRKET QARUN FORMATION, IN THE JEBEL QATRANI AREA, FAYUM DEPRESSION, EGYPT

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Fossiliferous deposits of the Fayum Depression have been the focus of a considerable amount of vertebrate paleontological research over the past many decades, but there is still much work to do on the vertebrate fossils that have been recovered, in particular the fishes. Here we report on a diverse collection of fossil catfishes from Birket Qarun Locality 2 (BQ-2) in the upper Eocene Birket Qarun Formation. These new specimens add significantly to our knowledge of the catfish community in the oldest vertebrate-bearing levels of the Fayum Depression. The BQ-2 locality has been interpreted as a freshwater deposit; however, some of the catfish material may represent the same species as found in the overlying marine Qasr el-Sagha Formation. The assemblage includes the first record of *Fajumia stromeri* from the Birket Qarun Formation, which represents the oldest record for this genus and the first outside the younger Qasr el-Sagha Formation. This occurrence may indicate that the BQ-2 locality has marine influences, or that *Fajumia* is euryhaline, or that it invaded marine waters from its previous freshwater habitat.

Previously reported catfish material from the Fayum Depression includes a number of genera of uncertain familial relationships. Some of the material is most similar to, and may belong to, the family Claroteidae. There are also a number of indeterminate siluriform elements. Notable among the findings are two first dorsal spines that represent two different species of catfishes that are unique first occurrences in the Fayum deposits. Several abdominal vertebrae (varying in size) are also preserved, along with a second dorsal pterygiophore that preserves parts of the nuchal plates. A number of dorsal skull roof and pectoral girdle elements are preserved that show variation in ornamentation, recording the presence of more than one taxon of catfishes of different body size in the near shore ecosystem of the Fayum area during the earliest part of the late Eocene.

Grant Information**:**
Jackson student travel grant

Technical Session XII (Friday, August 25, 2017, 11:15 AM)

EARLIEST EVIDENCE OF TAIL REGENERATION IN A FOSSIL SQUAMATE

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Caudal autotomy, the ability to shed the tail, is common among lizards as a defense mechanism to escape predation. Caudal autotomy is a basal synapomorphy of Lepidosauria. About two-thirds of extant lizard families include species that retain the ability. Many can also regenerate the tail after shedding it. The oldest known fossil evidence of caudal autotomy in a reptile comes from early Permian captorhinids. Here I report the earliest and only documented evidence of caudal autotomy for Squamata, in a glyptosaurine specimen from the early middle Eocene Bridger Formation in the Bridger Basin of southwestern Wyoming.

I identified signs of caudal autotomy in this specimen based on disproportions in an intact 1.5-cm segment of the tail. The segment includes *in situ* imbricate osteoderms, a rare find. Two rings of larger osteoderms surround the anterior half, and three rows of osteoderms that are 50% smaller surround the posterior half. Autotomized tails in extant armored lizards also have smaller osteoderms on the regenerated portion of the tail, even when it has regrown to its full length. In the glyptosaurine specimen, the tail diameter past the breakage point is only 65% that of the original half. Extant lizards also exhibit an abrupt decrease in diameter between the original and the regenerating portions of the tail.

The specimen is assigned to Glyptosaurinae based on a characteristic bumpy surface texture that is present on the osteoderms. The specimen also includes a partial parietal with a similar texture, and right and left mandibles with square-cusped teeth that are diagnostic of Glyptosaurinae. The age and locality of the specimen warrant assignment to the common Bridgerian genus *Glyptosaurus*. Based on mandible length, I estimate that this individual had a snout-vent length of about 220 mm. This is only 33% of the maximum SVL that I have estimated for other individuals in this genus. This specimen represents either a subadult or a smaller species of *Glyptosaurus.*

Computed tomographic scanning reveals diagnostic morphology on the terminal caudal vertebra preserved within the osteoderms. The fracture plane runs between a pair of distally converging transverse processes. A medial groove present on the ventral side deepens toward the chevrons, which are fused to the vertebra. These features are consistent with extant anguid lizards, supporting placement of the Paleogene lizard group Glyptosaurinae within the extant anguid lineage.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

INTEGRATING FILM, THEATER, AND DESIGN APPROACHES WITH PALEONTOLOGICAL PERSPECTIVES TO EXPLAIN SCIENCE

ELSHAFIE, Sara J., UC Berkeley, Berkeley, CA, United States of America

Communication experts agree that the most effective way to engage an audience with new information is to frame the content within a story. Studies show that audiences process and recall new information more efficiently if the content is structured as a story. Stories also humanize the storyteller, which can help scientists counter pervasive public misperceptions that scientists are non-relatable. Effective storytelling benefits from narrative training that is often not included in science communication workshops.

In consultation with artists and educators at an animation studio, a museum, a data visualization company, and a theater company, I developed a series of workshops that adapt story strategies from film, theater, and graphic design for science communication. These workshops aim to 1) help scientists better articulate their research and career motivations, and 2) offer scientists practical tools to make their work accessible and engaging for any audience.

The first workshop unit focuses on principles of story development (e.g., character dynamics, conflict, stakes, and theme), applied to several common scientific narratives. The second unit explores methods of translating a science story, including data, into visual language through strategic use of color, shape, layout, and visual cues. Each unit includes hands-on exercises that help scientists translate their research into a cohesive and accessible presentation.

This approach is particularly effective for communicating historical sciences such as paleontology. Paleontological studies fit well into narrative frameworks because they follow unusual characters; chronicle dramatic events and changes; and evoke wonder in reconstructing lost worlds.

I have run workshops at university campuses for groups of 14 to 175 participants, and at a scientific meeting for a group of over 350 participants. The majority of participants in each workshop were graduate students in STEM degree programs. In post-workshop surveys, 93% of respondents indicated that they would use story strategies in future scientific presentations; 91% said that they would recommend the workshop to colleagues. Recommendations for improvement included 1) tools for using narrative structure in manuscripts and grants, and 2) strategies for addressing specific audiences. I will address these topics and continue to beta-test material in workshops scheduled at university campuses, museums, and scientific meetings over the next year. Ultimately, I plan to create an online platform for this material.

Technical Session VI (Thursday, August 24, 2017, 12:00 PM)

HETEROGENEOUS EVOLUTIONARY RATES IN LATE PALAEOZOIC-EARLY MESOZOIC AMNIOTES

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One of the greatest turnovers in vertebrate history was the replacement of synapsid/parareptile-dominated faunas by archosauromorph-dominated faunas in the Triassic. This turnover was presumably mediated by the end-Permian mass extinction and its key outcome was the rise of the dinosaurs. All three groups were characterized by a huge variety in body size, spanning several orders of magnitude. Body size is considered a crucial biological trait as it correlates with physiology, life history and ecology. The capability of a clade to make rapid changes to its body size range and associated ecological niches could therefore be of fundamental importance for its success.

We present the first comprehensive exploration of body size evolution in all major amniote clades during the Permo-Triassic (PT). Using phylogenetic comparative methods that allow for rate variation we examined evolutionary rates in parareptiles, archosauromorphs and therapsids.

Models that allow for rate variation between different branches outperform homogeneous rate models for Parareptilia. Early diverging parareptiles experienced low evolutionary rates but rates increased to normal with the emergence of the first Ankyramorpha, as expected from a Brownian model of evolution. Evolutionary rates accelerated further with the appearance of the pareiasaurs and peaked within procolophonids at the PT boundary. Rates then plateaued in the Triassic, being an order of magnitude higher than normal rates.

A heterogeneous rate model is also favoured for Therapsida. Early diverging members of the clade were characterized by rates close to normal background. Rates increased substantially during the late Permian, reaching a peak before the Permo-Triassic mass extinction event (PTME). Middle to Late Permian members of the speciose clade Dicynodontia exhibited considerably higher rates than other contemporary therapsids. Following the PTME, rates remained high, albeit lower than just before the PT boundary.

Conversely, a homogeneous rate model is favoured for archosauromorphs. This indicates that elevated evolutionary rates were not necessary for Archosauromorpha to replace Therapsida as key players in terrestrial ecosystems. The results further suggest that elevated evolutionary rates do not necessarily confer long-term success of clades, as shown by both parareptiles and therapsids. Short-term diversification events, however, appear to be associated with increased evolutionary rates.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

FIRST FOSSIL OCCURENCES OF THE *SPHENOMORPHUS* SPECIES GROUP (SQUAMATA; SCINCIDAE; LYGOSOMINAE) FROM THE LATE OLIGOCENE NAMBA AND ETADUNNA FORMATIONS OF SOUTH AUSTRALIA

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Scincidae (skinks) is represented by an impoverished fossil record in Australia. Despite the incredible diversity and abundance of extant skinks on the continent, fossil samples are surprisingly rare. Therefore, any fossils of their early evolution on the continent would be of great benefit to Australian paleoherpetology. Previously, the only extinct genus of Scincidae in Australia was represented by the *Egernia* species group skink *Proegernia palankarinnensis* of the Late Oligocene Etadunna Formation. Here, we detail three mandibular elements, all dentaries, two are from the Namba Formation of the Frome Sub-basin and the other is from the Etadunna Formation of the Tirari Sub-basin. Albeit incomplete, the sole character diagnosing these skinks as pertaining to the *Sphenomorphus* group is the presence of an open Meckelian groove, which is closed in the *Egernia* and *Eugongylus* species groups. A phylogenetic analysis via maximum parsimony shows that the two Namba skinks are sister taxa relative to the Etadunna specimen, which is a sister taxon to the Namba skink clade. We can determine that the two Namba skinks are at least different species, but whether they are different genera is still to be determined. The Etadunna *Sphenomorphus*-type skink (as is *Proegernia*) is from the Minkina Local Fauna (L.F.), which is the oldest and stratigraphically lowest local fauna from the Etadunna Formation. The two Namba *Sphenomorphus*-type skinks are both from the Pinpa L.F. which is the oldest and stratigraphically lowest local fauna from the Namba Fm. The Minkina L.F. and Pinpa L.F. are considered to be biostratigraphically correlated with each other in age, latest Oligocene (ca. 26 million years ago). These three new taxa, plus *Proegernia* are the oldest fossil skinks known from Australia, and their age is consistent with divergence times for the radiation of both the *Sphenomorphus* species group and the *Egernia* species group at 25 mya based on DNA sequence data of extant skinks.

Technical Session XV (Friday, August 25, 2017, 3:15 PM)

A NEW, EARLY RELATIVE OF SABER-TOOTHED SPARASSODONTS (METATHERIA: SPARASSODONTA: THYLACOSMILIDAE) FROM THE EARLY OLIGOCENE CACHAPOAL FAUNA, ANDEAN MAIN RANGE, CENTRAL CHILE

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Thylacosmilid sparassodonts are among the most iconic groups of endemic South American Cenozoic mammals due to their distinctive morphology and convergent resemblance to saber-toothed placental carnivorans. However, the early evolution of thylacosmilids and their relationships to other sparassodonts are poorly known, as this group is primarily represented by stratigraphically young, specialized taxa such as *Thylacosmilus*, *Anachlysictis*, and *Patagosmilus* from the mid-to-late Miocene and Pliocene. Here, we describe a new sparassodont specimen, SGO-PV 3490, from the Cachapoal Fauna of the Abanico Formation in central Chile that likely dates to the early Oligocene (?Tinguiririan SALMA). This specimen represents a senescent individual of a new, undescribed taxon that, based on direct observation and CT imaging, exhibits a combination of features resembling both thylacosmilid and proborhyaenid sparassodonts. Thylacosmilid-like features include: (1) an unfused symphysis (reversal from condition in "proborhyaenids"); (2) lack of longitudinal ridges on the roots of the canines (reversal, derived for thylacosmilids among borhyaenoids); (3) reduction of median canine sulci (reversal); (4) upper canines that are relatively laterally compressed compared to almost all other sparassodonts (derived); and (5) a short rostrum with a deep maxilla and shallow dentary (derived). "Proborhyaenid"-like features include: (1) three upper and lower premolars, with replaced DP3 (primitive); (2) lack of a mandibular flange (primitive);

(3); retention of a sulcus on the lingual face of the upper canines (derived for "proborhyaenids"); and (4) possibly open-rooted lower canines (derived for "proborhyaenids"). In particular, this specimen resembles IGM 251108, a putative basal thylacosmilid from the middle Miocene of La Venta, Colombia, in having more vertically implanted upper canines than other sparassodonts. Phylogenetic analyses recover the Chilean specimen as the sister taxon to the included thylacosmilids, with traditionally recognized "proborhyaenids" representing a paraphyletic series of successive outgroups to this group. These results support prior hypotheses of a close relationship between thylacosmilids and "proborhyaenids" and the paraphyly of "Proborhyaenidae".
Grant Information:
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

INFERRING DIETARY ADAPTATIONS OF PALEOCENE SMALL MAMMALS FROM WALBECK (GERMANY) BY MOLAR RELIEF INDEX

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Walbeck is one of the most important Paleocene vertebrate localities in Europe and the only one from Germany. The karstic fissure filling was discovered in 1939 and yielded over 6000 mammalian remains of 16 different species from seven orders. The Walbeck assemblage is characterized by a low faunal diversity with few dominant species which indicate an open and unstable environment.

In order to infer dietary adaptations for the Walbeck small mammals the size-independent relief index was calculated for the molar dentition. The relief index is an indicator for the crown complexity and is calculated by dividing the 3D crown surface area by the 2D crown base area.

For this study, eight species from the following families were studied: Pseudorhyncocyonidae, Cimolestidae, Louisinidae, Adapisoricidae, Plesiadapidae, Adapisoriculidae. Their dentitions range from conservative to slightly modified tribosphenic morphologies. Despite some reworking during the Rupelian Transgression in the Oligocene, the majority of teeth from Walbeck is not water-worn and well suitable for functional analyses of the occlusal surface. Micro-CT scans of second lower molars (m2) were used to generate three-dimensional dental surface models for the calculation of the relief index.

The second molars (m2) of the Walbeck cimolestids show higher relief index values than the second molars of the other families, which all fall within the same range. A comparison with extant bat taxa with known dietary preferences suggests an insectivorous diet for the Walbeck cimolestids because high relief index values are associated with insectivory. The other studied taxa fall within the range of frugivorous and omnivorous bats. In comparison with previously published data on plesiadapids from other localities, *Plesiadapis walbeckensis* shows relatively low relief index values, which may reflect its the basal phylogenetic position. The open habitat which is assumed for Walbeck, rather suggests an opportunistic omnivorous diet for most taxa than a strictly frugivorous nutrition.

Grant Information:
DFG-Project number: MA 1643/21-1

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

TRACKING THE LAST MEALS AND MOVEMENTS OF AN ADOLESCENT *MAMMUTHUS COLUMBI* WITH STABLE ISOTOPE ANALYSIS OF ENAMEL AND VEGETATION

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Waco Mammoth National Monument (WMNM) is a Pleistocene vertebrate site in Waco, Texas. There are at least two bone-bearing strata at the site; the younger dates to ~53 ka and the older to ~67 ka. This older strata dates to Oxygen Isotope Stage IV (OIS IV) and is of primary interest, as it contains the remains of at least 16 female or juvenile Columbian mammoths (*Mammuthus columbi*) that died in a single event. It is the only known nursery herd of *M. columbi*.

Research at the site has focused on determining the kill mechanism or on using data from the site to shed light on Texas' climate during OIS IV. Less work has been done on the migratory and dietary habits of the herd. Stable isotope analyses were done on bulk samples of mammoth enamel from the site, but this produced time-averaged results that made detecting seasonal variation impossible.

This limitation can be avoided by using serial sampling. Cheek teeth in mammoths grow in height by accreting enamel over up to 15 years. By taking minute samples of aprismatic enamel along the height of a tooth plate, changes in $\delta^{13}C$ and $^{87}Sr:^{86}Sr$ reflect changes in the diet and location of the mammoth respectively. $\delta^{13}C$ reflects diet because plants using different photosynthetic pathways discriminate differently between carbon isotopes. This carbon is incorporated into structural carbonate in enamel. $^{87}Sr:^{86}Sr$ ratios reveal location because they vary in plants depending on the age and lithology of parent material in the soil where the plant grows. This Sr is also incorporated into the enamel's structural carbonate. $\delta^{18}O$ values reflect the evaporative balance the mammoth's water source. The balance varies over the course of the year, and is recorded in the enamel. Together these analyses reveal what the mammoth was eating, in what place, and in what season.

We applied this sampling and analysis strategy to a tooth from the adolescent mammoth "N" from the nursery herd at WMNM. Twenty-seven samples were taken from a single plate of this tooth. Each sample was 1.59 mm in diameter, producing a sample that time-averages over 43 days. The length of enamel measured was 89.5 mm, representing 6.62 years of tooth growth. The samples thus represent 43 day periods every 49 days.

The $\delta^{18}O$ calendar from the tooth roughly conforms to the time of deposition predicted from estimated growth rates. Changes occurred in the C3:C4 balance over the period measured, but correlation with seasons was not obvious. $^{87}Sr:^{86}Sr$ showed limited movement over the period measured, which is in keeping with what has been hypothesized by other researchers.

Technical Session XIX (Saturday, August 26, 2017, 2:30 PM)

BONE MICROSTRUCTURE AND HETEROCHRONY SHAPE FISH-EATING HABITS IN SPINOSAURS

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Spinosaurus aegyptiacus is one of the most enigmatic dinosaurs. The recent description of a neotype specimen provided new insights into the anatomy and ecology of this bizarre giant theropod. Here, we present novel research on the osteohistology of *Spinosaurus*. Several postcranial elements were sectioned: a neural spine, dorsal ribs, the fibula and the femur. The increasing organization of vascular canals toward the outer surface, the presence of Haversian systems, the decreasing spacing between LAGs and the absence of an EFS are observed in all of the sectioned bones. This is consistent with a sub-adult ontogenetic stage and provides an additional line of evidence, demonstrating that the neotype specimen represents a single individual of *Spinosaurus*, a taxon characterized by a shortened femur and reduced hind limbs.

Bone density analyses were performed to compare ecological adaptations in *Spinosaurus* and related megalosauroids to those in extant taxa. Using a broad dataset of 60 archosaur taxa, including extant crocodilians, non-avian dinosaurs and extant birds, the compactness of long bones was used as a proxy for ecological inference in extant and extinct taxa. Long bone compactness was quantified using Bone Profiler. Paleoecological profiles for different taxa were based on similarities in bone density values; these were assessed through morphometrics using R. *Spinosaurus* clusters with extant penguins, a result that is consistent with previous conclusions on its semiaquatic habits.

Finally, the role of heterocrony in patterning the anatomical characteristics present in spinosaurids was examined in the light of osteohistological data. Previous studies suggest that heterocrony plays an important role in secondary aquatic adaptations based on anatomical observations: it has been suggested that ichthyosaurs and tanystropheids underwent paedomorphic shifts during their progressive adaptation to aquatic lifestyles. We performed 2D geometric morphometrics on non-avian theropod skulls using 45 landmarks. We found a progressive peramorphic trend in Megalosauroidea shaping the crocodile-mimic skull morphology adapted for fish-eating, contrary to other clades of tetrapods with secondary adaptations for an aquatic or semiaquatic lifestyle. Moreover, we conclude that peramorphosis is a general driver for gigantism in Theropoda.

Romer Prize Session (Thursday, August 24, 2017, 11:15 AM)

LARGE VOLCANIC ERUPTIONS DRIVE LOCAL MAMMALIAN COMMUNITY CHANGE

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It is clear that ecosystems are devastated after a volcanic eruption coats the landscape with a layer of ash; however, the ecological recovery of mammalian communities after eruptions is poorly understood. Volcanic eruptions vary with magnitude and type and only a fraction of them have been analyzed for effects on mammalian communities. To better understand mammalian community recovery, I investigated how species richness, evenness, and similarity change across volcanic boundaries. Three volcanic systems were studied to investigate the impact of the size of eruption. The 1980 Mount St. Helens eruption sheds light on short term recovery after a moderate sized eruption. The 1914-1917 Mount Lassen eruption permits an analysis of long-term impacts from a relatively small eruption. The Picture Gorge Ignimbrite (28.7 Ma) within the Turtle Cove Member of the John Day Formation was a supervolcanic eruption associated with the Yellowstone hotspot. Vouchered occurrence data of modern and fossil mammals was used to calculate Chao richness, Shannon and Hurlburt indices of evenness, and for chord distance analysis of similarity. Richness and evenness remains unchanged in both Mount Lassen and the Picture Gorge Ignimbrite. Mount St. Helens saw an immediate drop in richness followed by an increase over five years to pre-eruptive levels, resembling succession. Chord distance analysis suggests no long term change in the Mount Lassen fauna, while the pre and post Mount St. Helens fauna are different from one another, with the post fauna being more similar to the fauna of neighboring regions. The pre and post Picture Gorge Ignimbrite faunal assemblages are also distinct. The pre-eruptive fauna shows more affinities for closed habitats while the post-eruptive fauna shows greater affinity for open habitats. It is clear from my results that larger eruptions tend to have a greater impact on mammalian community recovery than smaller eruptions. While richness and evenness may not change across volcanic boundaries, the species and their relative abundances do. It is clear that the size of the eruption matters when it comes to mammalian recovery, but ultimately, mammalian populations are robust and the presence of refugia is important for recolonizing devastated areas.

Preparators' Session (Thursday, August 24, 2017, 11:15 AM)

GEOCHEMICAL 'FINGERPRINTING' OF GOBI DINOSAURS; A TOOL FOR REPATRIATING POACHED DINOSAUR FOSSILS IN MONGOLIA

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Illegal poaching of vertebrate fossils from the well-known Cretaceous exposures in southern Mongolia has now reached epidemic proportions. Although a number of valuable specimens have now been repatriated, the question of provenance remains paramount for both scientific and legal reasons. To address this issue, we investigated the geochemistry of the Baruungoyot and Nemegt formations (both sediments and associated fossils), using X-ray fluorescence (XRF) in order to ascertain possible geochemical 'fingerprints' that could be used to differentiate formations and reassign poached specimens. Field data are representative of several localities across the Nemegt Basin (Nemegt, Khulsan, Altan Uul I-IV, Tsagaan Khushuu, Ulan Hushu). Additional XRF data were acquired from specimens housed at the Mongolian Palaeontology Centre in

Ulaanbaatar, including type, recently described, and poached specimens. We used a combination of multivariate analysis and data mining techniques to determine the uniqueness of the geochemical fingerprint of samples and to determine the most informative elements from the geochemical array in predicting likely provenance. Results indicate that the fingerprints of the Baruungoyot and Nemegt formation sediments largely overlap but contain distinct individual elemental patterns. Using a combination of Ca and Si, sediment samples of known provenance could be statistically assigned to the correct formation with 86% accuracy. A blind test of this method using three museum samples of known provenance resulted in two samples being correctly assigned to their known formation. Application of the method to poached sediment samples of unknown provenance assigned all samples to the Nemegt Formation. Fossil samples were more problematic. Within the Nemegt Formation, fossils from the Nemegt locality could be identified with 90% accuracy based on Ti content alone, whereas individual elements or their multivariate geochemical fingerprint were less defined for other localities. Variation, however, in concentrations of U, Nb, Ni, and P are documented in fossils representative of different stratigraphic intervals within the Nemegt Formation (Altan Uul II vs III, or Nemegt vs Tsagaan Khushuu) suggesting direct connection between *facies* variations and trace element distribution. This new methodology represents the first systematic attempt to provide an innovative and indisputable tool to support legal and scientific assumptions.

Grant Information:
National Geographic Society / Waitts Grant Program (Grant #W434-16) to F.F.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

IT TAKES NERVE: PERIPHERAL NERVE CONDUCTION TIME WAS A POTENTIAL LIMIT ON DYNAMIC FLIGHT CONTROL IN GIANT PTEROSAURS

FAUDE, Sophie, University of Southern California, Los Angeles, CA, United States of America; HABIB, Michael, University of Southern California, Los Angeles, CA, United States of America

Pterosaurs included the largest known flying animals, which would have presented a number of mechanical and physiological challenges. The constraints associated with mass-specific muscle power and hard tissue structural strength have been previously considered for large pterosaurs. The constraints on control and reaction times, which are critical for flying animals, have received less attention. These may have been critical constraints for pterosaurs: they possessed innervated tissues all the way to the tips of their wings and likely possessed some of the longest appendicular neurons of any vertebrate. We estimated maximum and minimum lengths for both the afferent (sensory) and efferent (motor) nerve axons in the wings of two well-preserved specimens of *Pteranodon*: LACM 50927 and LACM 51132. Sensory nerve lengths were calculated from wingtip to the expected origins of the brachial plexus while motor nerve lengths were calculated from brachial plexus origin to 75% the length of metacarpal IV. Reaction times were estimated using an action potential speed of 150 m/s, which is typical for many living vertebrates. We then extrapolated the results to species with larger spans, adjusting for differences in wing and cervical proportions, including *Quetzalcoatlus northropi* (with an estimated span of 10.5 meters). Although the action potential time did not represent a significant percentage of the flap cycle for the *Pteranodon* specimens, the estimated reflex loop time for the larger species exceeded 2% of the total estimated flap cycle time (0.021 sec total reflex loop time versus a 0.9 sec flapping cycle time). The estimated reflex time might have been sufficient to preclude some of the more rapid dynamic control options, potentially requiring some degree of passive stability during flight for the largest pterosaurs. We consider these estimates of response lag to be conservative. In large azhdarchids with elongate necks (including *Arambourgiana* and possibly *Quetzalcoatlus northropi*), the roots of the brachial plexus may have been particularly long. Any flight response signals that required input from the brain, rather than the spinal cord, would also have had significantly longer paths to traverse in these taxa.

Grant Information:
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Technical Session III (Wednesday, August 23, 2017, 3:15 PM)

DIFFERENTIAL GROWTH RATE IN THE WINGS OF RATITE EMBRYOS SUPPORT INDEPENDENT FLIGHT LOSS MECHANISMS

FAUX, Cynthia, Washington State University, Pullman, WA, United States of America; FIELD, Daniel, University of Bath, Bath, United Kingdom

Recent phylogenomic studies conclude the ratites (large, flightless birds incorporating ostriches, rheas, kiwis, emus, and cassowaries) do not form a monophyletic clade to the exclusion of flying taxa. Thus, various groups of ratites, including ostriches and emus, may have acquired flightlessness and large body size independently. Although repeated losses of flying ability, and attendant anatomical changes, have evolved in other avian clades (e.g. dozens of times among rails (Rallidae)), the convergent loss of flight among ratites has, thus far, only been closely investigated from phylogenetic and genomic perspectives. Such studies have convincingly established the general pattern of paleognath interrelationships, and therefore the pattern by which flight must have been lost deep in ratite evolutionary history. However, the mechanistic developmental processes underlying such repeated losses of flight have not been investigated.

We examined comprehensive embryonic skeletal developmental sequences from ostriches, emus, tinamous, and chickens and compared wing development growth trajectories. We find the rate of ostrich embryonic wing growth falls within the range of variation exhibited by flying taxa (tinamous and chickens), but that of emus is extremely slow. Overall growth patterns support the hypothesis that ancestral stem ostriches were flying birds which grew large and subsequently lost flight, while ancestral stem casuariids (emus + cassowaries) lost flight at small body size before evolving to giant proportions. We conclude flightlessness was acquired by different developmental mechanisms in emus and ostriches, corroborating the recent phylogenomic evidence that flight loss has evolved repeatedly among ratites. Direct fossil evidence bearing on flight loss among the modern ratite subclades has proven extremely elusive, despite detailed studies of known fossil paleognaths. Future fossil evidence is predicted to shed light on how and when the various ratite subclades lost flight and acquired large body size; such discoveries will ultimately be necessary for us to fully understand what has quickly become a classic example of convergent evolution.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

TAPHONOMY AND TECTONIC DEFORMATION OF CANADA'S OLDEST DINOSAURS: 3D DIGITAL RECONSTRUCTION OF THE FUNDY DINOSAUR BONE BED

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An Early Jurassic (Hettangian) dinosaur bone bed was digitally reconstructed using open-source animation software (Blender.org) and a functionally articulated digital scan of *Plateosaurus*. The 3D models were used to reconstruct the individual skeletons found in the Princeton Quarry at Wasson Bluff, near Parrsboro, Nova Scotia.

Paul Olsen and colleagues discovered the first dinosaur bones in the eolian and fluvial sandstones of the McCoy Brook Formation at Wasson Bluff in 1976. Then in 1992-1994 a nearly complete skeleton was discovered at the same site (Grantham, Hyrnewick, Adams). Additional skeletons were then collected over six field seasons between 1997-2007. At **least five individual** animals are now identified from this mass accumulation, including several articulated skeletons, one with a disarticulated but nearly complete skull.

A 3D model of the mass accumulation was developed to assess the taphonomy and tectonic deformation of the specimens. A composite map representing three years of field work was used to position functionally articulated skeletons using the animation software. Rotation of one element (eg. sacrum) moved all other bones linked to it. Care was taken to locate rotational centres for elements on articulation planes rather than object centres. The activity of posing the skeletal elements with the animation software provided anatomical insights into the rotation, flexion, and accumulation of skeletons.

The McCoy Brook Formation fluvial sandstones at Wasson Bluff represent an active paleofault rift, a rapid erosion and depositional cliff face environment, where frequent and prolonged tectonic activity had a dramatic affect on the rate and quality of fossil preservation. The digital model provides support for fluvial deposition and burial of this important mass accumulation of early dinosaur skeletons.

The 3D reconstructions use postural information to assess burial processes. Videos and demonstrations of using 3D animation software for research will be available at: http://edinos.ca/3d-bonebed.

Special thanks to Heinrich Mallison and Philip Havlik for access to the digital *Plateosaurus* model that is based on the specimen at Palaeontological Collection of Tübingen University.

Grant Information**:**
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Technical Session VII (Thursday, August 24, 2017, 4:00 PM)

BIRDS OF A FEATHER EVOLVE WITH HETEROGENEOUS TEMPO AND MODE

FELICE, Ryan N., University College London, London, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom

Birds of a Feather Evolve with Heterogeneous Tempo and Mode

Birds are thought to have achieved their exceptional diversity largely through two major radiations, the first immediately after the K-Pg mass extinction and a second one later in the Eocene. Recent analyses have also demonstrated great variation in evolutionary rates across avian lineages, but are limited to single anatomical structures or speciation/extinction rates. New methods for evolutionary modelling and shape analysis allow us to quantify complex structures and consider how differences in tempo and mode of evolution among traits have contributed to ecomorphological diversity through time. Using high-dimensional 3-D geometric morphometrics (36 landmarks, 723 sliding semi-landmarks), we comprehensively quantified skull morphology in 358 bird species, spanning their phylogenetic breadth. We fit univariate and multivariate evolutionary models using a range of approaches (implemented in BAMM, BayesTraits, and mvMORPH) to reconstruct patterns of trait evolution across cranial modules. Analysis with BayesTraits suggests that the facial skeleton is best fit by a variable-rate Ornstein-Uhlenbeck model, with clades with extremely long, wide, or curved beaks (e.g., Phoenicopteridae, Ramphastidae, Psittaciformes, Threskiornithidae) showing rapid facial evolution. Overall morphological rates for the rostrum accelerated during the late Cretaceous and again in the Oligocene. Using the mvMORPH method, we find that the first principal component (PC) of rostrum shape (describing beak elongation) evolves slowly (low σ) and with weak pull (low α) toward the optimum ($\sigma = 2.4$, $\alpha = 0.02$) compared to the second PC (beak curvature, $\sigma = 8.4$, $\alpha = 0.29$). This result demonstrates that high trait variance is not necessarily the result of rapid adaptive evolution. Moreover, higher PCs may reflect phenotypes that are restricted to a few clades which experienced a strong pull, and higher evolutionary rates, toward new adaptive optima. In contrast to results for the rostrum, the braincase follows a variable rate, punctuated evolution model ($\kappa = 0.27$). Compared to the rostrum, the braincase exhibits fewer branches with high rates, notably at the origin of the highly encephalized Psittaciformes and oscine passerines. For both the rostrum and braincase, disparity is significantly higher than the Brownian expectation from the Cretaceous through the Oligocene. Together, these findings demonstrate that avian ecomorphological diversity evolved through disparate evolutionary processes and selective regimes acting on individual cranial modules.

Grant Information:
European Research Council grant ERC-STG-2014-637171

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW SPECIES OF *AGERINIA* (ADAPIFORMES, PRIMATES) FROM THE EARLY EOCENE OF THE PYRENEES (NE IBERIAN PENINSULA)

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Euprimates originated in the early Eocene and reached great abundance and diversity in the Northern Hemisphere, being mainly represented by two groups, adapiforms and omomyiforms. In Europe, the early Eocene primate record is still scarce and poorly known, although the recent description of new material of the genus *Agerinia* from several Spanish fossil sites has increased the knowledge about the early evolution of the group in this continent. Here, new euprimate material from the locality of Masia de l'Hereuet (early Eocene, NE Spain) is presented. The described remains consist of one fragment of mandible and 15 isolated teeth, which can be confidentially assigned to the genus *Agerinia*. These new material shows several traits that were previously unknown for this genus, such as the morphology of the upper and lower fourth deciduous premolars and the P_2, and the unfused mandible. The material from Masia de l'Hereuet clearly differs from the previously known species of *Agerinia, A. smithorum* from Casa Retjo-1 and *A. roselli* from Les Saleres. It can be distinguished from *A. smithorum* by several traits such as the reduction of the number of roots in the P_2, the more molarized P_4, or the lack of paraconid on the M_2. It further differs from *A. roselli* in the central position of the P_1 in the mandible, in the less molarized P_4 or in the larger paraconid on the M_1. Therefore, this new material from Masia de l'Hereuet will allow the description of a new species of *Agerinia*. The joint analysis of the three samples of *Agerinia* known from NE Spain reveals a progressive change in several morphological traits from *A. smithorum* to *A. roselli*, whereas the form from Masia de l'Hereuet shows intermediate features. These changes include the lingual shift of the P_1, the reduction of the number of roots of the P_2, the molarization of the P_4, the reduction of the paraconid on the lower molars and the mesial displacement of the mental foramina. These gradual changes allow the proposition of a single evolutionary lineage, in which the new species from Masia de l'Hereuet would represent an intermediate form between *A. smithorum* and *A. roselli*.

Grant Information:
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Technical Session XVII (Saturday, August 26, 2017, 10:30 AM)

CLIMATE CHANGE IN THE EOCENE WASATCH FORMATION OF SOUTHWESTERN WYOMING

FENDLEY, Isabel, University of California Berkeley, Berkeley, CA, United States of America; PARK, Yuem, University of California Berkeley, Berkeley, CA, United States of America; HOLROYD, Patricia A., university of California Berkeley, Berkeley, CA, United States of America

The early to middle Eocene saw major global temperature fluctuations, evolving from the warm Paleocene-Eocene Thermal Maximum to the cooler earliest Eocene and then back to the warm Early Eocene Climatic Optimum. These temperature fluctuations undoubtedly had effects on the environment and ecosystems of the time, including on mammalian diversity in North America. However, the exact nature and extent of the relationship between global climate change patterns and local environmental conditions remain unclear, partially due to the relative paucity of data outside of a few localities in the Bighorn Basin of northwestern Wyoming. The Greater Green River Basin of southwestern Wyoming preserves early Eocene rocks of the fluvial Wasatch and lacustrine Green River formations, and is an ideal system to test whether these temperature fluctuations are detectable outside of the Bighorn Basin and how they relate to lake development.

Here we present a new isotopic data set from two fossiliferous sections through the Main Body of the Wasatch Formation in the Washakie Basin that are tied to the stratigraphic master section. These superposed vertebrate faunas have been assigned to mid to late Wasatchian North American Land Mammal Age biozones, which overlap with the early Eocene cool period and subsequent warming. This study uses the oxygen isotopic composition ($\delta^{18}O$) of the enamel hydroxylapatite from *Lepisosteus* (gar fish) scales and *Coryphodon* (mammal) teeth fossils from the Wasatch Formation to estimate mean annual temperature. Twenty-three fossils from 8 UCMP localities tied to the stratigraphic master section were sampled and analyzed.

Our results capture both a cool period and a warming event in the Washakie Basin, similar to that previously reported from the Bighorn Basin. Inferred temperatures are generally warmer than those recorded in the Bighorn Basin, consistent with the more southerly location of the Washakie Basin. The onset of warming is coincident with the first persistent, pervasive ponding in the basin and shows that the initial development of lakes occurred during the late Wasatchian warming, earlier than in other regional basins. Correlating this local record to that of other regional and global climate data sets allows us to refine sedimentation rate models for the formation and independently test biostratigraphic correlations with other basins.

Grant Information**:**
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Technical Session IV (Wednesday, August 23, 2017, 3:45 PM)

DIETARY PREFERENCES OF *PLIOHIPPUS POTOSINUS* PASO DEL AGUILA LOCAL FAUNA, CLARENDONIAN OF SAN LUIS POTOSI, CENTRAL-EASTERN MEXICO INFERRED FROM CARBON AND OXYGENE STABLE ISOTOPE RELATIONSHIPS

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The major effort of the vertebrate Community of Mexico still hinges in the alpha Taxonomy, yet some taxa are rather well known and are amenable to other kind of studies, like inferring their dietary habits by means of enamel $^{13}C/^{12}C$ and $^{18}O/^{16}O$ isotopic relationships analysis. One such is the Family Equidae, from which there are several published reports, which disclose that the Mexican Cenozoic equids displayed a wide dietary habits. In keeping with this effort, in this study we present our inference on the diet of *Pliohippus potosinus* from the Sierra Madre Oriental morphotectonic Province, which has the added bonus of radio-isotopic dates. [^{40}Ar-^{39}Ar dates of 12.33-7.41 Ma], which also allow calibration.

This taxon is part of the Paso del Águila local fauna, which was collected from the floodplain facies of the Late Miocene [Clarendonian] San Nicolás Formation, an ~1100 m thick fluvio-lacustrine sequence preserved in the Peotillos Graben, central San Luis Potosí State, within coordinates 22º11'-22º19' N Lat. and 100º30'-100º39' W Long.; it overlies a Late Eocene-Early Oligocene volcanic succession (San Isidro and "Santa María Ignimbrite") and underlies Quaternary epi/pyroclastic deposits.

Pliohippus is regarded as open country [i.e., savanna-like environment] dweller, largely feeding on grasses [C4 plants] on account of its hypsodont, complex occlusal-patterned teeth. It is expected than *P. potosinus* would show this kind of dietary preferences. To test this tenet, we used carbon and oxygen stable isotope relationships in molar enamel samples of topotypic material. The isotopic analysis produced these results: The $\delta^{13}C$ was -3.9‰ and $\delta^{18}O$ -2.9‰, thus indicating that this taxon had a mixed C3/C4 diet, which largely corroborates the feeding habits mentioned above, and discloses an open country grassland/savanna scenario habitat for *P. potosinus.* Palynological evidence supports this interpretation.

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Technical Session VII (Thursday, August 24, 2017, 3:30 PM)

ANCESTRAL ECOLOGICAL RECONSTRUCTIONS AND EVIDENCE OF CANOPY DESTRUCTION REVEAL STRONG ECOLOGICAL SELECTIVITY AMONG BIRDS ACROSS THE K-PG MASS EXTINCTION

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Both the fossil record and recent molecular phylogenetic datasets support an extraordinary radiation of the avian crown group in the early Cenozoic, following a limited initial diversification in the Late Cretaceous. However, questions remain regarding the mechanisms responsible for the survival of the deepest lineages within the avian crown across the K-Pg, particularly since this event resulted in the complete elimination of even the most crownward representatives of the avian stem group. Here, Bayesian ancestral state reconstructions of avian ecology reveal a strong bias toward taxa exhibiting predominantly terrestrial lifestyles across the K-Pg, with multiple convergent transitions toward predominantly arboreal ecologies later in the Cenozoic. By contrast, ecomorphological inferences suggest predominantly arboreal lifestyles for most known enantiornithines, the most diverse and widespread Mesozoic avialans.

To attempt to test the hypothesis that widespread destruction of forests across the K-Pg may have strongly selected against arboreal birds, we combined pollen and fern spore analyses with reconstructed Leaf Area Index (rLAI)–a taxonomically independent proxy for vegetal cover density–at ~1cm resolution across the Maastrichtian Hell Creek and Danian Fort Union Formations from the John's Nose section of North Dakota. Although our analyses confirm a significant decrease in Cretaceous pollen diversity and a pronounced fern spike directly coincident with markers of the Chicxulub impact, rLAI results are equivocal with respect to providing direct evidence of mass deforestation as a result of the impact blast and/or associated wildfires. We suggest that these data indicate a temporary (<700-year) loss of plant cover at the K-Pg boundary (possibly beyond the resolution threshold for the rLAI analyses at this site), which may have strongly selected against avian taxa with arboreal ecologies. This apparent selective filter yielded a predominantly terrestrial post-extinction avifauna that ultimately gave rise to modern neornithine diversity, providing a unified explanation for the extinction of arboreal enantiornithines and the persistence of terrestrial crown clades such as paleognaths, galloanserines, and terrestrial total-clade neoavians in the aftermath of the extinction. We hypothesize that alternative selective pressures were responsible for the extinction of obligately marine stem birds at the K-Pg, such as Ichthyornithes and Hesperornithes.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A DESCRIPTION OF A SECOND SPECIMEN OF *URENCHELYS ABDITUS* FROM THE SMOKY HILL CHALK MEMBER OF THE NIOBRARA FORMATION (UPPER CRETACEOUS: SANTONIAN) OF KANSAS WITH NEW CHARACTERS FOR THE SPECIES

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The fossil record of the order Anguilliformes is very rare relative to that of other teleost taxa. Fossil eels have been reported from the Cretaceous, Eocene, and the Oligocene. There are four eel genera known from the Cretaceous: *Anguillavus*, *Enchelion*, *Enchelurus*, and *Urenchelys*. The only North American Cretaceous eel is *Urenchelys abditus* from the Smoky Hill Chalk Member of the Niobrara Formation (Upper Cretaceous: Santonian). Its description is based on a single specimen collected from the Hell's Bar locality in Gove County, Kansas. We describe a second specimen of *U. abditus* collected from the Castle Rock locality also in Gove County, Kansas.

The specimen measures 67mm long, with the skull measuring 9mm long, however a posterior portion of the fish was not preserved. This new specimen reveals a number of characters not preserved in the holotype. These include the quadrate with a large condyle for articulation with the mandible and a long, almost vertical preopercular process; narrow ectopterygoid; epihyal; lateral line ossicles; slender pterygiophores for the median fins; very long, thin epineural and epipleural intermuscular bones. Differences from the holotype include a single row of dentary teeth; narrow, needlelike teeth; a ceratohyal with a long spine that runs along the dorsal border of the epihyal, dorsal fin starting on the 16th rather than the 12th vertebra; unsegmented pectoral, dorsal, and anal fin rays. This second specimen does add further morphological information not found on the holotype, but *U. abditus* still cannot be assigned to a specific anguilliform family at this time. Nonetheless, the additional information is useful for comparative studies of the other Cretaceous genera of eels.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW CROCODYLIFORM SPECIMEN FROM THE CRETACEOUS OF MOROCCO WITH *HAMADASUCHUS* AFFINITIES AND THE MORPHOLOGICAL VARIATION WITHIN THE GENUS

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Hamadasuchus rebouli was first described on the basis of a single fragmentary mandible (MDE C001) from the locality of Hamada du Guir in southern Morocco. Later, a series of more complete material from the Kem Kem beds were referred to this species, including a complete skull and mandibular remains (ROM 49282, ROM 52045, ROM 52047). A new fossil (MN 7070-V) comprises a fragmentary mandible similar to other *H. rebouli* material, but it also shows evidence for more morphological variation than previously observed. The diagnostic features of the holotype included the extension of the mandibular symphysis (at the border of the fifth alveoli), and the pattern of dental morphology, i.e. close-set ziphodont teeth with regional variation in size. The four teeth distal to the fourth enlarged one are reduced and placed in the concavity between the two waves of the festooned jaw. Starting at the 9th tooth, the crowns get larger and reach their maximum size at the 12th tooth. All these teeth are placed in the long second wave of the dentary. The referred specimens show important morphological variation regarding the holotype. Despite also showing ziphodont dentition, ROM 49282 differs in the pattern of size regionalization of the teeth. There are seven reduced teeth (5th-11th) in the shallow inter-wave concavity, and only the 12th and 13th have enlarged crowns, with the later being the larger one. Also, the second wave is short and only encompasses the larger tooth (i.e. 13th). MN 7070-V comprises the midsection of a right mandibular ramus showing three complete ziphodont teeth. The preserved crowns are set in the long second mandibular wave, similar to what is observed in MDE C001. However, in the new specimen there are a total of five teeth in the wave, which includes the enlarged one and the two mesial and distal elements. In MN 7070-V the wave is placed at a lower level in comparison to the posterior region of the dentary, which includes the dental groove. In the holotype and in ROM 49282 this convex region is higher than the posterior-most portion of the jaw. The ornamentation of the lateral surface of the dentary also varies among different specimens. In MDE C001 and ROM 49282 a series of deep pits and grooves are present in the lateroventral surface of the bone, whereas in MN 7070-V this area is smooth and displays shallow grooves. All specimens are similar in size and probably also in age. The morphological variation observed suggests more than one species within the genus. However, the fragmentary nature of most fossils associated with *Hamadasuchus* hampers a reliable taxonomic decision.

Grant Information:
CNPq, FAPERJ, FAPES.

Technical Session XIV (Friday, August 25, 2017, 3:00 PM)

CORTICAL VS TRABECULAR BONE AND THE SPECIALIZED KILLING BITE OF SABER-TOOTHS

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The repeated evolution of elongate and laterally compressed (saber-like) canine teeth in different lineages of carnivorous mammals is one of the most spectacular cases of convergent evolution towards a specialized killing behavior. Although scimitar-toothed and dirk-toothed sabertooths have been traditionally identified as different ecomorphs, it is not clear whether these morphs deployed different killing bites. Here we use histologically-based algorithms to quantify the volume of cortical and trabecular bone in coronal sections of complete skulls to create biomechanical profiles of the 'scimitar-toothed' Homotherium serum and in the 'dirk-toothed' Smilodon fatalis, as well as in a comparative sample of living carnivores, including the 'conical-toothed ' Panthera leo. Whereas trabecular bone is well suited to deal with continuous and repetitive loads, cortical bone is better able to dissipate larger, more localized stresses. Our data indicate that Smilodon has much thicker cortical bone in its rostrum than other taxa. In the posterior region of the skull, cortical bone thickness is similar in Homotherium and Smilodon, but greater than in P. leo. In the same region, the trabecular bone in Homotherium is thicker than in Smilodon but thinner than in P. leo. Our results suggest that the two ecomorphs of saber-tooths differ in the distribution and quantity of cortical and trabecular bone across their skulls, reflecting different behaviors during prey dispatch. The thickened rostrum of Smilodon suggests that it deployed one or two very strong killing bites with its canines, whereas Homotherium might have used multiple, less forceful slashing bites. This suggests that the saber-tooth killing repertoire was more complex than previously suspected.

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Technical Session XIX (Saturday, August 26, 2017, 3:45 PM)

DINOSAUR ICHNOLOGY AND PALEOENVIRONMENTS FROM THE CHIGNIK FORMATION (ANIAKCHAK NATIONAL MONUMENT, LATE CRETACEOUS, SOUTHWESTERN ALASKA)

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While there are now numerous records of dinosaurs from Cretaceous rocks around the state of Alaska, very few fossil records of terrestrial vertebrates are known from the Mesozoic rocks of the southwestern part of the state. Here we report the new discovery of extensive occurrences of dinosaur tracks from exposures of the Cretaceous Chignik Formation in Aniakchak National Monument of the Alaska Penninsula. These tracks are in the Late Cretaceous (Maastrichtian) Chignik Formation, a cyclic sequence of rocks, approximately 500 – 600 m thick, representing shallow marine to nearshore marine environments in the lower part and continental alluvial coastal plain environments in the upper part of the section. These rocks are part of the Peninsular Terrane and paleomagnetic reconstructions based on the volcanic rocks of this terrane suggest that the Chignik Formation was deposited at approximately its current latitude which is almost 57 degrees N.

A recent expedition in Aniakchak National Monument has revealed over 30 new track sites, dramatically increasing the dinosaur record from the Alaska Penninsula. The track assemblage from this part of the Chignik Formation is dominated by the footprints of hadrosaurian dinosaurs. The hadrosaur tracks range in size from those made by likely full-grown adults to juveniles. Rare tracks attributable to ankylosaurs are also known from the new localities.

Previous interdisciplinary sedimentologic and paleontologic work in the correlative and well-known dinosaur bonebeds of the Prince Creek Formation 1400km-1500km further north in Alaska suggested that high-latitude hadrosaurs preferred distal coastal plain or lower delta plain habitats. The current interdisciplinary paleontologic and sedimentologic project in the Chignik Formation finds that hadrosaur tracks here were also made in distal coastal and delta plain conditions. This similarity may corroborate the habitat preference model for Cretaceous high-latitude dinosaurs proposed for the data gathered from the Prince Creek Formation.

Technical Session VI (Thursday, August 24, 2017, 10:15 AM)

NEW DIADECTOMORPH COTYLOSAUR MATERIAL FROM THE MIDDLE CLEAR FORK FORMATION, LOWER PERMIAN OF TEXAS

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Diadectomorphs are late Paleozoic tetrapods that include the oldest known high-fiber terrestrial herbivores. Oral processing in diadectid diadectomorphs was accomplished via tooth-on-tooth wear using transversely expanded, molariform teeth. Diadectomorph material is known from the Permo-Carboniferous of the U.S. Southwest and Germany, as well as the Upper Permian of China.

In North America, the diadectomorph record extends from the latest Carboniferous to late Early Permian, with the latest appearance represented by a single vertebra collected from the middle Clear Fork Formation and described by E. C. Olson over 60 years ago. Collections from a new site in the same formation, the Mud Hill locality in Knox County, Texas, have yielded numerous diadectomorph elements representing several individuals. Assignment to Diadectidae is based on the preservation of several dentigerous elements bearing transversely-expanded molariform teeth. Additional elements include a parabasisphenoid, vertebral elements, an ilium, a humerus, a femur, a tibia, and fragments of these and other elements. Subadult status is indicated by the poorly ossified ends of the propodials. Tooth marks are present on distal and proximal ends of some limb bones, where the bone would have been more exposed to teeth in comparison to other, fleshier parts of the limb. The diadectid, therefore, appears to have been scavenged by another tetrapod, as has been inferred previously for varanopid synapsid remains described recently from the same locality.

These Mud Hill diadectid specimens augment the meagre material described by Olson in 1956 and confirm that diadectids extend well into the time represented by the middle Clear Fork Formation. Thus, diadectids outlived the other archaic members of the classic Early Permian terrestrial fauna, such as edaphosaurid synapsids, ophiacodontid synapsids, and microsaurian lepospondyls, and continued for a time as elements of the succeeding fauna characterized by varanopid synapsids, caseid synapsids, and moradisaurine captorhinids.

Grant Information:
Natural Sciences and Engineering Research Council Discovery Grant.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

INFERRING BEHAVIORAL AND SOCIAL ORGANIZATION IN FOSSIL ANTILOCAPRIDAE

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Extant Artiodactyla display a range of social grouping and feeding habits. This degree of social organization is correlated to body size and species threat response and is expressed in the shape and complexity of headgear. Consequently, previously categorized extant taxa allow inferences to be made for extinct taxa and to be established into organizational groups. With fossil diversity greater than extant, antilocaprids were often a dominant ungulate of North American Neogene ecosystems, making modern artiodactyls a reasonable analogue. This analysis uses previously established categories to assign extinct antilocaprid taxa to ecological and behavioral classes on the basis of headgear shape. In bovids, straight horns are associated with open environments and smooth horns that curve medially and posteriorly to the boss are associated with closed environments. For cervids, antlers with 2-5 tines are associated with a closed environment because a more complex structure with more tines is likely to limit freedom of movement. Behaviorally, the known implication for bovids and cervids is that intraspecific fighting over mate access influences headgear shape. Applying these same classes to fossil genera like *Ramoceros*, with its 2-5 tined antler-like headgear, or *Sphenophalos* and *Osbornoceros,* with lateral- and posterior-facing tines, our results would find them in open grassy environments. Pronged or deer-like headgear suggests classification into categories with large groups of females and a single territorial male or large, migrating herds. These categorizations provide hypotheses for testing behavioral and environmental constraints with additional lines of evidence from the fossil record. Smaller extinct taxa with fewer tines and shorter headgear (e.g.: *Capromeryx*, *Plioceros*, *Ottoceros*) fall into classes with smaller, more territorial social groups found in more complex vegetated environments. Smaller groups imply less competition for mates and less complicated intraspecies fighting. The results from a categorized fossil fauna that is far more diverse than today allows for analyzing these behavioral traits in evolutionary context as we study the decline of antilocaprid diversity.

Technical Session X (Friday, August 25, 2017, 10:45 AM)

A NEW MIDDLE JURASSIC METRIORHYNCHID AND ITS IMPLICATIONS FOR MACROPREDATORY ORIGINS AND EVOLUTION

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Metriorhynchids are an extinct group of Jurassic-Cretaceous crocodylomorphs that secondarily adapted to a marine lifestyle. They were major component of Mesozoic marine ecosystems, and one particular subgroup, the Late Jurassic Geosaurini, was ecologically important as a major group of predators at or near the top of the food chain. While the Late Jurassic derived taxa of this sub-clade (*Torvoneustes*, *Plesiosuchus, Dakosaurus* and *Geosaurus*), are thought to be closely related, they evolved distinct craniomandibular and dental adaptations linked to macrophagy. However, the time of origin and evolution of these important characters within each lineage is currently not well understood, particularly because of several Middle Jurassic specimens in need of rigorous re-description.

Here, we describe one of these specimens (NHMUK PV OR 46797) from the Oxford Clay Formation (Callovian, Middle Jurassic) of England, which adds valuable information on the timing of Geosaurini evolution. We identified a series of autapomorphies and a unique combination of characters that warrant the creation of a new genus and species. This is confirmed by our phylogenetic analysis, which places this new taxon as sister to the Late Jurassic–Early Cretaceous genus *Geosaurus*. This new specimen, combined with an improved understanding of several long-overlooked and misinterpreted specimens, clarifies the interrelationships of Geosaurini, which was initially thought to have evolved and radiated during the Late Jurassic. In particular, the phylogenetic re-evaluation of *Suchodus durobrivensis* as a *Plesiosuchus* sister taxon and recently identified Callovian *Dakosaurus*-like specimens in the Oxford Clay Formation (Callovian, Middle Jurassic), and the key position of *Tyrannoneustes* at the base of a *Torvoneustes* sub-clade, have important implications for the evolution of Geosaurini.

First, and most importantly, the four major lineages of geosaurins culminating in the terminal taxa *Torvoneustes*, *Plesiosuchus, Dakosaurus* and *Geosaurus* originated earlier than previously supposed, and were already present in the Callovian. It follows that numerous craniomandibular and dental adaptations linked to macrophagy independently evolved within each individual lineage. Specifically we demonstrate that four different true ziphodont morphologies in the derived Late Jurassic geosaurins independently evolved from a unique non-functional microziphodont common ancestor.

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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

A LONG-NECKED TANYSTROPHEID FROM THE MIDDLE TRIASSIC MOENKOPI FORMATION GIVES INSIGHTS INTO THE BIOGEOGRAPHY AND ECOLOGY OF TANYSTROPHEIDS

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The end-Permian extinction paved the way for subsequent diversification of the surviving reptiles, particularly archosauromorphs. By the Late Triassic, archosauromorphs were highly diverse, disparate, and widespread across Pangaea. However, the early patterns of diversification, biogeography, and the ecologies of these Middle Triassic archosauromorphs remain poorly understood. Tanystropheids are one such clade of extinct archosauromorphs that ranged from the late Olenekian (~249 Ma; *Augustaburiania*) to the middle Norian (~212 Ma; unnamed Hayden Quarry tanystropheid). They are unique in form because some members of the clade have extremely long cervical vertebrae that are autapomorphic. Here we describe four partial cervical vertebrae from a large-bodied tanystropheid from the Middle Triassic (Anisian) Moenkopi Formation of Arizona and New Mexico. This material includes a nearly complete axis, two partial cervical vertebrae (an anterior and posterior portion, respectively), and one well-preserved centrum. These cervical vertebrae are assigned to Tanystropheidae based on the following combination of character states: the centrum is at least five times longer than tall; presence of a dorsoventrally low and anteroposteriorly elongate neural arch; the dorsal surface of the neural spine is flat; and presence of epipophyses. More exclusively, the Moenkopi tanystropheid shares apomorphies of the extremely long-necked tanystropheids (e.g., *Tanystropheus longobardicus*) including the presence of an extremely hollow centrum, anteroventral-posterodorsal inclination of the anterior articular surface, and an axis centrum that is more than three times longer than tall. However, it lacks a ventral keel in the post-axial vertebrae like that present in *Tanystropheus*. These cervicals were found in the Holbrook and Anton Chico members of the Moenkopi Formation, both fluvial sequences consisting of sandstones and mudstones without any marine influence. Thus, the Moenkopi tanystropheid represents the first large-bodied, long-necked form found in a clearly fluvial sequence, well separated from marine environments common to *Tanystropheus*. Biogeographically, the new specimens are the first to occur on the far western portion of Pangaea at low latitudes. The discovery of these cervicals adds to the growing body of evidence that the North American tanystropheids lived in varied environments, possessed disparate body sizes, and persisted through much of the Triassic Period.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A PRELIMINARY U-PB ZIRCON AGE FOR THE FRUITA PALEONTOLOGICAL AREA MICROVERTEBRATE LOCALITIES, UPPER JURASSIC MORRISON FORMATION, MESA COUNTY, CO

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The Fruita Paleontological Area (FPA) in Mesa County, Colorado, is a Bureau of Land Management protected research area that contains several important microvertebrate fossil localities in the Upper Jurassic Morrison Formation. Discovered in 1975, the area has been worked by many researchers and institutions and has yielded a diverse fauna. More than 20 localities have been discovered in the FPA, and several of these have produced holotype and paratype specimens.

As part of the Morrison Formation Dating Project, we collected smectitic mudstone from the fossil-bearing horizon of FPA Quarry 4, one of the main microvertebrate localities. This locality is at a similar stratigraphic level to another important locality within the FPA, Tom’s Place. We processed this mudstone using manual and ultrasonic disaggregation techniques as well as standard heavy-liquid and magnetic separation methods. The resulting heavy-mineral separation was hand-picked under a microscope, and selected single zircons with specific morphologies typical of ash-fall zircons such as elongate tips, longitudinal bubble tracks, and transverse channels were chosen for analysis using the CA-TIMS method. At present one zircon crystal has been analyzed, and several more are awaiting analysis. An age of 152.0 ± 0.3 Ma has been obtained for this single zircon crystal, and a second crystal gave a similar age. We are optimistic that the other zircons we have selected for analysis will produce overlapping ages and will result in a single, high-precision age for these localities.

This preliminary age allows direct correlation with another important microvertebrate locality in the Morrison Formation, Reed’s Quarry 9 at Como Bluff, WY. Quarry 9 has been dated using U-Pb CA-TIMS methods as 152.51 ± 0.47 Ma, and thus the localities overlap in age. These localities previously were not thought to be so close in age, as Quarry 9 is high in the local section at Como Bluff and the FPA microvertebrate localities are much lower relatively. The two areas share 6 genera as well as many other higher-level taxa, and work is underway to complete paleoecological comparisons between the areas.

Our preliminary radiometric age for the FPA microvertebrate localities will be fine-tuned in the near future, and it will add valuable information for decoding the complex stratigraphic and paleoecological relationships among microvertebrate localities in the Morrison Formation.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ENAMEL MICROSTRUCTURE IN LAGOMORPHA (MAMMALIA: GLIRES): IN THE SEARCH OF FUNCTIONAL AND PHYLOGENETIC IMPLICATIONS

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Lagomorphs of the modern aspect are small herbivore mammals currently known in the fossil record since the late Early Eocene of Asia. Their upper and lower incisors are open-rooted and ever-growing, the cheek teeth express variously developed hypsodonty and also grow continuously. We studied the enamel microstructure of the molars and incisors in 20 species of fossil Lagomorpha, ranging from the late Middle Eocene to the Pliocene. We focused on *Palaeolagus*, the most speciose Paleogene North American genus, and on the early Miocene European ‘amphilagids’. The incisor enamel in most of the stem taxa (and crown Leporidae) is simple and single-layered, consisting of the decussating enamel showing Hunter-Schreger Bands (HSB). Advanced ‘amphilagids’ (*Titanomys*) and *Piezodus* show two-layered incisor enamel with the radial internal and decussating external portion, respectively. The molar enamel is more complex and changes along the tooth perimeter. The main shearing edge at the anterior margin of the tooth or at the

posterior margin of the trigonid (in upper and lower molars, respectively) is the thickest (up to 320 µm in *Megalagus*) and most complex. In all studied species it is two-layered, with the thicker internal layer consisting of the radial enamel and the external layer of the decussating enamel. The decussation in the external layer is extremely weak in *Mytonolagus*, *Megalagus turgidus* and *Desmatolagus*, while it is best expressed in all studied species of *Palaeolagus* and 'amphilagids'. Molars of *Amphilagus*, *Megalagus*, and *Palaeolagus* show the internal radial layer differentiated into two sub-layers of different prism inclination. *Megalagus brachyodon*, *Palaeolagus temnodon*, *P. haydeni*, and *P. burkei* share overall similarity in the enamel structure. However, the enamel structure in *Megalagus turgidus* is almost identical with that of *Mytonolagus*, but the enamel is twice as thick as in the latter. The enamel structure of European amphilagids is similar to that of paleolagids, although the external layer is simpler. Among all studied *Palaeolagus* species, the enamel of *P. intermedius* is most advanced structurally, with irregular enamel in the external layer (resembling that of crown lepords). The enamel structure may be helpful in establishing relationships between morphologically similar taxa (e.g., *Megalagus brachyodon* and *M. turgidus*), which however, may not form a phyletic lineage. Finally, our research suggest that there is no obvious relationship between the enamel structure and degree of hypsodonty in the studied genera.

Grant Information:
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Technical Session XVI (Saturday, August 26, 2017, 11:15 AM)

THE OLDEST "*CHASMOSAURUS*"? A NEW SKULL FROM THE JUDITH RIVER FORMATION OF MONTANA

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In 2012, the partial skeleton of a chasmosaurine ceratopsid dinosaur (MOR 6635) was collected from Kennedy Coulee, Hill County, Montana, from the lower Judith River Formation (JRF; middle Campanian, Cretaceous; 79.52 to 79.22 Ma recalibrated Ar / Ar dates; lithostratigraphic equivalent to Unit 1 of the Oldman Formation, Alberta). Although fragmentary, the remains suggest MOR 6635 represents the oldest known member of the *Chasmosaurus* lineage, revealing the influence of heterochrony on morphological evolution of the parietosquamosal frill. MOR 6635 comprises a left squamosal with fused episquamosals, left lateral / transverse bar of the parietal, left jugal with fused epijugal, left pterygoid, isolated teeth, tibia, fibula, and fragmentary ribs and tendons. The squamosal is posteriorly elongate, (permitting referral to Chasmosaurinae) and articulates with the narrow and strap-like parietal fragment. This demonstrates that the posterior border of the parietal was rounded in shape, extending posteriorly far beyond the end of the squamosal, with a laterally facing epiparietal (ep) 3 locus and posterolateral ep2 locus. This is most similar to specimens referred to the disputed taxon *Mojoceratops perifania* (AMNH 5656; TMP 1983.25.1) from the lower Dinosaur Park Formation, Alberta, ~2 m.y. younger than MOR 6635. MOR 6635 is comparable to parietal fragments from the lower JRF recently described as *Judiceratops tigris*. However, it is unclear whether material referred to *Judiceratops* is diagnostic, or if all referred specimens pertain to the same taxon. If indeed the same taxon, then the reconstruction of the parietal of *Judiceratops* would need to be significantly altered. Phylogenetic analysis recovers MOR 6635 as a basal chasmosaurine in a polytomy with *Agujaceratops*, *Mojoceratops*, and *Chasmosaurus russelli*. MOR 6635 exhibits characters consistent with subadult status (elongate squamosal; fused episquamosals; broad blunt episquamosals; fused epijugal), whereas morphologically similar specimens referred to *Mojoceratops* exhibit characters indicative of immature or juvenile status (small size; lack of cranial fusion, pointed and/or unfused frill epiossifications; crenulated frill margin; squamosal only weakly elongated; lack of resorption of postorbital horns). This suggests that similarity between the two forms may be representative of heterochrony with the rounded parietal posterior border of the subadult MOR 6635 subsequently exhibited only in less mature specimens of the ~2m.y. stratigraphically younger *Mojoceratops.*

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DENTAL ERUPTION SEQUENCE FOR LIMNOCYONINE HYAENODONTANS (CREODONTA)

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Little is known about the dental eruption sequences of creodonts, a clade of carnivorous eutherian mammals that are widely distributed in the Paleogene. Previous work with hyaenodontan creodonts used x-rays to examine dental eruption in hyaenodontine and proviverrine hyaenodontans. Here, we use CT scans to investigate the dental eruption sequence of *Thinocyon medius*, a limnocyonine hyaenodontan creodont. UCMP 55580 is a well-preserved lower jaw of a juvenile *Thinocyon medius* bearing deciduous and permanent teeth from "Bridger C" or the Twin Buttes Member of the middle Eocene Bridger Formation, Wyoming. CT data allowed us to refine previous interpretations of the *Thinocyon* dental eruption sequence as well as measure differences in crown and root development and document the relationship between deciduous and replacement teeth with more detail. The inferred dental eruption sequence based on the developmental stage is m1/dp1/i1/i2/i3-m2-p2-c-p3/p4.

Limnocyonines are unique among hyaenodontans in having reduced or missing third molars. However, comparing dental eruption patterns among hyaenodontans with three molars, *Thinocyon* shares similarities to European hyaenodontan *Hyaenodon*, for which dental eruption sequences in creodonts are most well known. Our finding lends support to the idea that the tooth eruption pattern shown by European *Hyaenodon* is the primitive pattern. Understanding dental eruption sequences is important for a number of reasons including phylogenetic signal and information on the life history of the animals studied. Dental eruption patterns are one piece of information in the puzzle of understanding the primitive conditions of creodonts and where they fit among mammals.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A TALE OF TWO FAUNAS: SMALL MAMMAL PALEOECOLOGY WITHIN AND AMONG PROJECT 23 DEPOSITS AT RANCHO LA BREA

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Recently discovered asphaltic fossil deposits at Rancho La Brea (Los Angeles, California, USA), collectively named "Project 23", provide new opportunities to study microvertebrates with improved spatial and temporal context for this site. Our goal for this project is to understand ecological dynamics within the small mammal assemblage in the region over thousands of years, especially whether niche tracking of changes in the local habitat and environment facilitated species persistence through time. Here, we report on the small mammal faunas from two excavated Project 23 deposits (1 and 14), including assemblage composition, radiocarbon dates, and preliminary isotopic analyses that elucidate the dietary niche of two taxa. A minimum of 17 genera, including members of Rodentia, Lagomorpha, Eulipotyphla, and Carnivora, have been identified after sampling matrix from each grid and level throughout both deposits. Most fossil representatives occur (presently or historically) near Los Angeles. However, at least one taxon (*Microtus townsendii*) is now extirpated from Southern California. In addition, there are marked differences in the relative abundance of taxa between the two deposits, which date several thousand years apart when averaged across all dated materials. For example, cricetid rodents including *Peromyscus* are most common within Deposit 14, which dates to >50 – 43 thousand calibrated years before present (ka BP), while *Sylvilagus* dominate the Deposit 1 fauna (~ 43 – 39 ka BP). These data suggest that small mammal community composition may have been less static through time than previously hypothesized for this site. Preliminary isotope analyses on a subset of *Sylvilagus* and *Otospermophilus beecheyi* from Deposit 1 indicate values within expectations for a C_3-based diet, with variation among *Sylvilagus* individuals. Additional radiocarbon dates and stable carbon/nitrogen isotope analyses should elucidate whether local environmental changes may have facilitated these changes in community structure over time. We will continue to date and isotopically analyze specimens from these faunas, and initiate sampling on additional Project 23 deposits to determine whether small mammal community composition and taxon-specific niche breadth change significantly between deposits and through time at Rancho La Brea.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

MOLD AND CAST FIDELITY AND DATA LOSS IN DENTAL MICROWEAR TEXTURE ANALYSIS

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Most dental microwear studies examine tooth casts. Tests of the underlying assumptions about the fidelity of molding and casting compounds have not kept pace with the field. Much remains to be known about the how resolution is influenced by data loss associated with studying casts and how this affects dietary discrimination. To measure resolution lost associated with casting wear surfaces, we evaluated ISO 25178 roughness parameters at magnifications 20x, 50x, and 150x from identical locations of real teeth and clear epoxy casts of experimentally fed rat M2s using a Sensofar PLU Neox white light confocal. The rats were fed one of two transgenic dough diets purchased with either quartz sand or diatomaceous earth added. Clear casts were made from standard dental microwear materials and methods using President Jet Regular body molding compound and Epokwick Epoxy Resin. In paired t-tests of 24 ISO roughness parameters, significant differences were found in parameters between teeth and casts. At 150x, significant differences were with among nine parameters including height parameters (Sq, Sp, Sv, Sz, Sa), hybrid parameters (Sdq, Sdr), one volume parameter (Vmc), one material ratio parameter (Smr). No differences were found among other families of parameters (Spatial, Feature). At 50x, 10 parameters were found to significantly differ, including height parameters (Sq, Sp, Sv, Sz, Sa), hybrid parameters (Sdq, Sdr), a volume parameter (Vmc, Vvc), and a material ratio parameter (Smr). At 20x differences were found among fewer height parameters (Sp, Sv, Sz), the same hybrid parameters (Sdq, Sdr), and a different volume parameter (Vmp). 150x and 50x yielded similar results, while fewer significant results were found at 20x suggesting the differences between teeth and casts are less apparent at low magnification. Six roughness parameters were significantly different between the two diet groups (dough-with-sand or dough-with-diatomaceous-earth) among the data generated from real teeth. Examination of casts at the same magnification found significant differences in only three parameters between the feeding groups. These results suggest that casting leads to significant alterations of microwear texture and these differences are more apparent at higher magnifications. Likewise, analyses of real tooth surfaces may lead to greater discrimination of diet-specific dental wear patterns in comparison to casts. Future dental microwear studies need to consider the potential of data loss associated with casting dental wear surfaces.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

CONSULTING PALAEONTOLOGY IN ALBERTA: PROCESS, METHODS AND RESULTS OF HISTORICAL RESOURCE IMPACT ASSESSMENTS FOR INDUSTRY

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Consulting palaeontology has a 44 year history in Alberta, starting with passage of the *Alberta Heritage Act* in 1973 (now the *Historical Resources Act*). The *Act* states that historic resources (historic structures, archaeological and palaeontological resources) must be protected as part of Alberta's natural and cultural history. Any project that may impact palaeontological resources may require an assessment to be conducted by a consulting palaeontologist on behalf of the proponent. The process to determine this begins with the submission of a Historic Resources Application to Alberta Culture and Tourism (ACT), the regulatory agency for historic resources in Alberta. These applications can include a Statement of Justification (SoJ), a brief desktop report, to assist with the review process. The SoJ includes project details, the potential of the project to impact palaeontological resources, a listing of palaeontologically sensitive lands within the project area and recommendations for mitigation, if necessary. If recommendations are accepted, mitigation requirements are issued by ACT. Palaeontological Research Permits are issued by the Royal Tyrrell Museum of Palaeontology and any collected fossils are curated there.

Three consulting projects, a water intake development, a proposed oil sands lease, and a wind farm, are discussed here as examples of successful consulting projects. The water intake was located along the Athabasca River in the Alberta oil sands. Several hundred ammonites, gastropods and bivalves from the early Cretaceous Clearwater Formation were collected during monitoring and two distinct facies identified. Detailed lithological data and intact fossils are rare from this formation as the shale erodes quickly in natural outcrops. The proposed oil sands lease project was an initial assessment of early to late Cretaceous bedrock in the Birch Mountains. The area is remote and could only be accessed by helicopter. It had never been examined for fossils and four weeks of prospecting yielded approximately 1400 kg of ammonites, bivalves, shark and fish fossils. The wind farm project involved monitoring of turbine footing excavations in southern Alberta through bedrock of the late Cretaceous St. Mary River Formation. Several microsites and small bonebeds were identified and collected during monitoring. This formation typically has few natural exposures and fauna collected from this project bridged the paleoenvironmental gap between fauna from two other localities.

Technical Session IV (Wednesday, August 23, 2017, 2:00 PM)

TOOTH WEAR DIETARY PROXIES SHOW STRONG PHYLOGENETIC SIGNAL

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The Eltonian niche specifically describes the trophic or dietary niche of a species. Numerous neoecological and palaeoecological studies use dietary indicators to estimate the Eltonian niches of extant and extinct species. One of the most widely employed set of approaches is to estimate Eltonian niches using tooth wear (alteration chewing surfaces as a result of interactions with food and opposing teeth). The tooth wear data are then often correlated with directly observed dietary data from a reference population or sample of species (the training dataset) under the assumption of taxon or phylogenetic independence. As a result, phylogenetic relatedness is rarely accounted for in studies of extant and extinct mammal diets, which may be problematic if closely-related species show strong overlap of their Eltonian niches (trophic phylogenetic niche conservatism or PNC). An assumption of "taxon independence" may become particularly troubling when investigators rely on p-values to distinguish amongst species in different dietary guilds or at different trophic levels; phylogenetic autocorrelation can increase type I error rates. To test whether trophic PNC is apparent in tooth wear, we synthesized tooth wear data (mesowear, low magnification microwear, 3D texture microwear) from a variety of published sources. To test for the phylogenetic heritability of tooth wear, we used phylogenetic generalized linear mixed-effect models and calculated phylogenetic heritability (H^2), which ranges from 0 (not heritable) to 1 (highly heritable). We show that all tooth wear metrics are strongly heritable ($H^2 > 0.5$), including microwear, which is most often described as "taxon free." We suggest that phylogenetic conservatism of the traits that determine the form of the chewing stroke (e.g., masseter size and orientation) and tooth shape (e.g., the orientation of cusps and enamel bands) strongly influence the ways in which the teeth wear. Thus, we recommend that, when possible, phylogenetic relatedness be taken into consideration when inferring the Eltonian niches of extant and extinct species. These statistical interventions can include phylogenetic comparative methods and ordination (e.g., phylogenetically independent contrasts, DFA, or generalized least squares). We also suggest that, in the absence of phylogenetic information, taxonomic data be used to reduce the effects of statistical non-independence amongst phylogenetically similar species.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THEROPOD ECOLOGY OF THE MIDDLE CRETACEOUS: DIET AND HABITAT PREFERENCE IN SMALL TO MEDIUM-SIZE PREDATORS FROM THE UPPERMOST CEDAR MOUNTAIN FORMATION OF UTAH, U.S.A.

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Niche partitioning is an ecological phenomenon wherein multiple competing organisms are able to coexist in the same ecospace by maximizing their occupation of non-overlapping lifestyles. Although generally well-documented in modern species, finding examples in Mesozoic ecosystems has been historically challenging. In this study, we investigated the hypothetical ecologies of multiple theropods derived from the Upper Cretaceous Mussentuchit Member of the Cedar Mountain Formation of Utah. The samples for this study come from six microsites, ranging in depositional setting from distal floodplain to channel lags. In total 866 teeth were analyzed, of which 309 were found to represent four unique tooth morphotypes: a large theropod, a medium-sized dromaeosaurid, a small dromaeosaurid, and a tooth-morph similar to the genus *Richardoestesia*. The four morphotypes vary significantly in mean size, from 15.1 mm in the large theropod (5.2–34.7 mm) to 3.7 mm in *Richardoestesia* (2.1–7.6 mm). Further, tooth representation from two of the best-sampled microsites show differing patterns. The large theropod teeth are about twice as common in the floodplain environment (V695, n=133) as compared to the splay/channel (V794, n=104); while medium-sized dromaeosaurid teeth are more than three times as common in the floodplain. Small dromaeosaurid teeth show little difference between the sites (30.8% to 38.45%), but *Richardoestesia* teeth increase more than three-fold in abundance from the floodplain to the splay/channel (12.8% to 41.3%). Preliminary sedimentological and taphonomic data suggest that sorting bias is not responsible for the observed faunal difference. Stable carbon isotope ($\delta^{13}C$, VPDB) analysis of carbonate in specimens from V794 show that *Richardoestesia* teeth tend to have the most depleted values (-6.44‰ to -1.82‰; avg. -3.77‰; n=3), while large theropod teeth are often the most enriched (-4.38‰ to -0.06‰; avg. -2.16‰; n=5); however, given small sample sizes we take the results as suggestive rather than indicative. Taken as a whole, we hypothesize that the Mussentuchit *Richardoestesia* likely had different habitat preferences, and presumably a different niche within the predator guild than the other theropods, hypothetically feeding in aquatic environments. The large theropod and medium-sized dromaeosaurid likely fed more terrestrially, while the small dromaeosaurid was more cosmopolitan. These lines of evidence all suggest plausible means by which ecospace was divided among the predatory dinosaurs of the Mussentuchit local fauna.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ON THE POTENTIAL COEVOLUTION OF ANKYLOSAURS AND THEROPODS

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Ankylousauria is a clade of armoured dinosaurs that, throughout the Mesozoic, demonstrate divergent evolution of defensive traits, between the robust nodosaurid spikes and osteoderms to the ankylosaurid tail clubs and lightweight armour. One of the longer-standing hypotheses - supported by histological data - stipulates that armament was a direct result of the predator-prey relationship between ankylosaurians and theropods. Such a hypothesis predicts that predatory pressures from Theropoda maintain, select, and drive the evolution of armament. Here we investigate the coevolutionary hypothesis in a phylogenetic context by searching for reciprocal selection and clade interactions. We undertake two separate analyses. The first is a host-parasite test (parafit), which tests, within a phylogenetic framework, the null hypothesis that the evolutionary history of two groups was independent. The second quantifies theropod dental crown height and body mass and visually compares their evolutionary patterns with changes in armour-related characters throughout the ankylosaurian tree. The analysis was conducted across 52 theropod species that were sympatric, in formation, with 44 ankylosaur species. The results of the parafit test suggest strong evolutionary links (global test: p=0.001) between Ankylosauridae and Tyrannosauridae, but not with Nodosauridae. As ankylosaurids replace nodosaurids in Asia during the Mid-Cretaceous this may be representative of local predators escaping from the classical arms race, necessitating a change in prey defensive strategy. The support for this lays in the different defensive strategies, and the abundance of Nodosauria in Gondwana, outside of the range of Tyrannosauroidea. Results of the trait analysis reveal that changes in theropod mass and tooth size, approximately, match the onset of discrete character shifts (such as the emergence of the tail club and its increased proportional width compared to its length). However, at this time, these associations remain qualitative. This study lays the groundwork for investigating coevolution between Ankylosauria and Theropoda within a phylogenetic context, but further investigation of phenotypic changes in Theropoda, and theropod-ankylosaur interactions, will be required to positively identify theropod traits that could have arisen as a specific response to ankylosaur armament.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

FIRST RECORD OF THE CHINESE CAPTORHINID *GANSURHINUS* IN THE LATE PERMIAN OF GERMANY

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The Korbach locality in northern Hesse (central Germany) represents the only tetrapod-bearing fissure filling from the upper Permian. This fissure formed in a marine carbonate during a local regression in the Changhsingian; it is tightly stratigraphically constrained by an overlying marine clay and is highly fossiliferous. Thus far, only the otherwise African cynodont *Procynosuchus* has been definitively reported from this fauna. Recent preparation of the extensive collections recovered from Korbach during the 1990s has established the presence of a very diverse late Permian continental tetrapod assemblage. Among these fossils are the remains of a large captorhinid reptile with strong dermal sculpturing on the cranium and multiple tooth rows in the maxilla and mandible. The dentition of the Korbach captorhinid is remarkable in having swollen bases of the tooth crowns, narrowing apically and terminating in strongly recurved tips. This morphology is otherwise known only in the middle-late Permian taxon *Gansurhinus qingtoushanensis* from the Dashankou and Naobaogou faunas of China. The discovery of *Gansurhinus* in Korbach provides the first evidence of tetrapod faunal connections between western Europe and east Asia in the Permian. Previous evidence for a broadly "Eurasian" Permian tetrapod fauna was based mainly on connections between the Chinese and Russian assemblages (e.g., the shared presence of the middle Permian bolosaurid *Belebey*). However, the presence of both *Procynosuchus* and *Gansurhinus* in the Korbach locality indicates a complex biogeographic pattern in late Permian tetrapods. Although some

Gondwanan elements may actually have had cosmopolitan distributions by the end-Permian (e.g., *Procynosuchus*), there also appear to be distinctly Eurasian faunal components that have never been found in the well-sampled basins of southern Africa.
Grant Information:
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Podium Symposium (Wednesday, August 23, 2017, 8:45 AM)

PREAXIAL POLARITY IN TETRAPOD LIMB DEVELOPMENT AND EVOLUTION

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The evolution and development of the tetrapod limb has been researched extensively in the past decades and the limb as no other organ system has served as a model for understanding the interplay of evolution and development. An extensive body of data shows that tetrapod limb development is generally speaking a rather conservative process with respect to the molecular markers involved and the order of events in early limb development as well as the pattern of skeletogenesis. It is therefore rather surprising that salamanders deviate from this conservative pattern in showing a reversed, preaxial patterning of skeletal limb elements. Because salamanders are the only extant tetrapods displaying this pattern, preaxial polarity was classically considered a derived character, albeit the underlying molecular control and the evolutionary history of this pathway remained elusive. While gene expression patterns in early phases of salamander limb development appear to be canonical, salamanders show distinct difference from other tetrapods in late phases of limb development when the autopod is established. These include non-canonical expression patterns of members of the *Shh*-pathway as well as late phase Hox genes, in particular *HoxA11* and *Hoxd13*. In addition, the fossil record shows that preaxial polarity in limb development was not only present in the derived temnospondyl dissorophoid *Apateon*, but also in the coeval basalmost dissorophoid *Micromelerpeton* as well as a more distant relative, the stereospondylomorph *Sclerocephalus*. This suggests that preaxial polarity in limb development was widespread among members of the temnospondyl lineage and may be plesiomorphic for this clade or even tetrapods as a whole. The differences in late phase gene expression patterns in salamander limb development compared to other tetrapods suggest that heterochronic changes in limb development and/or larval adaptations may have played a role in the establishment of or maintenance of preaxial polarity in limb development early on in the evolutionary history of tetrapods.
Grant Information:
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Technical Session XIII (Friday, August 25, 2017, 2:30 PM)

A NEW OVIRAPTORID (DINOSAURIA: THEROPODA) PROVIDES A RARE GLIMPSE INTO SOCIAL BEHAVIOUR IN DINOSAURS

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The Nemegt Formation of Southern Mongolia is one of the richest dinosaur-producing formations in the world. At least 30 genera are known from the Nemegt Formation, including ankylosaurs, hadrosaurs, sauropods, and theropods. Tghe abundance of these deposits has unfortunately attracted the attention of fossil poachers, and dozens of poached skeletons are suspected to hail from the Nemegt Formation. In 2006, Mongolian customs officers confiscated two important poached specimens. The first is a spectacular block of three articulated juvenile skeletons, representing a new species of oviraptorid theropod. This new taxon is characterized by a domed cranial crest, a functionally didactyl hand, and a short tail. In addition to the skeletons in the block, the second poached skeleton is an even younger individual. An unpoached, partial adult skeleton from Guriliin Tsav verifies the suspected provenance, and together the skeletons constitute an excellent ontogenetic series. This series indicates that the cranial crest is present early in development, and is positively allometric. Appendicular skeletal proportions change little throughout ontogeny, but the tail becomes relatively shorter and the chevrons longer. Additionally, the pygostyle fuses throughout development, which is consistent with its proposed function as a sexual display structure. In addition to anatomical and ontogenetic insights, the skeletons in the block are important for our understanding of oviraptorid and theropod behaviour. The three individuals are in sleeping posture, and would have been in contact in life. In addition to a remarkable instance of behaviour captured in the fossil record, the specimens also represent the first evidence of communal roosting in dinosaurs. The evolutionary origins of communal roosting in modern birds are debated, and this specimen highlights the possibility that this behaviour was inherited from their dinosaurian ancestors. In light of the oviraptorid style of synchronously laying paired eggs, the identical young ages of the individuals in the block suggest that they may be siblings. If this were the case, it would lend support to synchronous-breeding hypotheses of communal roosting evolution. Beyond the behavioural implications, this new taxon highlights the diversity of Nemegt oviraptorids, and raises questions of why and how this ecosystem could sustain this diversity.
Grant Information:
GFF: Vanier Canada, NSERC, Alberta Innovates, Dinosaur Research Institute
PJC: NSERC

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ANALYSIS OF ROBUSTICITY IN THEROPOD FORLIMBS USING GEOMETRIC MORPHOMETRICS TO INDICATE PREY SIZE PREFERENCE

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There are many hypotheses regarding the function of the forelimbs in nonavian theropods, including a role in prey capture, but a lack of clear extant analogs makes functional inference difficult. Among extant species, felids are one of the few that use their forelimbs in prey capture, and investigating their relationships may provide new insights into forelimb use in nonavian theropods. Previously, we performed phylogenetic principle component analyses (PCA) on a set of functionally relevant forelimb indices and compared the results from theropods to those of extant felids. The cat PC morphospace showed groupings by prey size preference, and the theropod analysis showed promising alignment of morphotypes with the felid model, but was limited by taxon sampling. To expand this study, we used geometric morphometrics to better capture variations in the shape of the bones and allow for the inclusion of more taxa than with linear ratios. Photographs of forelimb elements of theropod taxa representing all major clades were digitized using both stationary and sliding semilandmarks, and a principal component analysis was performed after Procrustes alignment. The analysis showed gradation in morphotypes from more gracile to more robust, with the robust morphotypes typically showing more development in the processes related to muscle attachment sites. A plot of the allometric trends shows that shape scores of the individual elements demonstrated only very weak correlation with the size of the bone itself, indicating that overall robusticity is not a function of element size. This is particularly clear in considering the humerus of *Ajancingenia,* which is far more robust for its size than other taxa in the analysis. Tyrannosauroids demonstrated significant variation, with *Tyrannosaurus* being the most robust of the group and considerably more robust than other large tyrannosaurids such as *Daspletosaurus*. The allometric plot also shows multiple *Tyrannosaurus* individuals of various sizes all plot at the same relative robusticity regardless of size, whereas *Allosaurus* shows far more variability in relative robusticity. The diversity of morphotypes within each size class shows that forelimb function is a major driver of the morpology across Theropoda and that robusticity is not merely a function of size. Given our previous work in comparing the types of shape change associated with prey specialization in cats, we hypothesize these functional differences are related to prey specialization.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HOW DID BISON CALVES GROW UP? POSTNATAL LIMB ALLOMETRY IN *BISON ANTIQUUS* FROM LA BREA TAR PITS

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The La Brea tar pits preserve a large sample of juvenile bones of many mammals; one of the few fossil localities known that allows us to study how limb bones changed shape as they matured. The extinct Pleistocene species *Bison antiquus* is very common at La Brea, so were able to study at least 50-60 specimens of the limb bones of juveniles, from the smallest calves to full-grown adults. We measured the diaphysis length, circumference, and cross sectional area of humeri, radii, femora and tibiae, using dial calipers and a flexible metric tape measure. Previous studies on the growth in the living species *Bison bison* give us a basis for comparison. The expectation is that the proximal limbs in cursorial mammals show display isometric growth in their proximal limb segments (humerus, femur), but that the distal limb segments (radius, tibia) grow long faster than they grow thick, making them more gracile. The expected isometric slopes are around 1.0 for length vs. circumference. In the radius, the growth trends in *B. antiquus* were indeed more gracile (slope = 2.29), even more than in *B. bison* (slope = 0.87). The tibia showed the same growth trends, with highly gracile (slope = 2.02) growth in *B. antiquus*, while *B. bison* had a slope of 0.75. Even some of the femora show the same trend, with the slope of *B. antiquus* = 2.16 (gracile) vs. 0.92 (isometric) for *B. bison*. This discrepancy is surprising, because previous authors have not commented that adult *B. antiquus* limbs are remarkably more gracile than those of living *B. bison*—but that is what their allometric growth trends suggest.

Technical Session XII (Friday, August 25, 2017, 9:15 AM)

THE CAUDAL INTERCENTRUM SYSTEM (CIS) OF FOSSIL AND LIVING SNAKES REVEALED BY A NEW SPECIMEN OF *DINILYSIA PATAGONICA*

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Snakes are an extremely derived and long-lived clade of lizards that have either lost or highly modified many of the synapomorphies that would clearly link them to their closest lizards sistergroup. This is one of the main reasons behind the seemingly intractable conflicts around the origin of snakes, as the identification of homologous characters that are shared with their lizard relatives is problematic. We focus here on one morphological complex, the caudal intercentrum system (CIS), otherwise known as haemal arches (or chevron bones), and their usually associated haemapophyses (or peduncles). Interpretations of a CIS have been reported for three fossil snake taxa: *Eupodophis descouenssi, Haasiophis terrasanctus, Wonambi naracoortensis.* For *Eupodophis* and *Haasiophis,* conflicting interpretations range from neomorphic structures with no homologies to the CIS, to haemal arches and haemapophyses homologized with those of other lizards. The isolated vertebra referred to *Wonambi* is more problematic. *Wonambi* and several other madtsoiids show posteroventral processes (i.e. haemapophyses) on the caudal vertebrae, leading previous authors to suggest the presence of haemal arches, although the arches are not preserved. A similar case occurs with *Najash rionegrina;* although the presence of haemal arches was not considered before for this taxon, a CIS is strongly suggested by distinct articulatory surfaces on the distal end of the caudal pedicels. *Dinilysia patagonica* is one of the best preserved and most well-known Cretaceous snakes, but its caudal region remained unknown. Here we describe the first known caudal series of *Dinilysia* based on MACN-RN-1016, which comes from the Bajo de la Carpa Formation of the Neuquén Group (Santonian, Upper Cretaceous), Río Negro Province, Argentina. It comprises a string of 13 articulated vertebrae, from posterior-most precloacals to the first caudals, displaying unequivocal evidence of a CIS: haemapophyses and unfused haemal arches. These new data provides important insights

on the presence of a CIS in other fossil snakes. It also challenges previous concepts on the homologies of the caudal region in snakes, such as the idea of "unpaired fused chevrons" in derived snakes. The new data from *Dinilysia* indicates it is more likely for the ventral projections in the caudals of extant snakes to represent elongated haemapophyses and the caudal intercentra (haemal arches) to be lost.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

NEW GEOEMYDID MATERIAL FROM THE EOCENE OF VIETNAM AND ITS IMPLICATION FOR GEOEMYDID SYSTEMATICS

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Aquatic testudinoid turtles have a particularly rich fossil record in the Tertiary of the northern hemisphere, but little is known about the evolutionary history of the group, as the phylogenetic relationships of most fossils have not been established with confidence, in part due to high levels of homoplasy and polymorphism. We here focus on a sample of approximately 100 geoemydid skeletons, mostly shell material, collected from the mid to late Eocene (35–39Ma) Na Duong Formation, Vietnam, a continental swamp deposit that has yielded abundant remains of aquatic and terrestrial faunas and floras. All turtle material was collected from a single stratigraphic horizon and is therefore thought to represents a true population. Although two size classes can be distinguished among our sample, a larger one ranging from 28 to 38 cm and a smaller from 13 to 17 cm of carapace length, we believe that the smaller morph represents the juvenile stage of the other, as it presents a three-keeled carapace, a diagnostic character for juvenile geoemydids. Our material shares many characters with two recently described geoemydids from the Eocene of China, *Isometremys lacuna* and *Guangdongemys pingii*, in particular by exhibiting anteriorly short-sided neurals with exception of an octagonal fourth neural and square or rounded fifth neural, by lacking a nuchal emargination, and by possessing a notched pygal bone completely divided by the intermarginal sulcus, an entoplastron anteriorly and posteriorly intersected by the humerogular and humeropectoral sulcus, respectively, and a deep anal notch. A phylogenetic analysis using an updated character matrix consisting of 87 shell characters that explicitly embrace the high levels of polymorphism found in geoemydids, reveals that the Vietnamese turtle material is located at the base of Geoemydidae thereby suggesting at least an Eocene age for the crown group.

Grant Information**:**
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

EXTREME TOOTH ENLARGEMENT IN A NEW LATE CRETACEOUS RHABDODONTID DINOSAUR FROM SOUTHERN FRANCE

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Rhabdodontidae is a successful clade of ornithopod dinosaurs characteristic of Late Cretaceous continental faunas in Europe. A new rhabdodontid from the late Campanian of southern France is characterised by the extreme enlargement of both the maxillary and dentary teeth, correlated to a drastic reduction in the number of maxillary teeth (4 per generation in adults). One interalveolar septum out of two is resorbed on the maxilla so as to be able to lodge such enlarged teeth. The rhabdodontid dentition and masticatory apparatus were adapted for producing a strict and powerful shearing action, resembling a pair of scissors. With their relatively simple dentition, contrasting with the sophisticated dental batteries in contemporary hadrosaurids, rhabdodontids are tentatively interpreted as specialized consumers of though plant parts rich in slerenchyma.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A MOSTLY COMPLETE BOWFIN (AMIIDAE: *AMIA* SP.) FROM THE COAL CREEK MEMBER OF THE EOCENE KISHENEHN FORMATION, NORTHWESTERN MONTANA

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The large-bodied fish fauna of the Eocene Kishenehn Formation's Coal Creek Member (43.5 Ma) in northwestern Montana is understudied due to a bias towards small fishes and insects in collections. Small-bodied specimens (mostly < 10 cm) of taxa, such as *Amyzon* (suckers), are most abundantly collected as nearly to fully complete compression fossils from the oil shale beds of the member's Middle Sequence. On the other hand, large-bodied fishes, such as amiids (bowfins), are previously only known from fragmentary remains for which taxonomic resolution is only possible to the family level. Here we describe the first mostly complete amiid fossil (USNM 618000) from the Kishenehn Formation. We assign this specimen to the genus *Amia* based on the presence of pointed coronoid teeth, a long and narrow parasphenoid tooth patch, and a long preural region (83 preural centra). The assignment of this specimen to the species level is more challenging. It exhibits a unique combination of features, including a total of 91 centra (like A*mia calva*), 8 ural centra (like *A. scutata* and *A. pattersoni*), and a concave anteroventral margin on the first postinfraorbital (like *A. hesperia*). USNM 618000 also exhibits a unique feature, a spade-shaped rostral; however, the discovery of more specimens is necessary to verify that this feature is not due to taphonomic effects. This new specimen enhances the known biodiversity of large-bodied fishes from this formation. The completeness of USNM 618000 (~59 cm length) is unusual for its size in comparison to the more abundantly collected isolated bones of larger fishes, casting doubt on the validity of a strong preservational bias against articulated skeletons of larger fishes. The lack of other well-preserved specimens could reflect the rarity of amiids in the ecosystem overall or a partitioning of habitat preference away from the shallow, near-shore regions of the ancient lake.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ANURAN MAXILLAE FROM THE PALEOGENE (LATE EOCENE–EARLY OLIGOCENE) OF SUMATRA, INDONESIA

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The modern-day region encompassing mainland Southeast Asia and extending south and eastwards through the Indo-Australian or Malay Archipelago, Australia, New Zealand, and the islands of the southwestern Pacific supports a diversity of anurans comprising about 1400 species (about one-fifth the global total) in 120 genera and 13 families. The resident anuran taxa exhibit a biogeographically intriguing mix of Laurasian and Gondwanan affinities, which are widely thought to reflect the complex paleogeographic history of the region, combined with the poor dispersal abilities of anurans across marine waters and in situ radiations of clades. Fieldwork in sediments of the Paleogene-aged Sawahlunto Formation in the Ombilin Basin in west-central Sumatra, Indonesia, has revealed tantalizing evidence of plants, actinopterygians, turtles, crocodilians, birds, mammals and, most recently, anurans. The Sumatran anuran fossils are two isolated and incomplete maxillae, both preserved as poorly permineralized bone and natural molds in coaly mudstone. Both maxillae are dentate, moderate in size, moderately deep and elongate in form, ornamented labially with short and irregular ridges, and lingually bear a reduced lamina horizontalis. The two maxillae are sufficiently similar that they may belong to the same taxon. Both maxillae are relatively generalized and lack obvious autapomorphies. Aside from clearly not belonging to Bufonidae on account of having teeth, at present neither specimen can be assigned to any anuran family currently resident in the region. Although their familial affinities are unclear, the Sumatran maxillae are notable for being the geologically oldest (late Eocene or early Oligocene) and most westerly fossil record for anurans in the Indo-Australian Archipelago and the first anuran fossils to be discovered in Indonesia. Elsewhere in the broader region, nine anuran families are reported to have fossil occurrences in the early Eocene–Holocene of Australia (Limnodynastidae, Microhylidae, Myobatrachidae, and Pelodryadidae), the Miocene (indet. anurans) and Quaternary (Bufonidae, Megophyridae, Ranidae sensu lato, and indet. anurans) of Thailand, the Miocene (Leiopelmatidae) and Quaternary (Leiopelmatidae and Pelodryadidae) of New Zealand, and the Quaternary of Malaysia (indet. anurans), Papua New Guinea (Microhylidae and Pelodryadidae), New Caledonia (Pelodryadidae), and Fiji (Ceratobatrachidae). How the fossil Sumatran anuran potentially relates to any of these taxa remains to be determined.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW SPECIES OF *PARASAUROLOPHUS* FROM THE UPPER CRETACEOUS KAIPAROWITS FORMATION OF SOUTHERN UTAH BASED ON A SERIES OF SKULLS

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Although first discovered nearly a century ago, much remains to be learned about the lambeosaurine hadrosaurid *Parasaurolophus*, despite it being one of the most iconic dinosaurs. In particular, phylogenetically significant details of crest architecture and changes in external and internal crest morphology during crest growth remain poorly understood. Recent collection of over a dozen partial to complete skulls from the Middle Member of the Kaiparowits Formation of southern Utah provide unprecedented new insights into the anatomy and systematics of this genus. The new specimens reveal that the osteological makeup of the crest differs from most previous interpretations, which likely stem from poor preservation of previously described materials as opposed to species specific differences. For example, the relative contributions of the dorsal and lateral branches of the premaxilla along with the nasal in the Kaiparowits *Parasaurolophus* are not highly apomorphic, rather they mimic the crest architecture of other lambeosaurine hadrosaurids. Moreover, contrary to previous interpretations, the lateral premaxillary process extends to nearly the posterior region of the crest and the nasal broadly supports the ventral surface of the crest posteriorly from the frontals.

Referral of a previous specimen from the Kaiparowits Formation to *P. cyrtocristatus* is based solely on the degree of crest recurvature, which was considered a diagnostic feature of the latter. However, pronounced variation in crest recurvature exists among the Kaiparowits specimens, with the smallest specimens approximating the condition in *P. cyrtocristatus*, and the largest exhibiting an elongate straighter crest, closely resembling that of *P. walkeri*. This suggests that crest recurvature varies with growth and is taxonomically unreliable outside a rigorous ontogenetic framework, which has yet to be undertaken. Taxonomic comparisons made between the largest individuals suggest that the Kaiparowits specimens represent a new species closely related to *P. walkeri*, yet distinguished by unique morphology of the maxilla and internal crest architecture. Additionally, the interpretation of *P. cyrtocristatus* as a more primitive taxon based on the presence of a downturned crest needs to be reconsidered in light of this new material. Internal crest architecture may prove to be more insightful for constructing a phylogenetic analysis.

Grant Information:
Funding provided by the College of Sciences, North Carolina State University

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

AN ISOLATED PETROSAL OF THE PAMPATHERE *HOLMESINA FLORIDANUS* FROM THE BLANCAN NALMA OF FLORIDA

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Work on the cranial anatomy of the pampathere *Holmesina floridanus*, known primarily from abundant remains recovered from the Haile 7G quarry of north central Florida (late Blancan NALMA), has revealed an extremely well-preserved isolated left petrosal from a subadult individual (UF 48500). This specimen is the first isolated pampathere petrosal to be formally described. Comparisons to the extant armadillos *Dasypus* and *Euphractus* and the Miocene armadillo *Proeutatus*, the latter considered the sister taxon of pampatheres and glyptodonts, reveals a number of distinctive features. The fenestra cochleae is extremely compressed dorsoventrally, its width nearly three and a half times greater than its depth, whereas in other cingulates it is more ovate, its width no more than twice its depth. The crista interfenestralis bears a bony bridge connecting it laterally to the medial side of the tympanohyal, forming a partial floor to the facial sulcus. The promontorium bears both a narrow, spine-like anteromedial process, plus a rounded boss on its lateral surface of unknown function. The internal acoustic meatus is deeply recessed, situated very near the ventral margins of the intracranial exposure, and its two primary divisions, the foramen acusticum superius and inferius, are separated by a very narrow, sharp ridge. There are several features linking *Proeutatus* to *Holmesina* exclusive of the living taxa, including a mediolaterally broadened crista interfenestralis and an elongated anteromedial process of the promontorium, that suggest the petrosal may prove an informative source of systematic characters among cingulates, and perhaps within pampatheres themselves.

Technical Session VI (Thursday, August 24, 2017, 8:30 AM)

NEW MATERIAL OF *LLISTROFUS PRICEI* FROM THE CAVE DEPOSITS OF RICHARDS SPUR, OKLAHOMA AND THE PALEOECOLOGY OF THE HAPSIDOPAREIONTIDAE

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The Hapsidopareiontidae is a group of 'microsaurs' characterized by a significant reduction of several elements in the postorbital region that results in an exceptionally enlarged temporal emargination, the exact function of which remains uncertain. The clade comprises two taxa from the early Permian of Oklahoma, *Hapsidopareion lepton* and *Llistrofus pricei*. While *Hapsidopareion* is known from eight specimens from the South Granfield locality, *Llistrofus* was previously known solely from the holotype found near Richards Spur. Although the Richards Spur paleoenvironment includes more than 40 terrestrial vertebrate taxa, the paleoecological implications of the extreme paucity of *Llistrofus* have been relatively unexplored. Here we present data from new specimens of *Llistrofus,* which permits an improved characterization of its morphology. Our analysis also features data collected through the use of neutron tomography, a seldom-used technique, which revealed additional details of one specimen that could not be explored through traditional preparation methods.

Morphological details of these specimens contribute significant insights regarding the taxonomy of the hapsidopareiontids, which are differentiated by only a few features, including relative size. This study has revealed a higher degree of morphological similarity between *Llistrofus* and *Hapsidopareion* than previously recognized, suggesting that the former may be a more advanced ontogenetic stage of the latter. Additionally, the new specimens facilitate a discussion of the evolution and function of the large temporal emargination that characterizes the group, from which we can form preliminary conclusions regarding the paleoecology of *Llistrofus* in the context of the upland environment preserved near Richards Spur. We propose that the emargination, which could have accommodated much of the jaw musculature in order to reduce the cross-sectional profile of the skull, coupled with the elongate body, reduced forelimbs, and relative paucity of *Llistrofus* at the locality, is indicative of a cryptic lifestyle, likely some form of fossoriality. The marked morphological differences from recumbirostran 'microsaurs,' characterized by features such as increased cranial ossification and recumbent snouts that are absent in the hapsidopareiontids, could be reflective of different evolutionary trajectories toward fossoriality, possibly as the result of niche partitioning.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

APPLICATION OF BROOKS PARSIMONY ANALYSIS TO REVEAL THE RELATIONSHIP BETWEEN THE AREAS IN MESOEUCROCODYLIA PALEOBIOGEOGRAPHY

GEROTO, Caio F., UNIP, Sorocaba, Brazil

The South America Mesoeucrocodylia taxa reveal a close relationship with taxa discovered in Africa, Europe and Asia pointed to a cosmopolitan distribution to those groups. Biogeographical hypothesis try to explain the lore of dispersal and vicariance in this distribution focusing only in the separations of continental mass, but not the irradiation of the lineage inside them. The Brooks Parsimony Analysis (BPA) is a more sensitive methodology capable to this approaching, evaluating different geographical dispersion. The BPA tests the null hypothesis, meaning all taxa in an area shared the same biogeographical history and that is reflecting in your phylogeny. Homoplasies in general area cladogram represent dispersals events and falsify the null hypothesis. Since the Assumptions 0 are acceptable by BPA, a secondary analysis, called Secondary BPA, with the homoplastic areas divided, is applied to resolve this cases. For the analysis here presented was used a cladogram concern only the Mesoeucrocodylia with 57 taxa distributed between 19 areas to generate the area cladogram. After the construction of the taxon-area matrix, the same are running using the TNT v. 1.1 hold 15000 trees and implicitly enumeration search strategy. The general area cladogram results show a strong vicariance support between Bauru Group and Neuquén Basin and Iullemmeden Basin with Mahajanga Basin, areas with taxa close related, but also between areas not close related like the Araripe Basin, Chubut Group and Kem Kem Beds. However, the homoplasy in cladogram pointed to a reticulated history involved the areas with strong vicariance support. After three divisions of Bauru Group, four divisions of Neuquén Group and Ilummeden Basin, two divisions of Mahajanga Basin, and only one division of Araripe Basin, all homoplasies resolved, reveal that some of vicariance relationships are artifacts and disappear with division of the areas. The secondary BPA results in only one parsimonious tree without politomies and strong support to vicariances events between Bauru Group and Cajones Formation, also Nequén Basin and Bauru Group. The most of Later Cretaceous species appear by postdispersion speciation, especially the Bauru Group and Neuquén Basin. Peripheral isolated was identify in areas of Iullemmeden and Mahajanga basins, and between Araripe Basin and Neuquén Basin and Bauru Group. Indeed most of the Baurusuchidae and Sphagesauridae speciation events indicated paralogy. Thereby alopatry and simpatry is the main type of speciations regarding the South American mesoeucrocodylians.

Grant Information:
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Technical Session VIII (Thursday, August 24, 2017, 1:45 PM)

FIRST EVIDENCE FROM THE PALEOCENE OF MOROCCO OF THE CONVERGENCE OF THE QUADRITUBERCULAR-BILOPHODONT PATTERN IN AFROTHERIAN AND LAURASIATHERIAN UNGULATE-LIKE MAMMALS

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Molecular studies showed that extant "ungulate" placentals are polyphyletic and belong to the two main clades Afrotheria (Paenungulata) and Laurasiatheria (Euungulata: Cetartiodactyla, Perissodactyla). However, paleontological and neontological studies long failed to recognize the morphological convergence of African and Laurasian "ungulate" orders. They advocated the Mirorder "Altungulata" which includes Laurasian Perissodactyla and African Paenungulata, and is characterized especially by quadritubercular and bilophodont molars (4 main cusps, 2 transverse crests) adapted for folivorous diet. We have described new critical fossils of one of the few known African condylarth-like mammal, the enigmatic *Abdounodus hamdii* from the middle Paleocene of Morocco. They show that both *Abdounodus* and *Ocepeia,* known from the same locality, have key intermediate morphologies corresponding to early steps in the evolution of the bilophodont pattern in Paenungulata. They demonstrate that paenungulates unexpectedly have a metaconule-derived pseudohypocone, instead of the cingular hypocone seen in perissodactyls. It refutes the homology of the fourth main cusp of upper molars of Paenungulata and Perissodactyla, and supports the convergence of the quadritubercular and bilophodont pattern in these ungulate-like mammals. The phylogenetic analysis is consistent with our reconstruction of the structural evolution of the bilophodonty in paenungulates. It relates *Abdounodus* and *Ocepeia* to Paenungulata as stem taxa of the more inclusive clade Paenungulatomorpha that is distinct from Perissodactyla and Anthracobunidae. As a result, *Abdounodus* and *Ocepeia* help to identify the first strong synapomorphy within the Afrotheria - i.e., presence of a pseudohypocone - supporting the convergence of African and Laurasian ungulate-like placentals, in agreement with the molecular phylogeny. *Abdounodus* and *Ocepeia* are the only known representatives of the basal African ungulate radiation predating the divergence of extant paenungulate orders. Paenungulatomorphans evolved at least from the early Tertiary onwards and independently from laurasiatherian euungulates and allied Paleocene "condylarths" such as apheliscids. The rapid radiation of the Afrotheria and Paenungulatomorpha at the beginning of the Tertiary, as illustrated by Paleocene Moroccan mammals, is concurrent with that of the Laurasiatheria in a general explosive recovery event in both the South and North Tethyan continents following the KT extinctions.

Grant Information:
CR2P, UMR 7207, CNRS-MNHN-UPMC

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW SMALL-BODIED HOMINOID FROM LOWER SIWALIK DEPOSITS SURROUNDING RAMNAGAR (JAMMU AND KASHMIR), INDIA

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In 1922, on the advice of prominent geologist and local Superintendent Charles Middlemiss, Barnum Brown began systematic collection of vertebrate fossils from Lower Siwalik deposits surrounding the town of Ramnagar (Jammu and Kashmir), India. Brown immediately discovered a partial jaw belonging to a large hominoid ape and described it as a new species, *Dryopithecus pilgrimi*, now recognized along with all other known hominoid fossils from Ramnagar as *Sivapithecus indicus*. Fossil collection at Ramnagar has persisted on and off for the past 95 years, with only two other primate species documented in addition to *S. indicus*: the sivaladapids *Sivaladapis palaeindicus* (first documented in 1979) and *Ramadapis sahnii* (first described and documented earlier this year). Since 2010, we have conducted paleontological and geological fieldwork at Ramnagar, with a particular focus on primates. Here, we report our recent discovery of the first new hominoid species from Ramnagar in almost 100 years. The new taxon is represented by a lower M_3, similar in size to the corresponding tooth in *Hylobates agilis*, and it is identified as a hominoid (and not a pliopithecoid) based on characters such as a relatively short/broad mesial fovea, mesial cusps and mesial transverse crest transversely aligned (with metaconid slightly mesial to the protoconid), prehypocristid oriented mesiodistally (not obliquely), hypoconulid buccally oriented but not aligned with the

other buccal cusps, and the lack of a pliopithecine triangle. The specimen is easily distinguished from *Sivapithecus* on the basis of its smaller size, a reduced but present buccal cingulum, better-developed crests, and less bunodont cusps. We also conducted a 262 character (craniodental + postcranial) phylogenetic analysis of catarrhine taxa, with platyrrhines, *Catopithecus*, and *Aegyptopithecus* constrained as successive outgroups. The new Ramnagar M_3 is reconstructed as a stem hominoid in all most parsimonious trees, again suggesting that it represents an undersampled and perhaps newly recognized hominoid radiation in the Miocene of South Asia.

Grant Information:
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Technical Session V (Wednesday, August 23, 2017, 1:45 PM)

PALEOECOLOGY OF A VERTEBRATE MICROFOSSIL ASSEMBLAGE FROM THE EASTERNMOST DINOSAUR PARK FORMATION (UPPER CAMPANIAN) SASKATCHEWAN, CANADA: RECONSTRUCTING DIVERSITY IN A COASTAL ECOSYSTEM

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The Campanian-aged Dinosaur Park Formation (DPF) of Alberta, Canada is one of the most productive and well-studied dinosaur bearing units in the world. While the formation is present in Saskatchewan, outcrop is sparser, widely distributed, and difficult to access. As it has been less well studied, Saskatchewan's DPF is generally less well understood than the DPF in Alberta, despite being highly fossiliferous. The DPF in Saskatchewan represents the northeasternmost occurrence of the formation in Canada, and therefore holds considerable potential for addressing questions about the large-scale spatial diversity patterns in the Late Campanian that cannot be addressed by studying the DPF in Alberta alone. In particular, questions concerning the proximity of the Western Interior Sea, and its influence on diversity could be addressed in a much broader and more temporally expended scale.

A ~42 m section of Upper Campanian sediments in Saskatchewan Landing Provincial Park in southwest Saskatchewan represents the easternmost outcrop of the DPF in the Western Interior Basin. Between 2010 and 2015, the Royal Saskatchewan Museum (RSM) and McGill University have collected macrofossil material from several dinosaur taxa, including lambeosaurine hadrosaurs (the first known from Saskatchewan), Chasmosaurine and Centrosaurine ceratopsians, and at least three species of theropod. This locality also contains the first definitive ankylosaur scutes found in the province, as well as fossils of pachycephalosaurs and other small ornthiopods. In addition, hundreds of microvertebrate fossils have been collected, including a diversity of chondrichthyans, osteichthyans, turtles, champsosaurs, crocodiles, salamanders, mammals and rare hesperornithid birds. Palynology, ichnology, sedimentology, and vertebrate paleontology have been integrated to determine the paleoenvironmental and paleoecological conditions of the locality. The site is interpreted as having been deposited under marginal-marine conditions near a shoreline undergoing transgression by the encroaching Western Interior Sea. The vertebrate fossil assemblage found at this locality is highly diverse, and offers new insights into late Cretaceous ecosystems living near paleocoastlines. This ongoing research could provide critical insights into the large-scale alpha (within-site) and beta (amoung-site) diversity patterns, as well as the drivers of that diversity, that were occurring in the Late Campanian of North America.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

STASIS IN TERATORNS FROM THE LA BREA TAR PITS DURING THE LAST GLACIAL-INTERGLACIAL CYCLE

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Conventional evolutionary biology suggests that birds evolve rapidly in response to climate change, as exemplified by the Galapagos finches. However, previous studies of birds from the Rancho La Brea tar pits showed no significant size or shape changes over the last glacial-interglacial cycle, despite significant climate changes during the last 35,000 years. We studied the largest birds at Rancho La Brea, *Teratornis merriami*, to determine if they showed size or shape changes in response to the climate. Even though teratorns seem to exhibit a weak Bergmann's rule effect, with larger body sizes in colder climates, the Rancho La Brea teratorns showed complete stasis over this interval, with almost no statistically significant changes in size or robustness even during the peak glacial interval at 18,000-20,000 years ago, when the climate at Rancho La Brea was dominated by coniferous forests and snowy winters. These results are consistent with earlier studies on all the other large birds at Rancho La Brea. This result also suggests that the Galapagos finch model of rapid change in response to climate may not be appropriate for all birds.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

BIOSTRATIGRAPHY OF MARINE MAMMALS (CETACEA AND SIRENIA) FROM COASTAL SECTIONS OF THE EOCENE SAMLAT FORMATION SOUTH OF AD DAKHLA, MOROCCAN SAHARA

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Fossil mammals are known from stratigraphic sections along 30 km of Atlantic Ocean coastline, south and southwest of Ad Dakhla in southern Morocco. These lie in three areas, which are from south to north: Garitas, Porto Rico, and El Argoub. In 2014 we described remains of five basilosaurid archaeocetes referred to the genera *Saghacetus*, *Dorudon*, *Stromerius*, and *Basilosaurus*, all coming from a fossiliferous interval called 'B1' in the Garitas area proper. We also described a partial skeleton referred to the dugongid sirenian *Eosiren* that came from a slightly higher stratigraphic interval called 'B2' along the coast north of Garitas.

Here we are able to add new records of marine mammals from a lower interval 'A1' about 40 m below 'B1' in the south at Garitas, from 'B1' at Garitas, and from intervals 'B1' or 'B2' in the north at Porto Rico. The new fossils from interval 'A1' are dark in color, with brown bone, and include the sternebra of a small protocetid and several cheek teeth of the large protocetid *Pappocetus lugardi*. These are Bartonian in age and indicate the presence in coastal strata of protocetid archaeocetes better known from the inland locality of Gueran. The new fossils from interval 'B1' at Garitas include much of the skeleton of *Basilosaurus isis*, confirming our 2014 identification of this species. New fossils from interval 'B1' or 'B2' at Porto Rico include the well preserved dentaries of a new protosirenid sirenian similar in molar size to *Protosiren smithae*, but with a distinctive conformation of the mandibular symphysis. A good fauna of continental Oligocene mammals is known from interval 'C2' at Porto Rico and El Argoub.

Strata south of Ad Dakhla dip gently to the north, and the south-to-north succession of vertebrate faunas on the Moroccan coast resembles the classic Fayum marine-to-continental middle Eocene through Oligocene succession of vertebrate faunas found in Egypt.

Grant Information:
Field work in 2014 and 2016 was supported by the National Geographic Society, Hassan II Academy of Sciences and Technology, and University of Michigan Museum of Paleontology.

Technical Session XVI (Saturday, August 26, 2017, 10:30 AM)

INTEGUMENTARY STRUCTURES IN *KULINDADROMEUS ZABAIKALICUS*, A BASAL NEORNITHISCHIAN DINOSAUR FROM THE JURASSIC OF SIBERIA

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The origin of feathers is a major research area in palaeontology. Recent studies have been stimulated by discoveries of feather-like structures in various non-avian theropod dinosaurs from Middle Jurassic to Early Cretaceous deposits in northeastern China. Filamentous integumentary structures are also known in two ornithischian dinosaurs from China, but whether these filaments form part of the evolutionary lineage of feathers has been controversial. Kulindadromeus zabaikalicus, a basal neornithischian dinosaur from the Middle Jurassic of Siberia, preserves diverse integumentary structures, including different types of scales and filaments. The different structures are systematically associated with specific anatomical regions: (1) small non-overlapping scales are localized to the distal hindlimb and the manus, (2) larger imbricated scales with a proximal spur, to dorsal regions of the tail, (3) smaller imbricated scales with associated bristle-like structures, to the lateroventral region of the tail, (4) monofilaments, to the head and thorax, (5) clusters of filaments that diverge from a basal plate, to the proximal parts of the limbs (humerus and femur), and (6) clusters of ribbon-shaped structures, to the proximal tibia. Abundant melanosomes are directly associated to all those structures, definitely proving that they are epidermal in origin. The diversity and localized distribution of specific integumentary structures over the body of Kulindadromeus indicate that they had different functions. The simple filaments around the head, thorax and back may have functioned in insulation, but it is difficult to assess whether their density was sufficient to form an effective insulating layer. The regular organization of the clusters of filaments arising from a basal plate and the clustered arrangement of the ribbon-like structures suggests that they may have functioned in visual display. It is also possible that these integumentary structures had ancillary functions in balance or insulation of eggs. The scales around the tail were obviously too thin for efficient defensive functions but rather likely stiffened the tail dorsoventrally, the latter acting as a pendulum. These exceptionally preserved specimens suggest that the earliest dinosaurs were fuzzy animals and that 'protofeather'-like structures were potentially widespread among the entire dinosaur clade.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DRNEUROSAURUS: A BILINGUAL BLOG FOR CHILDREN ABOUT PALEONTOLOGICAL NEWS

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The DrNeurosaurus Blog launched in February 2016 with the goal of providing paleontological news to children in both English and Spanish. An estimated 437 million people speak Spanish and it's second only to Mandarin in terms of numbers of native speakers. By providing the same content in both English and Spanish, I am able to reach a wider audience, and attract kids and adults from around the world to view and read about paleontology. The articles are broadly accessible to children, but focused on ages 8 and up. I publish a weekly blog post on recent peer-reviewed paleontology research, placing an emphasis on articles that have appeared elsewhere in the popular media. Each post explains methods, results, and importance from a recent study in a way that is easily accessible. I incorporate images from the articles, reconstructions, original art and/or diagrams to clarify scientific concepts. Additionally, I provide a link to the peer-reviewed article for people who want to read further.

Since the launch, the site has received over 53,000 unique visitors and over 120,000 visits. As of March 2017, the site sees 200 visitors a day. This has increased from 50 daily visits in February 2016 and continues to rise. Most visitors are referred to the blog through links I provide in Facebook and Twitter, but others arrive through Google searches, many of which originate outside the United States. Even though English posts are by far more popular (25000 hits to 10000 hits on Spanish posts), some Spanish posts outperform their English counterparts. For example, the Spanish post on *Rusingoryx* had 658 hits to 251 on the English version, and the hammerhead reptile *Atopodentatus unicus*

that had over 2000 hits on the Spanish post and under 400 on the English version. Some posts perform equally well in both languages.
In order to share a broad spectrum of paleontology research with the public, blog posts have covered a range of topics, including fossil plants, invertebrates, and major vertebrate clades, along with a variety of methods. Of these topics, new animals with strange morphologies seem to be the most popular, such as *Atopodentatus unicus,* and durophagous marsupial *Malleodectes mirabilis*.
Creating bilingual content that is accessible to a wide audience is relatively simple, cost effective, and only uses a couple hours of time per week to produce. Using free online platforms, we can expand the reach of our research and scientific outreach to countries far and wide.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

3D RECONSTRUCTION OF THE BRAIN ENDOCAST AND INNER EAR OF *MALAWISAURUS DIXEYI* (SAUROPODA: TITANOSAURIA)

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A braincase of the Cretaceous titanosaurian sauropod *Malawisaurus dixeyi*, complete except for the olfactory region, was CT scanned and 3D renderings of the endocast and inner ear were generated. Cranial nerves appear in the same configuration as in other sauropods, including derived features that appear to characterize titanosaurians, specifically, an abducens nerve canal that passes lateral to the pituitary fossa rather than entering it. Furthermore, the hypoglossal nerve exits the skull via a single foramen, consistent with most titanosaurians, while other saurischians, including the basal titanosauriform, *Giraffatitan*, contain multiple rootlets. The size of the vestibular labyrinth is smaller than *Giraffatitan*, but larger than most derived titanosaurians. Similar to *Giraffatitan*, the anterior semicircular canal is larger than the posterior semicircular canal. This contrasts with more derived titanosaurians that contain subequal anterior and posterior semicircular canals, supporting the position of *Malawisaurus* as a basal titanosaurian. Measurements of the humerus and femur of *Malawisaurus* provide a body mass estimate of 11.4 metric tons. Comparison of body mass to radius of the semicircular canals of the vestibular labyrinth reveal that *Malawisaurus* fits the allometric relationship found in previous studies of extant mammals and *Brachiosaurus*. As in *Brachiosaurus*, the anterior semicircular is significantly larger than is predicted by the allometric relationship suggesting greater sensitivity and slower pitch movements of the head. Habitual head posture was calculated using orientation of the lateral semicircular canal of the inner ear. Based on our reconstruction, the angle of the jawline relative to the lateral semicircular canal appears comparable to *Camarasaurus*.

Romer Prize Session (Thursday, August 24, 2017, 8:15 AM)

AN EMERGING MODEL ON THE PALEOBIOGEOGRAPHIC ROLE(S) OF LATE CRETACEOUS AFRICA: NEW TITANOSAURIAN SAUROPOD DINOSAURS SIGNAL DISTINCT NORTHERN AND SOUTHERN AFRICAN REGIONS

GORSCAK, Eric, The Field Museum of Natural History, Chicago, IL, United States of America

The post-Cenomanian Cretaceous continental fossil record of mainland Africa is largely unknown despite past efforts that produced rare and incomplete specimens. In contrast to relatively well-known Late Cretaceous fossil records from adjacent regions (e.g., Europe, South America, Madagascar), the paleobiogeographic role of Africa has remained ambiguous due to a scarce fossil record. Recent efforts in Egypt, Kenya, and Tanzania have recovered new and phylogenetically informative titanosaurian sauropod dinosaurs that allow for the development of paleobiogeographical perspectives for the Late Cretaceous of Africa. Moreover, these specimens provide a coarse latitudinal assessment which indicates a more complex scenario than previously appreciated. Using tip-dated Bayesian phylogenetic and likelihood-based paleobiogeographic methods (503 characters, 53 taxa, including 5 from Late Cretaceous Africa), multiple models were tested to produce a robust titanosaurian evolutionary history. Models with a relaxed clock, varying speciation, extinction, and character evolution rates with paleobiogeographic models that allowed long-distance dispersal were best supported.
Two new titanosaurians from the Campanian of the Dakhla and Kharga Oases, Egypt, exhibit close affinities with Late Cretaceous titanosaurians from Europe and Asia. KNM-WT 65086, from the Maastrichtian Lapurr Sandstones of Kenya, is grouped with middle Cretaceous titanosaurians from both South America and northern Africa (e.g., *Paralititan stromeri* from the Cenomanian of Egypt). The revised age for the Namba Member of the Tanzanian Galula Formation indicates a younger age (Turonian–Campanian), re-interpreting *Rukwatitan bisepultus* as a member of a 'relictual' lineage and RRBP 02100 as closely related to Late Cretaceous South American aeolosaurines. Paleobiogeographic results reveal coarse bipartite regions within Africa that further developed into the latest Cretaceous. Southern African (Kenya and Tanzania) titanosaurians indicate a unique fauna of older endemic lineages and those with more recent South American and older northern African affinities. Northern African (Egypt) titanosaurians bear closer affinities with Eurasian titanosaurians than with other African forms. This pattern may be tectonically-driven with the progressive isolation of southern Africa from the rest of Gondwana during the Early Cretaceous whereas northern Africa developed its own Afro-Eurasian fauna following separation from South America around 100 million years ago.

Technical Session XX (Saturday, August 26, 2017, 3:30 PM)

DENSE PHENOMIC ANALYSIS OF CRANIAL SHAPE EVOLUTION ACROSS LIVING AND EXTINCT PLACENTAL MAMMALS

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Robust reconstructions of morphological evolution require both comprehensive representation of anatomical structures and appropriate sampling of the clade of interest, particularly inclusion of extinct taxa. While most large-scale studies use relatively limited descriptors of morphology, such as lengths or a small set of homologous landmarks, surface sliding semi-landmark analysis allows for detailed quantification of complex 3-D shapes, even across highly disparate taxa. Here, we conduct the largest analysis to date of morphological evolution in placental mammals using a dense dataset of cranial landmarks and sliding semi-landmarks for 285 placental mammals. Specimens include 184 extant species, representing nearly all extant families and most subfamilies, and 101 fossils spanning Paleocene to Quaternary species. Specimens were digitized in iDAV Landmark and patched with surface semi-landmarks with the R package 'Morpho'. Using both Procrustes coordinates and grouped and individual principal components for a dataset containing the full range of placental mammal skull diversity, including aquatic and aerial taxa, we applied a variety of model fitting approaches to identify evolutionary mode for the entire skull and for individual modules. A composite tree was dated in 'strap' using the equal branch sharing method with first appearance dates. Analysis with BayesTraits supported a punctuated, variable rates model for whole skull evolution (κ = 0.21-0.39 for different PCs). When the face and neurocranium are analysed separately, it is evident that the punctuated model is driven largely by facial evolution (e.g., κ = 0.072 for pooled PCs 1-8 of facial traits), with bursts in evolutionary rate associated with both the Paleocene-Eocene and the Eocene-Oligocene boundaries. Although some elements of shape show moderate phylogenetic structure, λ is generally low, less than 0.5 in all but one analysis (PC2 for the whole skull). The highest rates of evolution for facial traits were concentrated in aquatic taxa, particularly cetaceans and sirenians, as well as the unusual litoptern *Macrauchenia*, but were more dispersed for neurocranial traits, with some rodents, bats, xenarthrans, sirenians, primates, and cetartiodactyls showing increased rates. Disparity through time plots show that placental disparity for both the face and neurocranium significantly outpaced null expectation in the Paleocene. From the Eocene, disparity generally outpaces the null model, but remains largely within its confidence intervals through to the Recent.
Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE ARKANSAS KING MASTODON SITE AND ASSOCIATED MASTODON TUSK ALVEOLAR PATHOLOGIES

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The King Mastodon archaeological site was discovered in Arkansas in 1999 when the Little Bay Ditch was dredged and mastodon (*Mammut americanum*) cranial elements were uncovered by dredging contractor Mr. George King. The site is located southeast of Jonesboro, AR in the Eastern Lowlands of northeast Arkansas, in drainage networks that were part of a braided stream system during the Late Pleistocene. The site was subsequently monitored during which more mastodon elements were found, including more cranial fragments, axial and limb elements, and tusk fragments. Other taxa collected include long-nosed peccary, white-tailed deer, numerous small mammals, pig, cow, bison coyote, dog, various birds, turtle, snake, frog, various fish, and various invertebrates such as bivalves and gastropods. Many of these specimens were found in the disturbed spoil pile, so the association between the modern and Pleistocene forms was unclear, and this site may be of equal ecological interest as paleontological. The stratigraphy of the site consists of lenses of bluish gray clay of probable Pleistocene age, overlain by Holocene aged gray clayey sand, which underlies approximately 30 feet of tan sand and ditch spoil.
Dental material from the mastodon specimen found at the site was ^{14}C dated to approximately 12,000 years ago. The cranium is heavily damaged and is missing most of its superior elements, leaving primarily portions of the maxilla, premaxilla, ethmoid, sphenoid, and basioccipital bones. The skull is unusual in that the two alveoli for the tusks are vastly different sizes. The right alveolus and premaxilla appear normal. The left, however, shows several signs of pathology. The opening to the tusk alveolus is very small, only approximately five centimeters wide and shows signs of pathological bone growth around its margin, as well as on the ventral side of the premaxilla near the base of the alveolar cavity. Reduced and malformed tusks, including sometimes small supernumary tusks, have been observed in African elephants due to infection and abscess of the alveolus. The left maxillary molars of this specimen are also broken, leading to the possibility that the infection may have spread, but the breakage may also be simply taphonomic in nature. Due to the relative sizes of the two alveoli the damage or infection to the left alveolus must have happened when the animal was relatively young, but the size of the right alveolus shows that it lived for quite some time afterwards, and it seems unlikely that it died from the infection.

Technical Session XI (Friday, August 25, 2017, 8:30 AM)

BOVID TOOTH MINERALIZATION AND BAYESIAN METHODS FOR RECONSTRUCTING PALEOSEASONALITY

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Seasonal variation in diet, behavior, environment and climate can be reconstructed from spatially resolved elemental or isotopic sampling in teeth, which grow incrementally over time. New advances in the understanding of tooth mineralization, and sampling techniques, permit a more thorough investigation into the number and location of samples required to quantitatively reconstruct original seasonal patterns. Here, we present an updated model of tooth mineralization and Bayesian method of seasonality reconstruction, and test this model in a population of experimental sheep (*Ovis aries*, n=6) using tooth phosphate $\delta^{18}O$ measurements. Required sample frequency is dependent upon the complexity of the input signal. Unimodal seasonal patterns are easily reconstructed with very few samples, a finding consistent with the Nyquist-Shannon sampling theorem. More samples are required to reconstruct bimodal seasonality, and especially complex rainfall patterns in the tropics. We find that reconstruction fidelity and speed are improved using a number of computational approaches. These include "smart" first guesses, combined global and local search strategies, and the systematic relaxation of priors across multiple, mutually contingent search exercises. At high or low sample frequency, we observe that reconstruction fidelity degrades late in tooth formation, where cervical extension slows and integrates increasingly long periods of time into smaller spatial scales. We observe that less time is integrated near the enamel surface, where secretory and maturation waves occur simultaneously, compared to other enamel regions. Our reconstruction method performs well at 2-week resolution, and records transient meteorological events that were not a planned part of the experimental design. This method and experiment demonstrate that with simple modeling techniques, seasonal patterns can be quantitatively reconstructed from elemental or isotopic measurements in teeth.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

PRELIMINARY RESULTS OF LONG BONE HISTOLOGY IN AN ONTOGENETIC SERIES OF *CLIDASTES* (SQUAMATA: MOSASAURINAE)

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Previous histological studies of mosasaurid long bones have focused on adult-sized bones, but no study to date has looked at an ontogenetic series for these marine reptiles. Here, osteohistology is used to study ontogenetic changes in the internal microstructure of *Clidastes*. Four humeri from the Upper Mooreville Chalk in Alabama were chosen to represent a size gradient, including humeri described as belonging to a neonate, juvenile, sub-adult, and adult based on size.

The smallest humerus contains a distinct medullary cavity with a few large trabeculae cross-cutting the cavity. The cortical bone tissue consists of parallel-fibered bone (PFB) with primary osteons, radial canals, and longitudinal simple canals. Many radial canals open along the periosteal surface. The juvenile humerus contains a medullary cavity with numerous trabeculae. The cortical bone contains woven bone (WB) with primary osteons having longitudinal and radial canals and longitudinal simple canals. Near the periosteal surface, there is PFB with some primary osteons; longitudinal and radial canals open along the periosteal surface. The sub-adult humerus contains a medullary cavity filled with spongiose bone; though many are crushed, it is clear this cavity was filled with trabeculae prior to compaction. The cortical bone consists of WB and small amounts of PFB with longitudinally oriented primary osteons and a few secondary osteons. The largest humerus contains a crushed medullary cavity, though it is clear this space was filled with spongiose bone prior to deformation. The cortical bone consists of WB with some PFB near the periosteal surface. Longitudinal primary osteons are present in the outer cortical bone, but do not open along the periosteal surface.

In *Clidastes*, the medullary cavity becomes less distinct as it is increasingly filled with trabeculae through ontogeny. This result is consistent with previous studies of *Clidastes* ribs, which show a similar ontogenetic pattern. The presence of WB in the cortical area of most samples suggests fast growth. While WB is not present in the smallest humerus, radially oriented vascular canals can be used to infer rapid growth in the two smaller bones, while decreasing vascular canal density and predominately longitudinal vascular canals in the two larger bones indicate decreasing growth rates with increasing size. It is unclear whether the largest bone in this study has reached skeletal maturity due to taphonomic alteration along the periosteal surface.

Grant Information:
Thank you to the Western Interior Paleontological Society (WIPS) and Fort Hays State University for help in funding this project.

Technical Session XVIII (Saturday, August 26, 2017, 8:45 AM)

HIERARCHICALLY-ORGANIZED GROWTH INCREMENTS IN THE TUSK ORTHODENTIN OF DICYNODONTS (THERAPSIDA, DICYNODONTIA)

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Dicynodonts have enlarged caniniform maxillary teeth (tusks) that are mainly composed of orthodentin. Tusk dentin contains fine-scale (<30 µm thick) appositional growth increments (alternating light-dark bands) that are consistent with the spacing of daily Lines of von Ebner. Coarser features demarcating sets of fine-scale daily increments have also been reported, suggesting a hierarchical structure similar to that of mammalian teeth. Such a detailed record of growth could help elucidate life history strategies associated with dicynodont survivorship at the end-Permian extinction, yet detailed evaluation of the hierarchical nature of the coarser increments is lacking. We fill this gap by addressing two questions: 1) Is there a hierarchical aspect to the spacing of fine and coarse increments? 2) If a hierarchy is present, is there a constant number of fine increments within each coarse increment? We hypothesize that dicynodont tusk increments were laid down in a consistent hierarchical pattern. Longitudinal thin sections were produced from four tusks (*Lystrosaurus* – FMNH UR 2493; *Diictodon* – FMNH UR 2494; Dicynodontoidea sp. indet. - NHCC LB423, NHCC LB242). Increment thicknesses were digitally analyzed under polarized light at 100x using the IncMeas V1_3c plug-in in ImageJ by marking successive dark bands and compiling data on the distance between each marker. We ran three analyses per tusk: 1) measuring thicknesses of only fine-scale increments; 2) measuring thicknesses of coarse-scale increments; 3) counting the number of fine-scale increments within each coarse-scale increment. The mean thickness of daily increments ranged from 13.32 to 22.33 µm. The number of daily features was dependent on tusk size (*Diictodon* had only 74 daily increments, whereas the largest tusk, NHCC LB423, contained 536 daily increments). All four tusks had coarse increments containing daily increments, but coarser increments were not everywhere visible, probably due to preservation. Where visible, mean thickness of these coarse increments ranged from 71.57 to 105.19 µm. The modal number of daily increments per coarse increment was 4-6 (the mean ranged from 4.19 to 5.36 daily increments). Our data support the presence of a 2-order hierarchy in dicynodont tusk dentin, with 2nd-order increments being deposited on average every 4-6 days. However, there is variation in the consistency of this hierarchical growth pattern. The significance of the 4-6 day periodicity is not clear at this time, but may be elucidated with further sectioning and analysis.

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Preparators' Session (Thursday, August 24, 2017, 9:45 AM)

LEVERAGING GIS AS A COLLABORATIVE PLATFORM: ESTABLISHING A PALEONTOLOGY RESOURCE DATABASE FOR PUBLIC LANDS

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Anticipating the Paleontological Resources Preservation Act, the U.S. Forest Service initiated the creation of a GIS based application to track fossils located on lands managed by the agency. To obtain a broad view of the subject matter and to establish a common environment for all US land management agencies, several agencies were included in the development. The process included a year-long program working closely with USFS Paleontologists considering agency, regional, and field-level requirements with additional input from paleontologists at the Bureau of Land Management, US Geological Survey, and other agencies.

PaleoEx (short for Paleontology Extension for ArcGIS) includes a purpose-built geodatabase with a map-based interface designed to ease the data entry, editing, and tracking of fossil resources for historical, current and future activities within a paleontological area of interest. This includes key activities such as tracking individual fossil specimens; removal authorizations and accompanying curatorial agreements; National Environmental Policy Act clearance and reclamation monitoring data; and history of theft, vandalism, and site impacts. As an added benefit, PaleoEx provides a seamless link to detailed mapping, analysis, and reporting.

PaleoEx currently contains greater than 700 fossil localities and nearly 650 individual specimens in the US. The application will be demonstrated highlighting current uses including the automated fossil potential estimate; data mapping / reporting; and manual vs automated data entry of fossil locals, specimen locations, field images, field preparation notes, and reference materials.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

THE EVOLUTION OF THE DICYNODONT SACRUM, WITH IMPLICATIONS FOR EVOLUTIONARY CONSTRAINT IN THE VERTEBRAL COLUMN OF MAMMALIA

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The sacrum—the vertebrae that articulate with the ilium-—is the nexus between the axial skeleton and the hindlimb, and plays a key role in tetrapod locomotion. Reptilian lineages added sacral vertebrae in several ways (e.g., sacralization of trunk vertebrae, adding novel vertebrae), and possess extremes in sacral count and morphology, from the plesiomorphic 2 sacrals to >20 in some birds. However, apart from early-diverging "pelycosaur"-grade synapsid lineages, little is known of the mechanisms of synapsid sacral evolution or their similarity with convergent reptilian processes. Dicynodont therapsids have a wide range of sacral counts (3–7+), with a general trend of increasing absolute number of sacral vertebrae in younger divergences. We explored the addition of vertebrae to the dicynodont sacrum and placed these patterns in the broader context of dicynodont and synapsid evolution. We established sacral count and the identity of each sacral vertebra by the location of sacral rib—iliac articulation, either by direct observation in articulated specimens, or by the location of sacral scars on ilia. Photographs, CT scans, and published anatomical descriptions of specimens supplemented these data. The three primordial sacral vertebrae are located dorsal to the acetabulum, with additional vertebrae added to the sacrum anteriorly and posteriorly (i.e., articulating with the anterior and posterior iliac processes). Sacral ribs decrease in size in posterior sacral vertebrae in all observed taxa. Whereas the iliac articular surfaces of posterior ribs are roughly circular, those of the anterior sacral ribs are dorsoventrally elongate. Increase in sacral count is somewhat correlated with larger body size (e.g., *Sangusaurus*, 7 sacrals, femur length = 29 cm; *Aulacephalodon*, 5 sacrals, femur length = 30 cm), but not strictly (e.g., *Oudenodon*, 5 sacrals, femur length = 15 cm), and phylogenetic position is a better predictor of sacral count. Given that the number of presacral vertebrae is largely conserved across Dicynodontia, anterior sacral vertebrae are not added via the sacralization of trunk vertebrae, but by the addition of novel elements anterior to the primordial three. This contrasts with the likely addition of an anterior caudal vertebra in "pelycosaurs." Likewise, all crown mammals but xenarthrans are restricted to 1–3 sacral vertebrae, and sacrals are added exclusively from the caudal

series. This suggests that dicynodonts were able to escape a constraint on patterns of regionalization in the column that was otherwise common in synapsids.
Grant Information:
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NSF Graduate Research Fellowship

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

MORPHOLOGICAL AND ISOTOPIC ASSESSMENT OF DIETARY FLEXIBILITY: DIFFERENT STRATEGIES ALLOWING FOR PERSISTENCE IN THE FACE OF NATURAL AND ANTHROPOGENIC ENVIRONMENTAL CHANGE

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Climate warming through the Holocene and into today has driven increasing aridity and shifts in the plant community in the Great Basin. Additional restructuring of the resource base has unfolded due to the spread of invasive cheatgrass through the desert west in the last 150 years. The small mammal community has responded to Holocene and Modern floral change in dynamic ways, with small-bodied diet and habitat generalist having fared the best, while many, but not all, specialist species declined. We combine stable isotope analysis with morphometric assessment of mandibular shape variation to test the degree to which dietary flexibility is serving as a mechanism to buffer species in a changing landscape. We focus on two small-bodied sympatric mice found throughout the Holocene faunal record from Two Ledges Chamber in the Smoke Creek Desert of NW Nevada: *Chaetodipus formosus* (a specialist granivore) and *Peromyscus maniculatus* (a generalist omnivore). Both species showed relatively constant abundances for ca. 8000 years, followed by rapid increases into the Modern to become the two dominant members of today's rodent community.

Isotopically, *C. formosus* $\delta^{13}C$ and $\delta^{15}N$ values are variable through time, ranging across ca. 2.5‰ and ca. 5‰, respectively. Modern values fall at or outside the extreme lower boundaries of the Holocene range for $\delta^{13}C$ and $\delta^{15}N$, potentially indicating a shift in diet towards consumption of cheatgrass. In terms of mandibular shape dynamics, *C. formosus* centroid size is correlated to shape and decreases steadily from ca. 8000 years BP to the present. In contrast, *P. maniculatus* $\delta^{13}C$ and $\delta^{15}N$ values are shifted at or beyond the upper boundary of their Holocene range, indicating increased C4 and/or insect consumption in the Modern. Morphometrically, shape variation is relatively constant through time, with no change in centroid size through the Holocene or into the Modern. Taken together, these results suggest that for small-bodied, habitat generalist omnivores, mandibular shape may be optimized to accommodate a broad diet, thus diet flexibility may be important to persistence. However, success as a small-bodied, xeric adapted granivore may require morphological plasticity to enable continued seed consumption as the plant community is restructured by the invasive cheatgrass. Finally, combining stable isotope and morphometric analysis is a promising approach in terms of uncovering the different strategies by which species can persist and even thrive in response to today's warming climate and changing resource base.

Technical Session XVIII (Saturday, August 26, 2017, 9:45 AM)

EVIDENCE FOR FAUNAL PROVINCIALISM IN THE PERMIAN BEAUFORT GROUP (KAROO SUPERGROUP) OF SOUTH AFRICA

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Rocks of the Beaufort Group are internationally renowned for the wealth of therapsid tetrapod fossils chronicling the origin of mammals. The abundance of these fossils has enabled an eightfold biostratigraphic subdivision of the Beaufort Group that has Pangean-wide applicability for correlation. This subdivision has facilitated the partitioning of the Main Karoo Basin into proximal and distal sectors, and refinement of basin development models. The ages of the six oldest biozones are well constrained, with CA-TIMS radiometric dates having been recently obtained for several ash layers from the proximal sector of the basin.

Until recently, the late Permian *Daptocephalus* Assemblage Zone (AZ) was the oldest biozone considered to be present in the distal sector of the basin. However, new field work has revealed the presence of the dicynodonts *Eosimops, Robertia* and *Endothiodon,* the parareptile *Eunotosaurus,* and the therocephalian *Glanosuchus* in strata immediately overlying the Waterford Formation (Ecca Group) in the southern Free State Province, indicating a Middle Permian age for the lowest Beaufort strata in this part of the distal sector. The co-occurrence of these forms in the absence of dinocephalians suggests the presence of the mid-late Permian *Pristerognathus* AZ in the distal sector and challenges current understanding of Karoo Basin development.

Unexpectedly, no *Diictodon* specimens have been recovered from *Pristerognathus* AZ strata in the southern Free State, despite being the most abundant taxon in the *Pristerognathus* AZ in the proximal sector. Its absence from this zone in the distal sector of the basin can be best explained by faunal provincialism within the Karoo Basin during the mid-late Permian, suggesting that this phenomenon occurred within, as well as between, basins in southern Gondwana.

Our work has also shown that the Daptocephalus AZ is present immediately above the Pristerognathus AZ in this part of the basin. This suggests a Late Permian depositional hiatus or erosional period roughly 3.3 Ma in duration in the distal sector of the Basin, and lends support to the reciprocal basin development model.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

RESOURCE PARTITIONING AMONG THREE FOSSIL PROBOSCIDEAN SPECIES FROM THE SOUTH AFRICAN MIOCENE/PLIOCENE FOSSIL LOCALITY OF LANGEBAANWEG 'E' QUARRY

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When multiple species of megaherbivores co-exist, resource partitioning of vegetation is necessary for the continued success of each species in the community. The proboscideans *Mammuthus subplanifrons, Anancus capensis* and *Loxodonta cookei* co-existed at the Langebaanweg (LBW) 'E' Quarry, Western Cape, South Africa, approximately 5 million years ago. The habitat at LBW has been interpreted as a mosaic of fynbos elements, C_3 grasses, and woodland vegetation. A prior study suggested that *A. capensis* and *M. subplanifrons* were primarily grazers and *L. cookei* was a mixed feeder. These hypotheses of resource partitioning are here investigated via stable isotope analysis of proboscidean molar enamel. Bulk enamel samples were collected from 18 LBW proboscidean molars and analyzed for the $\delta^{13}C$ and $\delta^{18}O$ composition of structural carbonate. *Anancus capensis* (n=8) shows the least variation in $\delta^{13}C$ values (-12.3 to -10.5‰), *M. subplanifrons* (n=3) exhibits moderate variation (-10.7 to -7.0‰), and *L. cookei* (n=7) exhibits the most variation (-12.5 to -7.2‰). The $\delta^{18}O$ values of *A. capensis* range from -1.1 to 0.4‰, those of *M. subplanifrons* from -1.0 to -0.5‰, and those of *L. cookei* from -2.3 to 0.6‰. Results suggest that *A. capensis* likely fed in a partially closed habitat (low $\delta^{13}C$) and ate a relatively high proportion of browse (high $\delta^{18}O$). *M. subplanifrons* likely fed in an open habitat (high $\delta^{13}C$) and ate a relatively high proportion of graze (low $\delta^{18}O$). The broad range of $\delta^{13}C$ values exhibited by *L. cookei* suggests it fed in mixed habitats, and its high $\delta^{18}O$ values suggest that it ate a relatively high proportion of browse. In summary, the results of this study suggest that resource partitioning did occur among proboscideans at LBW, although specific dietary niches cannot be identified with these data. The isotopic data for *L. cookei* and *M. subplanifrons* support the hypotheses that *L. cookei* was a grazer/mixed-feeder and that *M. subplanifrons* was a grazer, but counter the hypothesis that *A. capensis* was a grazer.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 11:15 AM)

A NON-CONFORMIST: THE BEAR GULCH LIMESTONE CHONDRICHTHYAN LIONFISH

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Extant chondrichthyans align into the sister groups, Elasmobranchii and Holocephali. Evidence of Carboniferous and Devonian forms has expanded the range of chondrichthyan morphological variation to the extent that the Elasmobranchii and Euchondrocephali are recognized, with crown holocephalans in the latter. Despite this realignment, however, a number of well-preserved chondrichthyans remain unresolved in this hierarchy. One such taxon is ElWeir, a new chondrichthyan from the Serpukhovian Bear Gulch Limestone of Montana USA. The neurocranium is a single unit, with an extremely short rostro-ethmoid, large obits and short otico-occipital span. A precerebral fontanelle is equivocal, paired, dorsal rostral rods are not. Autodiastylic jaws are framed by a premandibular oral opening of four large, kinetically linked labial cartilages with monocuspid denticles. Families of these minute denticles traverse the jaws. Labial and mandibular arch elements are mineralized in interlocking linear arrays of tesserae. A median lower symphyseal element supports a denticular whorl, wherein cusp size increases labially. Branchial arches are subcranial in position. All fins in males and females are aspinous. The first dorsal fin is reduced to a small flap, midorbital in position. Pectoral, pelvic, second dorsal, and caudal fins are developed into broad fans. The second dorsal fin originates at suprascapular level and extends to the caudal. The first two first dorsal fin pterygiophores, supported by a basal plate, exhibit proximal and distal jointed units. All subsequent pterygiophores are tripartite, well-spaced spaced and broadly extended by ceratotrichia. The pectoral girdle is not positioned immediately behind the occiput. The scapular blade tapers dorsally to articulate with a vertical suprascapular element. Paired fin radials and basals are principally articulated on the girdles; axial elements are few and short. Males exhibit a pelvic clasper and cephalic tenaculum. The caudal is diphycercal; anal is small. The vertebral column distinguishable into cervical, trunk, and caudal regions.

Morphological features noted for ElWeir are found individually in other whole bodied elasmobranch and euchondrocephalan Bear Gulch taxa. Taken collectively, however, the combination of features in ElWeir challenges its definitive placement in either the Elasmobranchii or Euchondrocephali. ElWeir and other non-conformist taxa prompt us to re-consider the makeup of the Class Chondrichthyes and the likelihood of paraphyly or polyphyly.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

RUN CHEETAH RUN: EVIDENCE OF A RECENT SENSORY PERCEPTION SPECIALIZATION FOR HIGH-SPEED HUNTING

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The cheetah *Acinonyx jubatus* is a charismatic felid species, widely known as the fastest mammal on land, reaching top speeds of 105 km/h when chasing prey. Because of its specialized hunting strategy, this species evolved a series of morphological and functional body features to increase its predatory performance. We investigated the evolution of one of its key sensory organs for locomotion, the inner ear, through

exploration of the size and shape of its bony vestibular system. The vestibular system contains organs detecting gravity as well as linear and angular head movements during locomotion, helping most vertebrates maintain body balance and adapt their head posture and gaze direction during movement. We applied high-resolution X-ray computed micro-tomography (μCT) to scan the skulls of 21 felid specimens, including 7 extant cheetahs, one closely-related Pleistocene fossil cheetah (*Acinonyx pardinensis*), and 13 extant felid species. We then reconstructed three-dimensional (3D) bony labyrinths from those CT data, measured relative volumes of the vestibular system, and investigated its shape variation using 3D geometric morphometrics.

Our study revealed that extant cheetahs have a greater volume of the vestibular system relative to that of the entire bony labyrinth when compared to all other felids analyzed. This suggests a specialization of the inner ear of cheetahs emphasizing detection of gravity and head movements during locomotion over auditory function, playing a critical role in ensuring efficient high-speed hunts. The anterior and posterior semicircular canals (ASC, PSC) are more extended dorsally in cheetahs than in any other felid, an elongation linked in other mammals to more efficient vestibulo-ocular and vestibulo-collic reflexes associated with head movements, enabling visual and postural stability while the animal chases its prey. The fossil giant cheetah *Acinonyx pardinensis* exhibits a smaller relative volume of the vestibular system and shorter ASC and PSC, suggesting a less sensitive vestibular system, even though its postcranial anatomy already shows adaptations for fast running. Thus, the very specialized sensory perception of cheetahs could have evolved later than the middle Pleistocene last occurrence of *A. pardinensis*. These results also shed light on how predator-prey interactions influence the evolution of sprinting hunters, as in the convergent evolution of the Pleistocene North American "cheetah" (*Miracinonyx*) to prey on speedy pronghorns (*Antilocapra*).

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Technical Session XV (Friday, August 25, 2017, 2:15 PM)

GLIDING AND ROOSTING BEHAVIOR IN ELEUTHERODONTID STEM MAMMALIAFORMS FROM THE JURASSIC OF CHINA

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Identification of locomotor modes in fossil taxa is critical for assessing paleoecological diversity. This is especially relevant for early mammaliaforms because they were historically stereotyped as terrestrial generalists with limited ecological diversity. Recently described fossils have challenged this stereotype by demonstrating considerable ecomorphological diversity in multiple mammaliaform groups, including eleutherodontid haramiyids. Here, we investigate the locomotor preferences of eleutherodontids from the Jurassic of China, using previously published and new specimens. Limb and jaw measurements were collected from a considerable sample of modern mammals, which are used as analogs for discerning locomotor modes of extinct mammaliaforms via multivariate statistical analyses. Results indicate that some of the eleutherodontid specimens, including BMNH2940, BMNH2942, BMNH1133 and *Xianshou* (BMNH3253), are gliders, and other eleutherodontids such as *Shenshou* (LDNHMF2001) are likely non-gliding arborealists or scansorialists. Fossil evidence of patagia in BMNH2940 and BMNH2942 provide further support for this conclusion. Together, these fossils suggest that the gliding adaptation evolved from arboreal ancestry in the eleutherodontid clade, an iterative evolutionary phenomenon that has also occurred in several extant mammal clades. In addition, the manual and pedal digits show similar dimensions to the pedal digits of modern roosting bats, suggesting that eleutherodontids used both their forelimbs and hindlimbs to roost. Although the Jurassic *Volaticotherium* has been previously described as a gliding crown mammal, the eleutherodontid gliders are the first case of stem mammaliaform gliders. Further, roosting behavior has not been described in any other Mesozoic mammal. Thus, the specialized gliding and roosting ecomorphologies of eleutherodontids represent adaptations previously unknown in stem mammaliaforms, and they support prior assertions that mammalian ancestors convergently evolved many of the ecologically diverse behaviors that appear in crown mammals. Finally, they reinforce previous claims of a rapid taxonomic and morphological diversification of mammaliaforms in the Jurassic.

Technical Session XI (Friday, August 25, 2017, 11:30 AM)

TOWARDS A BETTER RESOLUTION ON THE PHYLOGENY OF PANDELPHINA (CETACEA: ODONTOCETI): DEFINITION OF NEW MORPHOLOGICAL CHARACTERS

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The Pandelphina was originally defined with molecular phylogeny studies of living species, and includes the most recent common ancestor between *Platanista* and *Delphinus* and all its descendants. However, there is no consensus about its monophyly when including fossil taxa, due to inconsistency in the taxa and character included in the different analysis. To improve the understanding of evolution within Pandelphina we aim to review in detail the characters used in these matrixes, its description and coding, as well as the definition of new characters. The morphological characters (soft and bony tissue), were proposed and then evaluated comparatively between the species and also observed in ontogenetic series of specimens. CT scan visualization and rendering 3D models were performed in OsiriX 5.6 for: *Cephalorhynchus eutropia, Sotalia fluviatilis* (CT only)*, S. guianensis, Globicephala melas* (dolphins and the pilot whale, Delphinidae); *Phocoena phocoena* (porpoises, Phocoenidae); (pilot whale); *Pontoporia blainvillei* (la plata dolphin); and *Inia geoffrensis* (amazon river dolphin). We could observe the morphology of soft tissue structures of the head and its connection to the skull. For comparisons we used available descriptions from *Tursiops truncatus* (bottlenose dolphin), *Kogia sima* (pigmy sperm whale) and *Mesoplodon desirostris* (beaked whale). To test for variation measurements were taken on extant and extinct taxa, as follows: Delphinidae (n=28), Pan-Inia (n=16), Inioidea (n=7), Kentriodontidae (n=24), Monodontidae (n=1), Odobenocetopsidae (n=2), Phocoenidae (n=20), Platanistidae (n=3), Platanistoidea (n=2) y Pontoporiidae (n=9). CVA and kruskal wallis analysis were performed, resulting in the identification of four less variable cranial characters: morphology of the melon, shape of the anterior extension of the melon, expension of the air sac system. All of which presented significantly higher interespecific than intraspecific variation in the data set analyzed. Future directions are to include more taxa to this data set for the correct definition of these characters and its inclusion on two of the most complete and reviewed matrix available in literature.

Grant Information**:**
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Technical Session X (Friday, August 25, 2017, 9:30 AM)

EVALUATION OF FLIGHT CHARACTERISTICS OF CANADIAN AZHDARCHID PTEROSAUR MATERIAL REVEALS UNIQUE FUNCTIONAL MORPHOLOGY AND HINTS AT HIDDEN AZHDARCHID TAXONOMIC AND ECOLOGICAL DIVERSITY

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The Royal Tyrrell Museum of Palaeontology (TMP) houses several specimens of relatively large azhdarchid pterosaurs with estimated wingspans of approximately 4.5 meters from the Late Cretaceous of Alberta, Canada. Most of the material appears to belong to a single taxon, represented by well-preserved cervical vertebrae from multiple age classes and a partial skeleton (TMP 1992.83.4) with three-dimensionally preserved cervical vertebra, proximal wing, and partial hind limb. Here we present on the functional morphology of TMP 1992.83.4, with focus on the load-bearing capacity of the neck and limb elements. Although this material was previously described and tentatively referred to *Quetzalcoatlus*, we find that TMM 1992.83.4 differs significantly from *Quetzalcoatlus* specimens in functional characters of the cervical vertebrae, suggesting referral to a distinct taxon. We use CT imaging to resolve cortical bone thickness in key elements, apply beam theory to estimate relative cantilever failure loads, and compare these maximum loads in TMM 1992.83.4 to those of other mid-sized pterosaurs, particularly *Quetzalcoatlus*. We find that the wing morphology of TMP 1992.83.4 and *Quetzalcoatlus* are very similar; the Relative Cantilever Failure Force (RCFF) of the humeri for both taxa are about 3.5x body weight. In both taxa, the robust morphology of the articular ends of the proximal wing elements would have increased drag on the wing (even with significant soft tissue faring) in exchange for improved compressive load resistance and muscle attachment area. The neck of TMP 1992.83.4 appears to have been quite robust, significantly more so than in *Quetzalcoatlus*. The well-preserved C4 vertebra in TMP 1992.83.4 was found to have a RCFF of 5.9, in contrast to a RCFF of 3.0 for the same element in *Quetzalcoatlus*. This suggests that TMP 1992.83.4 had a comparatively robust, potentially well-muscled neck. The robust build of TMP 1992.83.4, combined with apparent adaptations for compressive load resistance in the humerus and fourth metacarpal, are suggestive of an animal better adapted for rapid launch and burst flight than for maximally efficient soaring. While *Quetzalcoatlus* seems to have had a more gracile neck, it may be the case that azhdarchids were generally more robust, burst-adapted animals than previously suggested. Our analysis provides a better understanding of the build, locomotor performance, and potential ecology of the Canadian pterosaur and azhdarchids in general.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

RUMINANT DENTAL WEAR SUPPORTS THE EXISTENCE OF HETEROGENEOUS ENVIRONMENTS IN THE EAST AFRICAN EARLY MIOCENE

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The divergence and subsequent evolution of apes and monkeys is well documented by the rich record of early Miocene fossil sites found in Kenya and Uganda. Traditionally early catarrhine primates in East Africa were thought to inhabit dense tropical forests. Recently, isotopic analysis of mammalian enamel has indicated the presence of variable habitats. Isotopic signatures are consistent with open canopy forest, woodlands, and perhaps some non-forested areas. Ruminant artiodactyls (stem pecorans and tragulids) are common at these catarrhine-rich fossil sites, and it is well established that later pecorans such as bovids and cervids thrive in open habitats. Therefore, ruminants may be one of the first groups to utilize open habitats as they appear in East Africa. Using two well established dietary proxies (mesowear and hypsodonty), we tested the hypothesis that ruminants were beginning to utilize non-forested habitats in the East African early Miocene. We collected novel dietary data from 232 specimens of *Dorcatherium, Canthumeryx* and *Walangania* from nine early Miocene sites in the Napak, Kisingiri, Tinderet, and West Turkana fossiliferous areas. Hypsodonty indices for both pecorans and tragulids are stable throughout the early Miocene and only increase in the middle Miocene. In contrast, we see differences in mesowear scores between taxa and geographic areas in the early Miocene. At Kenyan and Ugandan early Miocene sites, pecorans consistently have higher mesowear scores than tragulid ruminants. Higher mesowear scores are correlated with diets causing increased abrasion such as tougher vegetation or increased grit consumption. *Walangania* specimens from Napak have the highest mesowear scores, higher than all tragulid species and contemporaneous *Walangania* from Kenya. When compared to data from modern ruminants, the mesowear results for *Walangania* at Napak are extreme for true browsers and overlap with mesowear scores for mixed feeders. This suggests pecorans from Napak were consuming a more abrasive diet than at similarly aged Kenyan localities. The early utilization of less

forested habitats by pecorans indicates a degree of dietary flexibility not seen in contemporaneous tragulids. Pecoran ruminant diversity and abundance increases through the middle Miocene while the abundance and diversity of tragulids decreases significantly from the early to middle Miocene. These results corroborate previously reported isotopic results, and indicate that variable habitats were available to catarrhines during the early Miocene.

Grant Information:
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Technical Session III (Wednesday, August 23, 2017, 2:30 PM)

THE FUNCTIONAL SIGNIFICANCE OF PTILOPODY IN EXTANT AND EXTINCT BIRDS

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The presence of crural and tarsal feathers in fossil paravians are often interpreted as aerodynamic structures. However, this is not necessarily always the case. By contrasting the feathers seen in these fossils with a review of the non-paleontological literature and specimens in modern ornithological collections, I show that crural and tarsal feathering, known as ptilopody, occurs in many species of modern birds.

While some extant taxa have large crural feathers and may utilize them functionally to increase stability during dives, or to assist in maneuvering in-flight, many instances of ptilopody are unlikely to be aerodynamically significant for extant, or fossil birds. In some animals, such as ptarmigans and some owls, ptilopody helps insulate the feet in cold climates. Additionally, some owls use feathers on the feet and legs to muffle sound as they approach their prey. In other avian species, such as chickens and pigeons, ptilopody is for display.

Breeders have artificially selected species of chicken and pigeon for high degrees of ptilopody for thousands of years. More recently, researchers have identified some of the genes that regulate ptilopody in silkie chickens. This trait in silkie chickens is controlled by three genes, 2 dominant (Pti-1 and Pti-2) and one recessive (Pti- 3). These genes may act either individually, or in concert to produce feathers along the leg. Although breeders only select and breed silkie chickens with elongate, plumaceous feathers, periodically a variant form of leg feathering known as 'vulture hock' recurs in these chickens as a mutation related to leg feathering. ‘Vulture hock’ causes elongate, stiff, asymmetric, pennaceous and overlapping feathers, which project posteriorly from the leg. ’Vulture hock’ repeatedly recurs in spite of continuous efforts by breeders to remove this trait. While it is currently unclear if a similar morphological change occurs in other avian species, this repeated, spontaneous occurrence of pennaceous, elongate and overlapping feathers show that it may be relatively easy for large, pennaceous feathers to suddenly arise in clades with otherwise plumaceous ptilopody.

These results show that ptilopody is phylogenetically widespread in extant birds, with a variety of possible functions and that pennaceous feathers may arise from plumaceous ones through relatively minor genetic changes. Going forward, these factors must be included in any analysis of crural and tarsal feather function for both extinct and extant paravians.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A PLEISTOCENE RANCHOLABREAN LARGE MAMMALIAN FAUNA FROM THE ARANSAS RIVER, SAN PATRICIO COUNTY, TEXAS

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This research is reporting on a Rancholabrean age assemblage from the Aransas River, San Patricio County, Texas collected in 1940-1941 by the Work Projects Administration (WPA) which was following up on research done at the collection locality by Hay (1926). The WPA collection (Texas Memorial Museum collections) was very extensive but has been left unpublished. The only documentation found for the WPA 1940-1941 collections is in the State-Wide Paleontologic-Mineralogic Survey of Texas Preliminary Survey Report.

A total of 28 species were found in the WPA collections. These include *Bison*, *Camelops* sp., *Canis dirus*, *Equus* sp., *Eremotherium* Mastodontidae, *Equus* sp., Crocodilia, *Neochoerus pinckneyi*, and *Taprirus*. The variety of species found at the location seem to represent both plains and a riparian type environment around the river.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

CRUISIN’ THE DEVONIAN HIGHWAY: THE 50TH ANNIVERSARY OF THE I-71 DIG

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The year 2015 marked the 50th anniversary of the initiation of the Interstate 71 (I-71) Project, a large-scale paleontological salvage operation conducted by the Cleveland Museum of Natural History in cooperation with the Ohio Department of Transportation between 1965 and 1968. Ground disturbance during the construction of I-71’s terminal stages in Cleveland impacted fossiliferous deposits of the Cleveland Shale Member (Fammenian) of the Devonian Ohio Shale, which preserves remnants of an anoxic, shallow epeiric sea bottom. The excavation uncovered hundreds of vertebrate, invertebrate, and plant fossils and cut through approximately 8.8 km (5.5 miles) of fossil bearing rock; in places cuts were deeper than 15 meters (50 feet), making it one of the longest continuous excavations ever undertaken in North America. The vertebrate fossils recovered include arthrodires (e.g., *Dunkleosteus*), sharks (e.g., *Cladoselache*), and paleoniscoid fish (e.g., *Kentuckia*). Many specimens featured anatomical elements not previously well recorded, including remarkable soft tissue impressions, gut contents, and 3-D cartilaginous elements. Although the total excavation was not precisely mapped, the intensity of the collection program and the large area covered provides one of the best records of the distribution of vertebrate remains along an epeiric sea bottom ever documented. Fifty years hence, much of the collected specimens have been prepared and will be highlighted as part of the museum's Centennial Transformation Project. However, the volume and condition of the I-71 collection presents ongoing challenges, both in terms of preparation and collections management. In the mid 1990’s several specimens from the Cleveland Shale Member were treated for rampant pyrite disease via combinations of reagent alcohol, methanol, polyvinyl acetate and Butvar, all of which proved ineffective. The long-term storage of I-71 specimens in the collection is an ongoing process of pyrite disease mitigation and remediation.

Technical Session XV (Friday, August 25, 2017, 3:45 PM)

THE GLOBAL AFFINITIES OF CRETACEOUS INDIAN FAUNAS

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During the latest Cretaceous and early Paleogene, India was an isolated island continent, having split from Madagascar and the rest of Gondwana before about 85 million years ago. Under a strict vicariant model, India's faunas at this time would be expected to be exclusively Gondwanan, and indeed they do include many typical Gondwanan taxa. However, several Laurasian clades, including eutherians and a troodontid, were also present in Cretaceous India. Recent work has further shown that the Deccan Volcanic Province and the Cauvery Basin represent distinct faunas, with the Cauvery Basin's Kallamedu Formation more similar to Late Cretaceous Madagascar, but a global comparison is needed to fully understand the affinities of India's Late Cretaceous fauna.

We collated global family-level Cretaceous and Paleocene tetrapod occurrences, with 486 families represented across 561 geological formations. We calculated pairwise faunal similarities using a modified Forbes metric. Each Indian locality was most similar to other Gondwanan formations: the Kallamedu Formation to the Madagascan Maevarano Formation, and the intertrappean and infratrappean beds to low-diversity South American formations. The inter- and infratrappean beds were highly similar to one another, but neither was to the Kallamedu Formation. An undirected network of formations, weighted using faunal similarities, identified formation community structure using edge betweenness values, resulting in three major clusters. Two of these mostly comprise early Cretaceous formations of North America and Asia. The third mixes Late Cretaceous and Paleocene sites, with subgroups largely corresponding with geographic regions, two of which are primarily gondwanan. The first includes the Kallamedu Formation and is characterised by the presence of bothremydid turtles and crocodylomorphs. The second is dominated by titanosaur-bearing faunas, including all other Indian formations, suggesting that this split may be driven in part by size-dependent preservational biases, although titanosaurs are also present in the Kallamedu Formation.

Our results suggest that the presence of northern clades such as eutherians and troodontids in Indian localities are anomalies, and that India’s Cretaceous fauna was dominated by its Gondwanan past. That all formations in Cretaceous India were most faunally similar to other Gondwanan formations suggests that the difference between the Kallamedu Formation and the Deccan Volcanic Province was probably driven by local ecological or environmental factors.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

DESCRIPTION OF TOOTH REPLACEMENT PATTERNS IN A JUVENILE *TARBOSAURUS BATAAR* (THEROPODA, TYRANNOSAURIDAE) USING CT-SCAN DATA

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Polyphyodonty is a characteristic commonly present in non-mammalian vertebrates and is essential in maintaining their functional dentitions. Tooth replacement patterns are diverse and provide important information on the morphology and function of the dentition. In Archosauria, however, details of tooth replacement patterns can hardly be obtained by external observations because their immature teeth are concealed by bony alveoli. We examined well-preserved dentitions (both premaxillae, left maxilla and both dentaries) of a juvenile tyrannosaurid *Tarbosaurus bataar* by computed tomographic scanning and obtained detailed data on the tooth ontogeny and replacement patterns. This is the first study on detailed tooth replacement patterns in coelurosaurian theropods based on CT data.

3D-rendered dentitions showed obvious, alternate replacement patterns, suggesting the presence of a time lag between the odd- and even-numbered alveoli. In the left maxillary dentition, the replacement process in the odd-numbered alveoli was more advanced than that in the even-numbered alveoli. The series of odd-numbered alveoli showed a pattern in which replacement appeared to take place from the distal to mesial order. In the premaxillae, the replacement teeth in the even-numbered alveoli were more mature than those in the odd-numbered ones. Neighboring two alveoli in the left premaxilla-maxilla junction had relatively mature replacement teeth, suggesting discontinuity of replacement patterns between the premaxillary and maxillary dentitions. This may facilitate the morphological and functional differentiation between the two dentitions previously inferred in tyrannosaurids. In the dentaries, the replacement process in the even-numbered alveoli was more advanced than that in the odd-numbered alveoli, producing simple alternate patterns. Such a simple alternation had never been reported in the adult tyrannosaurid specimens and thus may represent a juvenile condition in this clade. Under the simple alternation pattern, the half of functional teeth in a single dentition would be shed at the same time, potentially causing a serious problem in the foraging function, thus suggesting it is unlikely that such a pattern would have been retained throughout life. Therefore, this is the first evidence potentially suggesting ontogenetic changes in tooth replacement patterns in the tyrannosaurid dentary dentitions, which were considered constant throughout growth in a previous study.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A REVIEW OF JAPANESE PLEISTOCENE RHINOCEROTIDAE (MAMMALIA, PERISSODACTYLA) AND PALEOBIOGEOGRAPHICAL SIGNIFICANCE

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The Pleistocene rhinocerotid fossils have been found in Central and Western Japan. Several specimens of them had been identified as *Dicerorhinus* or *Rhinoceros*. Recently, taxonomic revisions of Eurasian Pleistocene rhinocerotids have been conducted and the fossil species usually referred to the genus *Dicerorhinus* have been reassigned to *Stephanorhinus*. In Japan, however, a taxonomic revision of the fossil rhinocerotid has not been undertaken since its first descriptions. Here, I review the fossil records of the Pleistocene rhinocerotids in Japan and discuss its taxonomic affinities and paleobiogeographic significance.

The Early Pleistocene fossil records are rare in Japan. An upper tooth row assigned as *Rhinoceros* aff. *sinensis* has been found in possibly Lower Pleistocene in Aira, Kagoshima Prefecture. However, it is difficult to identify it belong to *Rhinoceros* because the teeth are heavily worn down. Therefore, I re-identified this specimen as Rhinocerotinae gen. et sp. indet. Footprints of rhinocerotid have been found in the earliest Pleistocene (ca. 2.5 Ma) beds in several localities in Mie Prefecture, suggesting that rhinocerotid have already presented in Japan by this age. Five fossil records of rhinocerotid have been known from the Middle Pleistocene in Japan. Of these, a skull fragment and two limb bones from Western Japan were re-identified as *Stephanorhinus kirchbergensis* and *Stephanorhinus*. sp., respectively. The Late Pleistocene fossil record of rhinocerotid is unclear. Only an isolated lower cheek tooth has been known from probably the Late Miocene deposit in Kuzuu, Tochigi Prefecture, although its detailed stratigraphic data is uncertain.

The immigration event in Japan during the Early and Late Pleistocene is uncertain due to incompleteness of the fossil record. According to other studies, the immigration of continental Asian taxa in Japan occurred twice during the Middle Pleistocene: around 0.63 Ma, with Southern Chinese fauna, and around 0.43 Ma, with Northern Chinese fauna. *Stephanorhinus kirchbergensis* is a common taxon within Northern Chinese faunas in the Middle Pleistocene. The taxa belonging to the second immigration event and collected from several localities that rhinocerotids found are comparable to the Middle Pleistocene Northern China fauna. A relationship between *S. kirchbergensis* from China and the Japanese Middle Pleistocene rhinocerotids could suggest that this taxon reached the Japanese archipelago, together with several other Asian taxa, around 0.43 Ma.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

AMBER AND AMBIGUITY: A LIZARD'S TALE

HANDYSIDE, Ellen, Queen's University, Dartmouth, ON, Canada; TAPSCOTT, Madi, Queen's University, Kingston, ON, Canada; NARBONNE, Guy, Queen's University, Kingston, ON, Canada; LARSSON, Hans C., McGill University, Montreal, QC, Canada; TAHARA, Rui, McGill University, Montreal, QC, Canada; DECECCHI, T. Alexander, Queen's University, Kingston, ON, Canada

Vertebrate inclusions in amber deposits are rare in the fossil record, known for only a few localities and time slices. Yet their 3D preservation of both hard and soft tissues offer palaeontologists a detailed glimpse into the biology of extinct life that is not possible through other preservation methods. Here we will discuss a new study on a previously unreported fossil lizard specimen preserved in amber that has been housed in the collections of the Queen's Miller Natural History Museum. Using high resolution X-ray Microscopy scans we have reconstructed a 3-D digital model of this specimen including internal anatomy and to document the morphology and paleoecology of this specimen. Based on the lightly keratinized tubercles, lack of a pineal foramen, fused frontals, reduced (<7) cervical count and short parietal supratemporal process we place this specimen into the Gekkota. The specimen shows a high phalangeal index and recurved claws suggest a scansorial lifestyle, though taphonomy prevents assessing if toe pads were present. As the specimen lacked locality data we have undertaken Fourier Transform Infrared Spectroscopy (FTIR) and stable isotopic (C, H) analysis to investigate the paleoenvironmental conditions of the depositional environment. The highly negative Carbon-13 isotopic signal suggested that our sample is derived from Angiosperm resin and of Neogene in age from an area of high precipitation. FTIR shows a similar spectrum to other vertebrate bearing deposits from the Dominican and suggest that our sample is from this region. This combination of techniques has allowed us to rediscover the history of this specimen that had been lost due to insufficient documentation and gain a glimpse into the morphology, phylogenetic position and paleoecology of this specimen.

Technical Session VII (Thursday, August 24, 2017, 3:00 PM)

RECONSTRUCTING THE FEEDING APPARATUS OF A STEM BIRD: A COMPARATIVE STUDY IDENTIFYING OSTEOLOGICAL CORRELATES TO MUSCLES IN THE SKULLS LIVING ARCHOSAURS AND APPLYING THEM TO A FOSSIL TAXON

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The skulls of birds are remarkably modified from their theropod ancestors, incorporating highly kinetic bills that move independently of the braincase and a specialized jaw musculature. However, the origins and the variations among the musculoskeletal structures associated with this evolutionary novelty remain poorly understood.

In this study, we used contrast-stained μCT scans of palaeognathous birds (*Nothoprocta pentlandii*, *Dromaius novaehollandiae*) and aquatic (*Phalacrocorax penicillatus*, *Gavia stellata*) and terrestrial neognathous birds (*Gallus gallus*, *Porzana carolina*), and a crocodilian (*Alligator mississippiensis*) to identify osteological correlates to the adductor mandibulae, pseudotemporalis, and pterygoideus muscle complexes, and the depressor mandibulae muscle. We note differences in the adductor complex musculature between palaeognathous and neognathous birds, particularly in the size of the divisions of the adductor mandibulae externus and pterygoideus muscles. The osteological correlates to cranial musculature that we identified were then used to develop a hypothetical reconstruction of the musculature of the Cretaceous stem bird *Hesperornis regalis*.

Hesperornis was a gigantic, toothed, flightless taxon with a robust postcranial skeleton specialized for foot-propelled diving. It is also the only near-crown Cretaceous bird with nearly complete skulls preserved in three dimensions. Study of these skulls revealed osteological correlates of jaw muscles resembling those highly derived modern aquatic neognath lineages. These structures similar to those seen in modern pursuit diving birds like cormorants, penguins, and loons, include the sagittal and transverse crests of the parietal and the enlarged zygomatic process of the squamosal for the divisions of the adductor mandibulae externus in the temporal region. The substantial similarity of the adductor chamber of *Hesperornis* to specialized aquatic neognaths represents a remarkable convergence, indicating that modifications to the adductor musculature equivalent to those in modern taxa could occur in concert with an otherwise primitive skull.

Grant Information:
Yale Institute for Biospheric Studies

Technical Session I (Wednesday, August 23, 2017, 10:15 AM)

TOOTH REPLACEMENT, MIGRATION, AND LOSS IN THE EARLIEST ACRODONT REPTILE

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Opisthodontosaurus is an unusual captorhinid eureptile because it possesses a small number of large, conical teeth, all of which are ankylosed to the apex of the jaw, making it the oldest known example of true acrodonty in an amniote. This eureptile shows very few signs of tooth replacement; this apparent lack of replacement is abnormal for a captorhinid, all others species known to constantly develop new teeth and showing clear evidence of replacement. Lepidosaurs with acrodont dentition show an extreme reduction, or complete lack of tooth replacement. For this reason, acrodonty is typically considered an adaptation for retaining a single generation of teeth, due to its association with limited tooth replacement in extant reptiles. What remains to be determined, however, is if true acrodonty is restricted to Lepidosauria, and if acrodonty consistently evolves in association with a reduction in tooth replacement. Tooth development and replacement in *Opisthodontosaurus* is particularly interesting because it represents a case of acrodonty that evolved independent of that in lepidosaurs.

Known from several partially articulated skeletons and numerous isolated jaw elements of various sizes, *Opisthodontosaurus* is ideal for histological and ontogenetic studies. Comparison of jaw elements of different sizes reveals an ontogenetic reduction in tooth count, likely caused by a disproportionate increase in tooth size, providing a mechanism for crowding and the eventual loss of tooth positions throughout ontogeny. Moreover, thin sections through the jaws reveal remnants of dentine and attachment tissue that are embedded within the jawbone, suggesting that *Opisthodontosaurus* frequently replaced each tooth. These successive generations of old dental tissues also trace a posterior migration of tooth positions and associated vasculature, likely due to allometric growth of the lower jaw. We also identify several replacement pits, indicating that developing tooth buds formed in soft tissue, lingual to the tooth row, thus making their preservation exceptionally rare. This allows us to conclude that acrodonty is associated with regular tooth replacement patterns in *Opisthodontosaurus*. Given the limited amount of data regarding the capacity for tooth replacement in modern acrodont lepidosaurs, these data provide convincing evidence that amniote acrodonty is not necessarily associated with loss of tooth replacement, and that acrodonty does not constrain tooth replacement.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

SYSTEMATIC AND FUNCTIONAL IMPLICATIONS OF NEW MATERIAL FROM THE LATE CRETACEOUS MAMMAL *REIGITHERIUM*

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The Late Cretaceous Patagonian mammal *Reigitherium* presents a perennially confusing cheek tooth morphology, which has hindered the anatomical and systematic interpretation of the few published specimens referred to this taxon. Newly discovered isolated dental and gnathic remains from The La Colonia Formation (Chubut Province, Argentina) provide evidence for undescribed tooth positions, and support the close relationship of *Reigitherium* with the Paleocene mammal *Peligrotherium*.

The new La Colonia specimens demonstrate the highly derived nature of the trigonid on all lower molariforms, characterized by the loss of the paraconid and crenulation of the remaining trigonid basin. The upper molariforms show a centrally placed stylocone, medio-laterally aligned between the crenulated paracone and labial cuspules; this peculiar morphology is share only with *Peligrotherium* among meridiolestidans. While the crown pattern suggest that *Reigitherium* lost the capacity for embrasure shearing, the mandible would have been limited to mediolateral movements near centric occlusion by guiding ridges formed by these principal cusps. Fragmentary edentulous dentary bones, and comparison with *Peligrotherium*, also suggest the lower cheek-tooth dental formula to have four premolars and three molars.

Morphometric and dental topographic analyses based on the lower second molars of *Reigitherium*, *Peligrotherium* and a sample of Paleogene small-bodied therians show consistency in dental variation between non-tribosphenic and tribosphenic omnivorous/herbivorous taxa. However, a Partial Least Squares (PLS) regression between shape scores and dental topography values suggests that the association between trigonid shape and dental complexity is unique for *Reigitherium*, due to the intense crenulation of its trigonid basin. The evidence presented here suggests that *Reigitherium* and several other Upper Cretaceous meridiolestidans are more herbivoroulsy specialized than any contemporary group of shrew-like or opossum-like tribosphenic mammals, possibly as a result of co-adaption with the early radiation of angiosperms in the Southern Hemisphere.

Technical Session XIII (Friday, August 25, 2017, 3:30 PM)

NEW INFORMATION ON A PARAVIAN THEROPOD FROM THE MORRISON FORMATION

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In 2005 we presented a preliminary phylogenetic assessment of WDC DML-001, showing it was a maniraptoran theropod with paravian affinities. Additional mechanical preparation and segmentation of microCT data has significantly increased our understanding of the specimen. The specimen was preserved in a very-fine clay-rich sandstone. It exhibits partial articulation and tight association in much of the preserved appendicular elements. Presacral vertebrae are not articulated, but are found in series. The pelvis and anterior caudals are absent. The distal caudals are partially articulated and are found under the right manus and forearm immediately adjacent the skull. The specimen appears to have been buried in a resting position with the head and neck pulled back against the body and the tail curled around, similar to poses found in *Mei* and *Sinornithoides*.

Further preparation has increased the number of characters for the specimen. Expanding the phylogenetic analysis to increase taxon sampling, new characters, and error checking pre-existing character scoring recovered strong support for WDC DML-001 as a basal troodontid, closely allied with the Asian taxon *Sinovenator*. It also provides new evidence on the position of *Archaeopteryx* and troodontids relative to Avialae.

The new phylogenetic tree clarifies interpretations regarding the timing and occurrences of the origin of flight. Our strict consensus tree recovers short-armed, clearly non-volant taxa at the base of Pennaraptora, Paraves, Troodontidae, and Dromaeosauridae, while long-armed taxa such as *Rahonavis*, *Microraptor* and *Anchiornis* are deeply nested within their respective subclades. This contradicts hypotheses that pennaraptorans evolved from a flying ancestor, resulting in frequent parallel neoflightlessness within Paraves. Instead, non-avialan taxa with adaptations for aerodynamic locomotion such as *Microraptor* are better interpreted as examples of parallel acquisition of aerial behavior.

Grant Information**:**
Jurassic Foundation
Experiment.com

Technical Session XII (Friday, August 25, 2017, 11:30 AM)

CENOZOIC MARINE REPTILES OF CENTRAL VIRGINIA: EVIDENCE FROM THE EARLY EOCENE AND MIDDLE MIOCENE AT THE CARMEL CHURCH QUARRY FOSSIL LOCALITY

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Roughly 100 km from the preset-day shoreline, the Carmel Church Quarry (CCQ) fossil locality in central Virginia preserves a roughly 10 meter-thick section of marine deposits. The fauna from this site is remarkably preserved and diverse, with many different cetaceans, sharks, rays, and even terrestrial ungulates, yet little has been published regarding reptiles. Two units from this exposure have yielded herpetofaunal remains: the early Eocene Nanjemoy Fm and the middle Miocene Calvert Fm.

Certain vertebrate fossils have been recovered from the base of the Calvert Fm at CCQ, which appear to have been re-worked from the underlying Nanjemoy Fm. One such taxon is *Palaeophis*, an extinct marine snake known from many other shallow near-coastal environments. Four isolated vertebrae have been collected, each with vaulted, up-swept postzygapophyseal portions of the neural arches, single posterior hypapophyseal tubercles, and flat zygosphenes that are diagnostic of *Palaeophis virginianus*.

The Calvert Fm also contains several reptile fossils that fit more clearly with Miocene fauna. 32 crocodylian teeth have been recovered as well as three vertebrae and six un-keeled osteoderms with wide, shallow anastomosing pitting that are consistent with the tomistomine *Thecachampsa antiqua*, known from other Miocene near-shore environments of the eastern U.S. coast. One tooth is especially large (apicobasal height = 54 mm), larger than those from an approx. 5 meter skeleton from northeastern Virginia (max. tooth height = 43 mm). Sea turtles are the most common fossil reptiles, with taxa that are also consistent with Miocene faunas. These include mostly portions of carapace (n = 119), but also include at least 7 appendicular elements. The cheloniid sea turtle *Syllomus* has been recognized by its characteristic surface texture of very shallow ridges (distinct from trionychids) with small nutrient foramena. At least one neural plate exhibits the hexagonal shape typical of *Procolpochelys* (also a cheloniid known from the Calvert Fm); 3 costals may also represent this genus. Three isolated platelets of the dermochelyid sea turtle *Psephophorus* have been recovered as well, being characteristically thick, flat, and polygonal. Of these taxa, all but *Psephophorus* were likely inhabitants of near-coastal shallow environments, which is consistent with the other vertebrates of the site. Pelagic or deep water taxa are rare (as well as terrestrial taxa), but do indicate a mix of environments represented at CCQ.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DINOSAURS AND COMIC BOOKS: QUANTITATIVE REVIEW OF PALEONTOLOGICAL ACCURACY AND THE POTENTIAL FOR COMIC BOOKS FOR INFORMAL EDUCATION

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Comic books are an increasingly popular form of media with hundreds of titles produced every month that blend artistic talents with story-driven content. One of the most popular forms of scientific content in comic books is the field of paleontology, providing a great potential avenue for informal education using existing material, without having to produce new content. Dinosaurs, ice age fauna, and even Paleozoic fish have graced the pages of many comic books over the ages. However, the accuracy and therefore potential efficacy of comic books for informal education has not been evaluated for scientific validity.

In order to evaluate the potential of comic books for informal education, a sample of 151 issues was gathered from 66 different titles, 18 different publication companies, and dated from 1964 to 2017. A rubric was then established by which each issue was scrutinized for scientific accuracy of all contained paleotaxa. Main areas of evaluation were morphological accuracy, geologic age, and whether or not taxa lived in the same geographic region. Accuracy issues that were the result of unknown information at the time of publication were treated separately. The most common paleotaxa were non-avian theropod dinosaurs (35.7%), with the single most common genus in the dataset being *Tyrannosaurus* (12.0%). Pterosaurs were also very common (14.8%), particularly *Pteranodon* (8.4%).

Issues averaged 1.2 paleotaxa per issue on the cover (range: 0–5) with an average of 4.8 errors per cover (1.8 errors per cover paleotaxon). Internal content averaged 4.6 paleotaxa per issue (range: 0–21), and 14.1 errors per issue (3.1 errors per paleotaxon). The most pervasive accuracy issues were poorly defined or differentiated teeth (42.5% of all paleotaxa), over-sized paleotaxa (32.9%), and anatomically incorrect limb posture in theropod dinosaurs (24.3%). Accuracy plotted through time did not show a significant trend toward increasing or decreasing errors from 1964 to present.

By creating a repository of evaluated media, educators can be provided with knowledge of the accuracy and inaccuracy of the content, which can then be applied to lessons (formal or informal) in paleontology, evolution, and geologic time. Highlighting common errors can also help improve lesson plans for application to content not included in this study, and hopefully help drive greater accuracy in future comic book production.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

RECONSTRUCTION OF THE PEDAL MUSCULATURE IN *HERRERASAURUS ISCHIGUALASTENSIS* (DINOSAURIA: THEROPODA) AND ITS IMPLICATIONS IN THE TRANSITION FROM THE ARCHOSAURIAN ANCESTRAL CONDITION

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Because dinosaurs are obligate bipedal animals, the myology of their hindlimb has long been a focus of extensive research. Despite numerous attempts of reconstructing their hindlimb muscles, those in the pes have often been neglected in the previous studies. In order to rectify the trend, homologies of pedal muscles among extant archosaurs (birds and crocodilians) as well as their outgroups (turtles and lepidosaurs) were inferred based on detailed dissections. On the basis of the primary homology hypothesis, it was revealed that some remarkable transformations in myology have occurred within the ornithodiran lineage, such as the fusion of short and long digital extensors and losses of short digital flexors. In addition, detailed osteological correlates of most pedal muscles were determined in each dissected taxon.

On the basis of the homology hypothesis, the pedal musculature of the putatively most basal theropod *Herrerasaurus* was reconstructed based on detailed observations of its hindlimb skeletons. Most osteological correlates recognized in extant reptiles were present in the fossil specimens, leading to successful and rigorous inferences on the presence/absence and positions of attachments of most pedal muscles based on the extant phylogenetic bracketing approach. The reconstruction showed that the pedal musculature of *Herrerasaurus* basically retained the ancestral conditions for Archosauria, as are observed in extant crocodilians. This result suggests that the major part of the transformation to the specialized pedal musculature observed in extant birds did not coincide with the acquisitions of digitigrade, erect limb posture and bipedality and instead occurred along the more crown-ward part of the theropod lineage.

The present study is the first step for clarifying the evolutionary sequence of the pedal musculature in the dinosaurian evolutionary history. Further observations on a variety of fossil archosaurian taxa, especially theropods, would be necessary to understand when and how the major transitions of the pedal musculature occurred.

Grant Information**:**
Grants-in-Aid for JSPS Research Fellows

Technical Session IV (Wednesday, August 23, 2017, 3:15 PM)

ISOTOPIC OFFSETS BETWEEN DIET AND HAIR AND FECES IN EXTANT SLOTHS: IMPLICATIONS FOR PALEONTOLOGICAL INTERPRETATIONS

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Dietary interpretations of stable isotope data from fossil remains rely on an understanding of the factors that affect those values including: digestive physiology, microbial alteration, and diagenesis. Assumptions about metabolism and digestive physiology of extinct animals are made by comparing them to living relatives or to unrelated living species that are assumed to be ecological analogues. Groups like sloths complicate these assumptions because their closest living relatives, tree sloths, share some, but not all, niche characteristics with them, and because extinct ground sloths have no modern analogues. Additionally, there is little isotopic data available for extant sloths. Thus, stable isotope data from remains, including exceptionally preserved hair and feces, of ground sloths are interpreted in the context of other large herbivores, which may not be an appropriate comparison. To see if living tree sloths provide a significantly different context for the interpretation of data from extinct sloths, we collected hair, stomach contents, and feces from *Bradypus variegatus* (n=3) and *Choloepus hoffmanni* (n=12). Offsets between diet (i.e., stomach contents) and dung were 0.54 ± 0.23‰ for $\partial^{13}C$ values, higher than the fore- and hindgut fermenter offset range (-1.3‰ to -0.3‰), and 3.85 ± 1.06‰ for $\partial^{15}N$ values, slightly higher than the values of terrestrial herbivores (2.6‰ to 3.3‰). These results suggest that unique characteristics of sloths (e.g., poor thermoregulation, long retention time of food, and simplified gut flora) may lead to differences in how those isotopes are incorporated into tissues. Using these values to re-analyze stable isotope values from Pleistocene coprolites of *Northrotheriops shastensis* suggests a higher proportion of C_3 consumption than previously determined. Additionally, we found no significant differences in the $\partial^{13}C$ and $\partial^{15}N$ values between

proximal and distal tips of overcoat hairs (p = 0.65 and 0.36), nor between under- and overcoat hairs (p = 0.19 and 0.52), possibly due to low dietary diversity, growth cessation, and lack of strong seasonality in the tropics. Mean discrimination factors between diet and hairs were $?^{13}C = 4.64 \pm 0.91‰$, similar higher than the ungulate average of 3.2‰, and $?^{15}N = 1.76 \pm 0.66‰$, consistent with mammalian herbivores on a low-protein diet (2.0-3.8‰). Further analyses of other tissues and increased sample sizes will help to clarify the stable isotopic niche of sloths, and will potentially shed new light on the way we interpret stable isotope data from extinct members of the group.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

WHO ATE THESE BONES? SEM ANALYSIS OF DIGESTIVE WEAR ON THE BONES OF SMALL MAMMALS

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Predation is a significant source of small mammal bone concentrations worldwide. Paleoecological reconstruction therefore relies on accurately determining the taphonomic origin of fossil deposits. Bone breakage patterns are a well studied means for identifying predator taxa from concentrations of prey remains, but their interpretation requires large sample sizes and thus cannot be used to determine if single fossil specimens are predator-derived. The digestive process creates distinct micrometer scale linear fissures where acidic digestive juices have dissolved cortical bone, but microscopic analysis of the physical effects of digestion on the surface of prey bone remains understudied. Here we establish a quantitative approach to predator identification using Scanning Electron Microscopy (SEM) of prey remains at the 5-20 µm scale followed by image analysis. We collected the mandibles of rodents following ingestion and regurgitation by owls and diurnal raptors, and excretion by mammalian carnivores housed at local wildlife rehabilitation centers. We then imaged 5 mandibles produced by each predator species using an FEI Quanta 200 SEM. Bones exposed to gastric juices showed clear and distinctive digestive fissures, while fissures were absent on the surface of control bones cleaned by Dermestid beetles. On average, the density of microfissures on owl-digested mandibles was 2.6 times higher than for mammal-digested mandibles, and 1.6 times higher than for diurnal raptor-digested bones. Mandibles digested by owls showed a high density of microfissures and a mean fissure area of 1.6 μm^2. In contrast, mandibles digested by diurnal raptors and mammalian carnivores showed smoother bone surfaces overall, with a low density of large, deep microfissures (>10 µm). Mean fissure area for diurnal raptor-digested bones was 3 μm^2, while the mean for mammal-digested bones was 55 μm^2. Microscopic analysis of digestive fissures thus offers a promising new approach for identification of predator derived fossil concentrations. Future analyses will apply this method to microfossils of known raptor-derived origin from Holocene caves as well as microfossils of unknown taphonomic origin from the John Day Fossil Beds.

Technical Session XX (Saturday, August 26, 2017, 2:45 PM)

INTRATENDINOUS METAPLASTIC TISSUE IN THE TIBIA OF THE NINE-BANDED ARMADILLO (*DASYPUS NOVEMCINCTUS*) AND ITS USE AS A COMPARATIVE MODEL FOR METAPLASTIC TISSUE IN EXTINCT TAXA

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The developmental and functional advantages of vertebrate metaplastic hard tissue is still relatively unclear. Metaplastic tissue forms from the direct transformation of one cell type to another. Specifically, mineralization of preformed dense connective tissue results in intratendinous metaplastic tissue, and has been described in a variety of taxa and elements including turtle shell, reptilian osteoderms, sturgeon scutes, dinosaur cranial and vertebral elements, ossified tendons, portions of bird skeletons, and tendinous entheses in mammalian bone. However, histological analysis of the extent of metaplastic hard tissues, both across Mammalia and within individual mammalian bones, is lacking. Here we serially sectioned both tibiae of a nine-banded armadillo, *Dasypus novemcinctus* [Xenarthra: Cingulata], transversely and longitudinally to identify the existence and possible patterns of metaplastic tissue. We found evidence of metaplastic tissue in the tibial crest, as well as the medial side of the diaphysis and the proximal lateral side of the tibia. The metaplastic tissue in the tibial crest appears interstitially within a primary woven bone matrix. Along the lateral side, metaplastic tissue forms a thin patch in the mid-cortex superficial to compact coarse cancellous bone. The presence of metaplastic tissue seems consistent with tendinous insertions through fibrous entheses along the length of the tibia and tibial crest. The entrapment of metaplastic tissue within the tibia is likely due to appositional bone growth at the enthesis. However, the presence of metaplastic tissue on the medial side of the mid-diaphyseal and proximal portion of the tibia does not appear to be associated with any tendinous insertions. Previously, unassociated metaplastic tissue was found extensively in osteoderms, ankylosaur tail clubs, and dinosaur cranial ornamentation such as the parietal frill of *Triceratops*. Study of metaplastic tissue in modern bone, independent of tendinous insertions, can improve our understanding of its potential biomechanical advantages and thereby possibly provide clues to its use in ornamentation. Additionally, because Xenarthra is proposed to be one of the four original clades of placental mammals, analysis of metaplastic tissue in the skeleton of *D. novemcinctus* could have implications for early mammalian bone development patterns.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TINY SKELETON OF AN ARCHOSAUR FROM THE UPPER TRIASSIC (CARNIAN) PEKIN FORMATION OF NORTH CAROLINA, U.S.A.: A GLIMPSE OF A HATCHLING AETOSAUR?

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We report a tiny, incomplete but articulated skeleton of an archosaur from the Pekin Formation of the Deep River Basin, North Carolina. The specimen (NCSM 16305) is exposed in ventral view and is only 7.7 cm long but includes all or parts of 23 rows of paramedian osteoderms, some caudal lateral osteoderms, and all or parts of the right ulna and radius, both femora, tibiae, and fibulae as well as elements of the left pes. Impressions of the remnants of some of these bones help augment our interpretations. As preserved all of the limb bones are gracile and elongate relative to their cross sections. We assign NCSM 16305 to Aetosauria because (1) there are two columns of rectangular paramedian osteoderms that are wider than long; (2) the osteoderms are imbricated, with each slightly overlapping the next most posterior osteoderm; and (3) there is a small but distinct anterior projection on the medial edge of the paramedian osteoderms, all characteristics of aetosaurs. A slight narrowing, or "waist" anterior to the pelvis is also characteristic of many aetosaurs. NCSM 16305 is unusual among aetosaurs in that (A) The width:length (W:L) ratios of preserved paramedians are low (≤2:1); (B) there are no unambiguous presacral lateral osteoderms; (C) the preserved caudal lateral osteoderms appear wider than the corresponding paramedians; and (D) osteoderms 9-11 on the right side (numbered from the first exposed) possess a sharp ventral deflection. We suspect that A-B and, possibly, C, reflect ontogenetic variation, and that D is an artifact of taphonomic processes although an affinity with revueltosaurs cannot be excluded. Osteoderms are minute, ranging from 5-8 mm wide and 3-6 mm long, and were preserved with the external, ornamented side down, but some are missing and left distinct impressions of pits in the matrix. The ornamentation of NCSM 16305 thus consists entirely of circular to slightly ovate pits that are distributed more or less randomly across the surface. Impressions indicate the presence of an anteroposteriorly elongate keel at the center of ossification, but there is no indication of a boss or horn. Although many aetosaurs possess distinctive ostoderms, this specimen cannot be referred to a known genus with certainty. Both *Coahomasuchus* and *Gorgetosuchus* are known from this locality, and *Lucasuchus* from elsewhere in the formation, so it is unclear whether this skeleton belongs to any of these or to another, undescribed taxon. This is by far the smallest known aetosaur specimen known, and thus the best candidate for a hatchling individual.

Podium Symposium (Wednesday, August 23, 2017, 9:45 AM)

BUILDING A BIRD: A MUSCULOSKELETAL MODEL OF THE *ARCHAEOPTERYX* FLIGHT APPARATUS

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Evolutionary transformations revealed by the fossil record are key to understanding the history of life. However, interpreting the functional attributes of fossils is difficult, especially when transitional forms are not easily compared to extant organisms. This is particularly true for the origin of avian flight, where the earliest fossils with bird-like wings lack most skeletal hallmarks that characterize advanced flight capacity in extant adult birds (e.g., sternal keel, strut-like coracoids). Many origin-of-flight hypotheses have been proposed, but quantitative testing of these hypotheses is challenging. Were extinct theropods with feathered forelimbs capable of bird-like locomotor behaviors? How might such behaviors have facilitated the evolutionary acquisition of powered flight? To address these questions, we created a dynamic musculoskeletal model of the exceptionally-preserved Thermopolis specimen (WDC-CSG-100) of *Archaeopteryx*, traditionally considered the first bird. Methods included an integration of various digital and biomechanical approaches: 1) high-resolution, three-dimensional reconstruction (multiplanar X-ray microtomosynthesis, macro photogrammetry), 2) extant phylogenetic bracketing of *in vivo* joint kinematics, recorded using XROMM (X-ray Reconstruction of Moving Morphology), 3) aerodynamic force measurements and modeling, and 4) biomechanical modeling with SIMM (Software for Interactive Musculoskeletal Modeling) and OpenSim. Together, these approaches provide a new framework for reconstructing the three-dimensional musculoskeletal anatomy, kinematics, and force production of extinct animals. Our results suggest that in spite of having a rudimentary pectoral girdle compared to modern flying birds, paravians like *Archaeopteryx* had pectoralis and supracoracoideus muscles capable of depressing and elevating the humerus during vertical locomotor behaviors, such as jumping takeoffs, vertical descents, or wing-assisted incline running. Functionally, *Archaeopteryx* can be thought of as having an "avian" wing on a "dinosaurian" shoulder. These findings provide new insights into the evolution of the avian body plan, and illustrate a rigorous and quantitative workflow for assessing functional attributes of fossils and reconstructing locomotor evolution among various clades.

Technical Session IX (Thursday, August 24, 2017, 3:00 PM)

UNRAVELING THE UNUSUAL TAPHONOMY OF THE LOWER MUSCHELKALK (MIDDLE TRIASSIC) LOCALITY OF WINTERSWIJK, THE NETHERLANDS: THE INFLUENCE OF MICROBIAL MATS AND CURRENTS ON THE DISARTICULATION PATTERNS OF MARINE REPTILES

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The Steengroeve Winterswijk (Gelderland Prov., The Netherlands) is an active quarry complex in the Vossenveld Formation. This carbonate unit rich in algal laminates is a marginal facies of the Lower Muschelkalk (Anisian, Middle Triassic). Located northwest of the Rhenish Massif, Winterswijk is the northwesternmost outcrop of the Muschelkalk in the Germanic Basin. In contrast to all other Muschelkalk localities, where associated or articulated remains of marine reptiles are extremely rare, a large number of marine reptile skeletons of generally small size (adult length <1 m) has been collected from Winterswijk. In addition, the Vossenfeld Fm. has yielded a low diversity-high abundance record of terrestrial reptile trackways. The depositional environment of the Vossenfeld Fm. is a carbonate mudflat with very shallow water and high salinity in which sediment was trapped by microbial mats, comparable to the present-day Persian Gulf shoreline. Although the Winterswijk marine reptiles (primarily sauropterygians) are well studied, their taphonomy remains poorly understood. Here we analyze the patterns of skeletal articulation and completeness in the Winterswijk marine reptile finds and show the influence of microbial mats and limited current activity on the preservation of the

skeletons. Specimens of the pachypleurosaur *Anarosaurus heterodontus* (39%) and of *Nothosaurus* spp. (36%) are the most common. Their skeletons and remains show diverse disarticulation patterns, ranging from relatively complete articulated skeletons to clustered and isolated bones. Interestingly, a total of 47 isolated articulated or associated limbs were identified within a dataset of 327 specimens (two or more associated or articulated bones), a pattern which is not known from other marine reptile localities. Furthermore, evidence was found for the recently described "stick 'n' peel" process by which carcasses are protected from disarticulation by microbial mats. This process might have led to the preferential preservation of limbs. Current activity, as well as pre-existing shallow depressions in the sediment, must have influenced further disarticulation and subsequent grouping of bones. Anchoring by microbial mats might be one of the key processes in the decay and disarticulation of small vertebrates in environments where scavenger and grazing activity is excluded by hostile conditions. Winterswijk adds hypersalinity to the list of the previously recognized hostile conditions of anoxia and alkalinity.

Technical Session VII (Thursday, August 24, 2017, 3:15 PM)

UNDERSTANDING THE CAUSES OF PHENOTYPIC INTEGRATION PATTERNS IN THE EVOLUTION OF FLIGHTLESS BIRDS

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Phenotypic trait integration strongly controls the strength and direction of natural selection. Traits may covary due to genetic or developmental factors (e.g. two traits influenced by the same gene) or functional factors (e.g., two traits of the same bio-mechanical apparatus). Historically, these underlying factors of trait integration have been extremely difficult to tease apart. However, understanding the relative contribution of these factors is important, because they determine how much of an effect selection can have on an animal's phenotype. Studies focused on the determinants of integration in vertebrates have been largely limited to mammal skulls and jaws. By studying the integration within and between limb elements of flying and flightless birds, this study provides an opportunity to more fully understand sources of evolutionary constraint of animal form in a taxonomic group very different from mammals.

Birds have become secondarily flightless many times across the avian clade, offering natural repetition of the transition from flight back to a terrestrial lifestyle. Intriguingly, flightless birds, despite independent evolutionary routes to flightlessness, share similar skeletal limb element proportions. Flightless birds also share an affinity for sexual dimorphism of body size, unlike flying birds. In this study, we compared these shared traits of flightless birds to the patterns of trait integration seen in the limbs of flightless and flying birds to distinguish genetic and developmental from functional factors of trait integration for the first time.

In this study, we found that the limb integration patterns of flightless birds seem to diverge from a shared pattern of flying birds. This suggests a functional cause of integration (flight) rather than shared, conserved, intrinsic mechanisms that constrain the phenotype of all bird limbs regardless of flight ability. Once bio-mechanical pressures of flight have been released in flightless birds, skeletal traits are allowed to reorganize into new patterns of integration, which can impact how animal form responds to sexual selection.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TAPHONOMY OF THE FORT MCMURRAY NODOSAUR – A THREE-DIMENSIONALLY PRESERVED ARMOURED DINOSAUR WITH *IN-SITU* SKIN, SCALES AND OSTEODERMS

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The specimen was recovered from the Wabiskaw Member of the Clearwater Formation during overburden removal in the Suncor Millenium Mine. This member records a lower shoreface or proximal offshore marine environment. The presence of fossilized wood in the Wabiskaw suggests that one or more rivers were emptying into the region, and these same rivers could have delivered the specimen as well. The Wabiskaw Member contains abundant glauconite, and this mineral will only form at depths greater than 50m, thus setting a minimum depth of burial for the specimen. The carcass arrived at the seabed on its back and with sufficient force to impact and deform the immediately underlying sedimentary layers. Surprisingly, despite the trace fossils left by burrowing animals in the hosting sediments, the specimen lacks any evidence of scavenging. When found, the fossil was completely encased in a very dense and strong, but brittle concretion that ranged in thickness around the carcass from 20cm on the upper side to 40cm on the lower, seabed side. Growth of the concretion must have commenced immediately after the carcass arrived at the seabed, preventing any scavenging, and allowing for all the scales and osteoderms to retain their original, in-life configurations. The rapid growth of the concretion had the unfortunate side effect of blocking the flow of groundwater through the fossil and disabling any permineralization of the fossil bone. The organic component of the original bone decayed away leaving a weak, powdery fossil that required great care to prepare and conserve. However, the mechanical strength of the concretion prevented compaction of the fossil by the weight of the several hundreds of metres of sediments that would accumulate above the specimen during the next 110 million years, resulting in a three-dimensional, uncrushed skeleton in perfect alignment with its dermal armour. The best preservation of the scales and other associated epidermal structures is on the dorsal side, the one that was pressed into the silty sands and kept away from the sea surface. Finally, the strength of the concretion protected the specimen when it was unwittingly struck by the excavator bucket during removal of overburden in the mine.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A TETRAPOD MICROFOSSIL ASSEMBLAGE FROM THE ALLISON MEMBER OF THE MENEFEE FORMATION (UPPER CRETACEOUS: EARLY CAMPANIAN), SAN JUAN BASIN, NEW MEXICO

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New Mexico possesses an extensive record of Late Cretaceous tetrapods, primarily from the Fruitland and Kirtland Formations, representative of the middle Campanian–Maastrichtian interval. Recent work in the Menefee Formation of northwestern New Mexico has expanded this record by recovering an assemblage from a lower Campanian deltaic floodplain convergent with the western shore of the Late Cretaceous Western Interior Seaway. The Allison Member of the Menefee locally preserves a rich collection of vertebrate body fossils from the early Campanian, particularly the microfossil-bearing locality NMNH L-5636, characterized by alternating sandstones and coal-bearing mudstones indicative of a transition from freshwater to brackish or even marine environments. After collection, sediment from 5636 was screen-washed and was picked for microfossils, approximately 15% of which pertain to tetrapods. Here we provide additional data on microvertebrates from several tetrapod species. The recent discovery of an albanerpetonid-like batrachian dentary, in combination with the presence of turtle shell fragments, reinforces past hypotheses of a floodplain environment and is the oldest lissamphibian from New Mexico. Multiple squamate scales and a dental plate were recovered, however the most abundant tetrapod fossils collected from this locality are osteoderms and isolated teeth belonging to a Brachychampsa-like alligatorid, a skeleton of which has been reported from a nearby Menefee Formation locality. Ornithischian teeth are rare and consist of fragments belonging to Hadrosauridae indet., as do some other bone fragments, although a centrosaurine has been reported from the unit. Diverse theropod teeth were collected, and pertain to a wide range of body sizes indicating multiple predatory niches within the ecosystem. These specimens include teeth assigned to the dromaeosaurid Saurornitholestes langstoni, troodontids Richardoestesia gilmorei and R. isosceles and an indeterminate tyrannosaurid. Several multituberculate teeth were collected, the most diagnostic of which appear to pertain to the "Paracimexomys group". Additionally, two marsupial teeth and two metatherian mammal premolars were recovered from the site. Together these represent the oldest mammalian body fossils known from New Mexico. Ultimately this data provides a more thorough understanding of tetrapod evolution throughout a poorly documented age interval in the Late Cretaceous.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A METHOD FOR MAKING FOSSIL VERTEBRATE SUPPORT CRADLES FROM AN EPOXY CLAY COMPOUND

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In 2013 the Section of Vertebrate Paleontology at Carnegie Museum of Natural History (CMNH) received a grant from the Institute of Museum and Library Sciences (IMLS) to consolidate and improve storage of holotypic specimens. The section currently has 472 holotypes and many were in need of support cradles. Felt cloth-lined cradles made of plaster strengthened with fiberglass initially were made. These cradles provided good support for the specimens, but they tended to be heavy, subject to breakage, and shed fiberglass splinters when handled. An alternative method was sought to avoid these problems.

We modified a technique used by one of us (J. L.) to make support mounts for exhibit specimens displayed in the CMNH Mesozoic gallery, *Dinosaurs in Their Time*. Because the product that he used, a marine epoxy, is no longer available, we experimented with three different products. Only one of these was considered suitable, a two-part, permanent, self-hardening, waterproof epoxy clay compound.

The following steps are used to make a cradle: 1) felt cloth is cut to conform to the side of the specimen being cradled; 2) the two-part epoxy clay compound is mixed and then rolled into a sheet using a rolling pin; 3) the felt cloth is pressed firmly onto the epoxy clay sheet, which is then trimmed to the outline of the felt cloth; 4) the sheet is left to cure until it stiffens but still can be manipulated; 5) a plastic sheet or aluminum foil is placed on the side of the specimen that will receive the cradle; 6) the epoxy clay sheet with felt is placed on the specimen, with the felt against the specimen. The sheet is usually sufficiently rigid that undercuts are not a problem, though some manipulation may be necessary; 7) the cradle is left to harden, which can take up to 24 hours; and 8) to keep the finished cradle stable, legs can be made from the epoxy clay compound and added to the cradle, or custom-cut pieces of polyethylene foam can be used.

Cradles were made using this technique for medium to large-sized fossil mammal skulls, jaws, and postcranial bones with great success. The cradles are durable, light weight, and add little to the specimen height, which makes for efficient use of storage space. The only disadvantage over plaster cradles is greater cost for the epoxy clay compound, so this method is not cost-effective for very large specimens such as sauropod dinosaur limb bones.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

PATTERNS OF DENTAL VARIATION WITHIN VOLES OF THE GENUS *ARBORIMUS*

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Voles of the genera *Phenacomys* and *Arborimus* are represented in Pliocene and Pleistocene mammal faunas in North America, but patterns of dental variation remain poorly understood and continue to hamper taxonomic interpretations of fossils. Paleontologists historically worked primarily with the lower first molar, and established taxonomic boundaries on the basis of the relative height of mesial and distal buccal dentine tracts, and the number, proportions, and relative confluence of the triangles on the occlusal surface. These data were used to support a new classification of these voles, but sample sizes of modern comparative material and fossil specimens were small, and there is general agreement among both paleontologists and neontologists that existing data are insufficient to resolve key taxonomic problems. Ignorance of dental variation is particularly acute for the arboreal species of *Arborimus* which are relatively under-represented in museum collections and have received considerably less attention from paleontologists than has *Phenacomys*. The paucity of holdings in most museum collections makes it difficult to study isolated teeth because curators often are reticent to allow removal of teeth. This poses particular challenges for efforts to document patterns of variation in the buccal dentine tracts which can only be evaluated fully on isolated dental elements. In an effort to address this deficiency we scanned specimens of *Arborimus pomo* (n=3), *A. longicaudus* (n=2), and *A. albipes* (n=3) from the collections of the Museum of Vertebrate Zoology at Berkeley. Specimens were scanned in an Xradia microXCT 400 machine. Our goals were to generate data sets that would permit evaluation of the change in enamel thickness and relative closure of triangles through simulated wear of the tooth (evaluated by imaging slices at different levels below the occlusal surface), and to determine whether the CT data sets were sufficient to clearly resolve buccal dentine-tract patterns. Our results indicate that patterns of variation in the enamel and triangle patterns are readily discernable in the CT data and are manifested within individuals (ontogenetic wear), within species, and between species. These patterns reveal that using apomorphy-based identifications based on these dental characters alone will pose challenges for species-level resolution within *Arborimus*. In addition, we also were unable to consistently image the dentine tracts on the scanned specimens, and interpretation of tract-height was not replicable between different observers.

Technical Session XII (Friday, August 25, 2017, 8:00 AM)

EARLY EVOLUTION AND MORPHOLOGICAL DIVERSIFICATION OF MESOZOIC SQUAMATES

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The fossil record of the Squamata (lizards, snakes and amphisbaenians) shows that the oldest known true squamates come from the Late Jurassic, and fossil remains of Cretaceous squamates are relatively abundant. Qualitative observations suggest that squamates had a massive radiation in the Late Cretaceous, showing great morphological and ecological variation. Here we explore this apparent radiation in a numerical framework, by quantifying disparity trends based on jaw geometric morphology, body size and dental morphotypes. We find that squamate morphospace changed considerably through the Mesozoic, for example Late Jurassic and earliest Cretaceous squamates formed a small cluster, but later forms moved into a different area of morphospace. Late Cretaceous squamates showed a big expansion in morphospace occupation, with lizards occupying most morphospace, and amphisbaenians a different region, but very close to lizards. Mosasauroids form a relatively wide cluster with high diversity, sharing some morphospace with snakes and some lizards. Snakes form a relatively tight cluster that completely overlaps with mosasauroids. When we divided Late Cretaceous taxa by feeding modes, morphospaces show that, among the many occupied feeding modes, these were clearly separated into two, insectivorous and carnivorous. Temporal body size trends reveal that Late Jurassic and Early Cretaceous squamates were predominantly small forms, while in the Late Cretaceous squamates showed a considerable diversification of sizes mainly driven by the morphological disparity of larger marine forms such as mosasauroids. Patterns of dental disparity show a similar trend, with a small number of morphotypes dominating the Late Jurassic and Early Cretaceous, followed by a massive expansion of more complex dental morphologies in the Late Cretaceous, of which many remain in modern squamates.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

STATISTICAL ANALYSES OF MOLAR CROWN RELIEF OF BATS WITH LINKS TO FOOD PREFERENCES

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In fossil mammals teeth are often the only means to reconstruct their food preferences and ecology. With the relief index (RI), the molar crown relief complexity can be quantified three-dimensionally by a quotient of the 3D molar surface area and its 2D base area. In this study, the crown relief of all upper and lower molar positions of 30 extant bat species with known dietary preferences was investigated and the following hypotheses were tested: (1) crown relief complexity is directly linked to dietary preferences, (2) all molars within the tooth row, despite morphological differences, share a similar crown relief complexity, and (3) morphologically similar molars can differ in their crown relief complexity and dietary adaptation.

Extant bats have a large variety of dietary adaptations, e.g. insectivory, omnivory and frugivory. All molar positions display an increase in RI values from frugivorous to omnivorous to insectivorous bats, demonstrating that molar crown relief complexity is related to food preferences and is independent of molar position. A linear discriminant analysis (LDA) was performed for the logarithmized data of the 3D molar surface area, 2D molar base area, molar length, width and height to determine dietary classification. Depending on molar position, 85-97% of the individual teeth were correctly classified in their respective dietary category by the LDA.

The RI method was applied to fossil bats in order to evaluate their food preferences. 23 isolated molars of nine Oligocene bat species from fissure fillings of Herrlingen, Germany, were studied. All show the tribosphenic crown pattern that is linked to insectivory. The Oligocene bats have lower RI values than the extant bats and fall within the range of omnivorous taxa. This indicates that the fossil teeth either derive from omnivorous bats or that molar crown relief complexity of insectivorous bats was lower in the Oligocene than it is today. LDA results predict an insectivorous adaptation for 21 of the 23 fossil bat molars and an omnivorous adaptation for two of them. In 17 of the 21 molars with insectivorous adaptation this prediction was higher than 90%. The two molars with omnivorous adaptation were classified with 88% and 57% respectively. The classification of most of the fossil bat material as insectivorous suggests an increase in molar crown relief complexity from the Oligocene to Recent.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

***PLATYCHELONE EMARGINATA*, GIGANTIC CRETACEOUS MARINE TURTLE FROM BELGIUM**

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Platychelone emarginata Dollo, 1909 is a large turtle from the Late Cretaceous (Maastrichtian) chalk sediments of Limburg, Belgium. Hitherto, only the name was given to this turtle without describing details or providing figures. A single well articulated carapace (IRScNB. Reg. 1681), lacking nuchal, peripherals, and pygal plates, is preserved. The distance from the first costal to the distal end of the eighth costal is 180 cm, indicating that the original carapace was about 210 cm long. Its gigantic size, flattened shell, reduction of distal half of costals, and loss of scute sulcus, indicate that *Platychelone* is a member of true marine turtles (superfamily Chelonioidea). Neurals are rectangular shape and inclination of the first thoracic vertebra is almost vertical, suggesting this turtle belongs to either Protostegidae or Dermochelyidae. Seventh and eighth costals are medially meeting due to the loss of neurals; this condition is shared with the genus *Mesodermochelys* from the Late Cretaceous (Santonian to Maastrichtian) of Japan. Thus, it seems most probable that *Platychelone* is a closest relative of *Mesodermochelys* among basal dermochelyids. *Platychelone* has presumed autoapomorphic characters such as very thickened distal ends of thoracic ribs and irregular sculptures on carapace, not seen in any other chelonioids. This genus is only known by the holotype, whereas *Allopleuron hoffmanni*, a very common cheloniid marine turtle from in the Maastrichtian deposits of Belgium and Netherland, is known from some hundred specimens. So far, there is no ancestral or related taxon of *Platychelone* from the Campanian deposits of Belgium. The occurrence of *Platychelone* is very rare but evokes a high taxonomic diversity of gigantic chelonioids in the Cretaceous Tethys.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

VERTEBRATE SPECIES RICHNESS CHANGE FROM THE LATE MIOCENE TO EARLY PLIOCENE OF LOTHAGAM, TURKANA BASIN, KENYA

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Turkana Basin in Kenya, Africa is home to many discoveries of both hominin and non-hominin fossils. To date, a myriad of isotopic analyses has been conducted to interpret the paleoenvironment of the region. These include stable carbon isotope analysis in fossil tooth enamel and fossil eggshell to determine diet, stable carbon isotope analyses in paleosols to determine the amount of C_4 biomass in the paleoecosystem, and oxygen stable isotope analyses in fossil enamel and paleosols to determine precipitation patterns. The purpose of the present study is to ascertain if paleoenvironmental shifts from the late Miocene to early Pliocene are associated with changes in vertebrate (mammals, turtles, and crocodiles) diversity (taxonomic richness) at Lothagam site in the Turkana Basin. The upper Miocene is represented by the Lower and Upper members of the Nawata Formation, and the lower Pliocene is represented by the Apak and Kaiyumung members of the Nachukui Formation. Both formations consist of alternating sandstone and mudstone, representing a perennial fluvial system. The Lower and Upper Nawata members also show repeated volcanic activity. The Apak Member is separated from the Kaiyumung Member by a basalt layer and lacustrine strata that have been excluded due to lack of vertebrate fossils, except for fish. The fossils utilized in this study were all collected from fluvial deposits, but further details about collecting methods and deposits are not available. Thus, possible taphonomic differences among the faunas cannot be ruled out and could conceivably be affecting the analyses of species richness. To determine richness changes, I compiled specimen counts for terrestrial, semi-aquatic and aquatic fossil species for each member, excluding fish and birds. Rarefaction analysis from the Lower and Upper Nawata, Apak, and Kaiyumung Members shows a significant ($p<0.05$) decrease in species richness from the Apak to Kaiyumung Member. There is also a decrease from the Lower to Upper Nawata Member, but it is not statistically significant ($p>0.05$). Paleoenvironmental interpretations show a shift from C_3 to C_4 vegetation and a transition from browsing to grazing ungulates at the Miocene-Pliocene boundary. The general change of vegetation and a shift of ungulate abundance are plausible drivers for the decline in species richness. Further broad scale richness analyses in the Turkana Basin would be required to determine if regional climatic changes were driving the decrease of diversity observed in the early Pliocene or if the pattern was localized to Lothagam.

Romer Prize Session (Thursday, August 24, 2017, 11:00 AM)

USURPERS AND INSINUATORS: THE ROLE OF COMPETITION IN THE DYNAMICS OF THE GREAT AMERICAN BIOTIC INTERCHANGE

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The Great American Biotic Interchange (GABI), in which terrestrial taxa dispersed between North and South America, has long provided an exciting natural experiment for the study of the ecological consequences of species invasions. The imbalance in the success of the North and South American mammals that dispersed is particularly striking: descendants of North American mammals account for over half of extant mammals in South America, but only three terrestrial genera of South American origin survive in temperate North America. A number of explanations have been proposed for this imbalance, including competitive replacement of native South American mammals by their North American ecological counterparts; insinuation, in which North American immigrants filled adaptive zones that were previously unoccupied; and passive ecological replacement, in which South American mammals in a given adaptive zone went extinct prior to the arrival of any ecological counterparts from North America.

These hypotheses for the dispersal patterns during the GABI can be tested by comparing the ecological characteristics of immigrant and native South American taxa. Adaptive zones are defined for all South American mammals occurring between 15 Ma—11 ka based on unique combinations of diet, mode of locomotion and substrate use, and body mass categories.

My analysis reveals that the majority of North American taxa were insinuators that filled adaptive zones that were not occupied by any South American taxa in the last 15 Myr. Cases of possible competitive exclusion — i.e., a decline in native diversity overlapping temporally with immigrants in the same adaptive zone — are very rare; in fact, so little ecological overlap exists between immigrant and native taxa that South American taxa likely competitively excluded their North American ecological counterparts that would otherwise have dispersed. Passive ecological replacement was also rare in the GABI. Instead, adaptive zones that were vacated by extinction typically remained open. This analysis indicates that in the GABI, and probably more generally in other biotic interchanges, incumbency rather than evolutionary history gives the primary competitive advantage.

Technical Session XVIII (Saturday, August 26, 2017, 11:00 AM)

POSTCRANIAL ANATOMY OF *KAYENTATHERIUM WELLESI*: SWIMMING ADAPTATIONS IN A MAMMALIAMORPH FROM THE EARLY JURASSIC

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The latest large-scale analyses of mammalian phylogeny attest to the extraordinary radiation of crown-group mammals in the aftermath of the end-Cretaceous extinction. Yet an increasingly rich Mesozoic fossil record has revealed much earlier ecological and morphological diversification in the evolutionary history of the mammalian total clade. Recent fossil evidence documents the repeated evolution of morphological features reflecting a variety of specialized locomotor behaviors, including habitual swimming. Adaptations for a semiaquatic lifestyle have been described in docodontans, a Mesozoic mammaliaform clade. Previously undescribed postcranial material of *Kayentatherium wellesi*, a tritylodontid from the Early Jurassic of Arizona, suggests that semiaquatic habits were also present in this more basal mammaliamorph lineage.

The specimen comprises a near-complete, three-dimensional, articulated posterior skeleton, including elements never reported for any tritylodontid. The pelvis, both hindlimbs, and part of the vertebral column are present. Notably, the entire tail (29 caudal vertebrae) and a complete hindfoot (tarsals, metatarsals, and phalanges) are preserved. Bifurcate transverse processes of the caudal vertebrae are comparable to those of *Castorocauda* and of extant and fossil Castoridae. These may have supported a wide, flattened beaver-like tail, used for propulsion and equilibration in swimming. In *Kayentatherium*, as in castorids, range-of-motion analysis indicates restricted lateral compared with dorsoventral movement of the tail. The haemal spines project cranially, providing a large surface for attachment of the ventral caudal flexors and thereby enabling a strong downward swimming stroke. The neural spines, associated with the dorsal caudal extensors, are comparatively small. The hindfoot is broad and oar-like, with robust phalanges and expanded metatarsal bases that would have prevented adduction of the digits. The digits are slightly pronated, as in *Ornithorhynchus* and various semiaquatic placentals, and may have been connected by webbing or stiff hairs to form a paddle. The strongly convex proximal articular surface of the first metatarsal, unique among cynodonts, enabled independent movement of the first digit, perhaps for enhanced agility in the water. In sum, multiple specialized locomotor features in the tail and hindfoot of *Kayentatherium* indicate semiaquatic adaptation in a proximal stem mammal at least 20 million years earlier than previously known.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

CT SCAN DATA COLLECTION THROUGH LOW KV PROTOCOLS PROVIDES ACCURATE DATA ON NON-MAMMALIAN CYNODONT FROM THE SANTA MARIA FORMATION, BRAZIL

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X-ray computed tomography (CT-scan) is a useful nondestructive tool in the research of morphology of extinct organisms. Despite its increasing relevance to paleontology, it remains poorly used in developing countries, as available facilities are equipped with medical scanners rather than dedicated, custom-built equipment. Medical scanners operate with low kV values (<200), while fossil specimens usually require higher energy levels (>300kV) to properly access morphology. In order to solve this problem while acquiring data for an endocranial anatomy study on non-mammalian cynodonts, we explored the use of four standard protocols ("default", "soft", "bone" and "axial"; settings: 0,625 slices, 140 kV and 380 mA) in a standard medical scanner. The specimen used was the skull of the chiniquodontid *Probelesodon kitchingi* (MCP 1600 PV, holotype) from Santa Maria Formation (Triassic, Paraná Basin, Brazil). Fossils from the Santa Maria Formation are often rich in calcite, a mineral that is highly reflective to CT beams, creating artifacts into the dataset. The 'soft' protocol used a less focused beam, leading to a more accurate differentiation of structures when low density variation occurred between the fossil and the sediment. Given the higher sensibility, this protocol led to a better, more accurate dataset, with fewer artifacts (e.g., interference by calcite). The acquired dataset provides sensible morphological information, can be 3D modeled and give full access to internal structures. Preliminary observations on the endocast anatomy revealed that *P. kitchingi* had a poorly developed telencephalic region, as expected for basal non-mammalian cynodonts. Also, it was possible to recognize that *P. kitchingi* had proportionally longer olfactory bulbs than other non-mammalian cynodonts, suggesting accurate chemical sensibility. The use of different scanning protocols proved to be key to data acquisition, allowing the production of a useful dataset, even using low kV values. The use of a soft beam protocol is an alternative to researchers constrained by medical scanners, particularly when calcite is involved.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DERMAL ARMOR AND LIMB BONE HISTOLOGY OF THE AETOSAUR *COAHOMASUCHUS* (ARCHOSAURIA: STAGONOLEPIDIDAE) FROM THE UPPER TRIASSIC PEKIN FORMATION, DEEP RIVER BASIN, NORTH CAROLINA

HOFFMAN, Devin K., Appalachian State University, Boone, NC, United States of America; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States of America; DELGADO, Yanelis, Appalachian State University, Boone, NC, United States of America; ZANNO, Lindsay E., North Carolina State University and North Carolina Museum of Natural Sciences, Raleigh, NC, United States of America

Aetosaurs were a clade of armored, quadrupedal herbivorous to faunivorous archosaurs that were widespread across Pangea during the Late Triassic. Despite being one of the few Triassic lineages to evolve herbivory and thus a key component of Triassic ecosystems, relatively little is known about aetosaur ontogeny and its systematic significance. To better characterize growth in the clade, we undertook a histological examination of *Coahomasuchus chathamensis*, sampling a paramedian osteoderm from the holotype as well as five osteoderms (two paramedian, one lateral, and two of uncertain position) and two incomplete limb bones (tibia and fibula) from referred specimens discovered at the holotype locality. All had been damaged during in the collection process. Paleohistological procedures were performed following standard petrographic thin-sectioning of fossil material. Osteoderms were sampled transversely, longitudinally, or both, bisecting the center of ossification and/or the anterior bar or posterior margin, depending on preservation. The largest osteoderms were approximately 117 mm wide, the largest known for *Coahomasuchus*.

The identification of annual lines of arrested growth (LAGs) has been used in previous studies to obtain minimum ages for fossil archosaurs, including aetosaurs. Our work indicates that the referred specimens are from individuals ranging in age from at least two to as much as eight years old based on unambiguous LAGs. The holotype specimen of *C. chathamensis* appears to be an ontogenetically young individual, approximately two to three years old, but not a hatchling. Given paramedian osteoderm widths of up to 90 mm in the holotype specimen (sectioned osteoderm 70 mm), we hypothesize that *C. chathamensis* was growing rapidly, more so, for example, than the similarly-sized to smaller holotype specimen of *Aetosauroides scagliai* (92 mm maximum width paramedian osteoderm bearing 5 LAGs). Such rapid growth may explain, in part, the diagnostic faint radial ornamentation of subparallel grooves and ridges on the paramedian osteoderms of *Coahomasuchus*. LAGs were most clearly observed in appendicular elements, and transverse sections rather than parasagittal among osteoderm sections. Our work indicates the presence of disparate growth strategies within Aetosauria, possibly linked to a phylogenetic signal. Future efforts should investigate such trends within an evolutionary framework to more fully understand the possible implications of variable growth rates among aetosaurs.

Romer Prize Session (Thursday, August 24, 2017, 11:30 AM)

THE 'GRIT EFFECT' ON UNGULATE TOOTH WEAR: EVIDENCE FROM EXPERIMENTS AND NATURAL POPULATIONS

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Tooth wear (e.g., microwear and mesowear) has been correlated with diet in modern ungulate populations and is widely used as a paleodietary proxy (e.g., browser vs. grazer). Similarly, ungulate hypsodonty is classically viewed as a coevolutionary response to the spread of Neogene grasslands. However, the relationships between wear, diet, and hypsodonty are confounded by abiotic abrasives (e.g., soil, volcanic ash) and numerous variables, both environmental (e.g., openness, precipitation) and behavioral (e.g., feeding height, grass intake), have been correlated with hypsodonty in modern ungulate communities. To better understand the causes of tooth wear and the implications for paleoecological research, I present the results of three studies that evaluate the abrasive effects and attributes of ingested abiotic silica.

My approaches included experimentation with live subjects and observations of natural populations, both modern and fossil. Controlled feeding trials with sheep illustrated a 'grit effect' (i.e., increased microwear pitting) from diets treated with medium-grained quartz sands (250-425 μm). I also measured the proportion and grain sizes of fecal silica from modern bison (hypsodont grazers) and deer (brachydont mixed feeders) to estimate the silica contributions from local soils and plants (i.e., phytoliths). Relative to deer, bison scat contained higher proportions of medium sands (i.e., greater soil ingestion) and fine-grained silica that was uncommon in local soils and plants. Finally, a 'grit effect' was found in the microwear of extinct ungulates that had fed on ash-covered vegetation at the Ashfall Fossil Beds in Nebraska. The Ashfall ungulate community displayed

prominent pitting that obscured dietary classifications (i.e., browsers, grazers, and mixed feeders) inferred for the same taxa at contemporaneous localities.
These data document a 'grit effect' on the occlusal microwear of ungulates and also support a 'grit model' of enamel abrasion that is modulated by grain shape and size (i.e., fracture mechanics). Angular grains, such as the rhyolitic glass deposited at Ashfall, are required to abrade enamel. In this model, larger quartz grains (e.g., medium sand ingested by bison and sheep) fracture more easily during mastication to create smaller, angular grains. Further exploration of this abrasion model will strengthen the use of tooth wear proxies in interpreting paleodiets and the selective forcing for hypsodonty.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

COMPARISON OF MAXIMUM PARSIMONY AND BAYESIAN APPROACHES TO EARLY PERISSODACTYL (MAMMALIA) PHYLOGENY

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Model-based methods, particularly Bayesian methods, are the standard approach to phylogenetic analysis of sequence data. More recently, these methods have been applied to phylogenetic analysis of morphological data as an alternative to using the criterion of maximum parsimony (MP). While many of these studies concerned combined analysis of morphological and molecular data, some have applied Bayesian techniques to analysis of data matrices consisting solely of morphological characters. Model-based approaches were originally proposed as being less likely than MP to be misled in cases where homoplasy is expected to be more common, e.g., long-branch attraction, and there is some evidence that Bayesian inference (BI) can outperform MP even when analyzing morphology alone. In this study, the phylogeny of early perissodactyls was analyzed using BI and MP, based on a matrix of 207 variable morphological characters in 45 taxa. The MP analysis recovered 27 most parsimonious trees (MPTs), while the BI analysis recovered over 59,000 trees in the 95% highest posterior density interval (HPD). The consensus of the 27 MPTs and the consensus of the 95% HPD trees are largely congruent, although the MP consensus is much better resolved. The main topological differences between the results of the two methods concern the relationships among different sets of early equoids, as well as whether *Lophiodon* is united with chalicotheres or with ceratomorphs. Interestingly, both analyses recovered clades uniting derived European palaeotheriids and post-Wasatchian North American equids, to the exclusion of early putative equids and early palaeotheriids. This topology is driven in MP by similar degrees of molarization of premolars between post-Wasatchian equids and derived palaeotheriids. Premolar molarization evolved multiple times in perissodactyls, and previous studies interpreted premolar molarization in equids and palaeotheriids as homoplastic. In this instance, BI was not any more successful than MP in identifying homoplasy in premolar molarization.
Grant Information**:**
This study is supported by an award from the US National Science Foundation (DEB-1456826).

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A COMPARATIVE ANALYSIS OF RECONSTRUCTED CRANIAL MYOLOGY OF PHYTOSAURIA

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Myological reconstructions allow the function of structures such as jaws to be studied in extinct taxa, providing a functional basis for constraining habitual behaviors in those taxa. This study is the first to compare reconstructed jaw musculature of multiple phytosaur genera. Muscles of the early-branching phytosaur *Parasuchus angustifrons* and late-branching *Machaeroprosopus pristinus* were reconstructed and compared to each other and *Alligator mississippiensis*. Compared to the alligator, origins of the adductor mandibulae externus (mAME) group shift caudally in phytosaurs, coincident with the caudal location of the supratemporal fenestra and caudal projection of the squamosal. This shift is greater in *M. pristinus*, which exhibits a very large origin area and sharp rostroventral angle of mAME. The medial division (mAMEM) was larger in *M. pristinus* than the other taxa, and its angle possibly required a pulley structure to pass over the quadrate/basisphenoid. Adductor mandibulae posterior was large in all taxa, compensating for poor mechanical advantage caused by proximity of insertion to jaw joint. Pseudotemporalis was larger in phytosaurs and largest in *M. pristinus*, but the angle was similar across taxa. Pterygoideus ventralis (mPTv) size was comparable across taxa, but between the phytosaurs, distance between origin and insertion was greater in *P. angustifrons*. The rostral extent of pterygoideus dorsalis was much greater in phytosaurs than the alligator, with the rostral terminus lying equal to that of the antorbital fossa in *P. angustifrons* and far rostral to the antorbital fenestra and nares in *M. pristinus*. Depressor mandibulae (mDM) likely had two divisions in phytosaurs, with one origin on the expanded lateral surface of the squamosal and the other on a rugose, ventrally oriented process off the squamosal. Greater mDM size and complexity in phytosaurs likely compensated for poor mechanical advantage, compared with the alligator, to achieve a similar effect of quickly depressing the mandible before a bite or forcefully elevating the cranium with the mandible fixed. Most adductors functioned similarly across taxa, though the greater size and angle of mPTv and the deep mAME in phytosaurs resulted in greater closing speed and force when the jaws were opened wide, and the greater size and angle of mAMEM resulted in greater closing speed and force when the jaws were nearly or completely closed, relative to the alligator. These reconstructed muscle configurations are essential for developing future studies on phytosaur feeding mechanics.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

WHAT DOES THE CO-OSSIFICATION OF THE VERTEBRAL AND PECTORAL GIRDLE ELEMENTS SHOW ABOUT THE SKELETAL MATURITY OF DOLICHORHYNCHOPS?

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The genus *Dolichorhynchops* consists of four species: *D. osborni, D. bonneri, D. hershelensis,* and *D. tropicensis*. Adult size has been used as a characteristic to distinguish among the species with *D. bonneri* as the largest and *D. hershelensis* as the smallest species of *Dolichorhynchops*. Adult size in *D. hershelensis* is described as comparable to the size of a juvenile of *D. osborni*, with skeletal maturity based on the co-ossification of the neural spine to the centrum of the vertebra and the fusion of certain pectoral girdle elements. Co-ossification of vertebral and girdle elements has long been used in plesiosaurs to estimate their ontogenetic stage. The purpose of this study is to test whether co-ossification is a valid method for determining skeletal maturity in the genus *Dolichorhynchops*.
In this study, the *D. hershelensis* holotype (RSM P2310.1) was compared to two specimens of *D. osborni* (FHSM VP-404 and UCM 35059). UCM 35059 was previously described as a juvenile and has a centrum length that is 15% shorter on average than RSM P2310.1. FHSM VP-404 has also been described as a skeletally immature specimen of *D. osborni* and has a length of three meters. This is comparable to the estimated two and a half to three meter length of *D. hershelensis* (RSM P2310.1). Both *D. osborni* specimens show co-ossification of the neural spine to the centrum and FHSM VP-404 also shows advanced ossification of some pectoral girdle elements. Results indicate that the vertebral co-ossification used to determine adulthood in *D. hershelensis* is present in the presumably younger specimens of *D. osborni* and should not be used to determine skeletal maturity across *Dolichorhynchops*.

Technical Session XI (Friday, August 25, 2017, 8:15 AM)

EVIDENCE FOR ROSTRAL ELONGATION IN LATE MIDDLE EOCENE BOTHRIODONTINES (ANTHRACOTHERIIDAE: ARTIODACTYLA) IN NORTH AMERICA

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Anthracotheriid artiodactyls rapidly diversified and spread through northern continents and into Africa during the middle and late Eocene. At the time of their first appearance in the late middle Eocene, they had already differentiated into two major clades and multiple genera. The near simultaneous appearance of these distinct lineages on multiple continents has made reconstruction of their phylogeny and biogeographic history challenging. Recent work has brought much resolution to the history of those lineages in the Old World; less well understood are the earliest anthracotheres in North America and their evolution in the middle and late Eocene. Two genera representing these clades (the anthracotheriinae *Heptacodon* and the bothriodontinae *Aepinacodon*) are present by the late middle Eocene in North America and may represent the oldest documented records of each subfamily, although they are thought to have arrived as immigrants from Asia.
Among the oldest occurrences are specimens from the late middle Eocene (Duchesnean NALMA) Brian Head Formation of southern Utah. First noted over a decade ago, continued collecting has produced crania and postcrania of the anthracothere *Aepinacodon* and both adults and juveniles. Here I better characterize the morphology of the earliest representatives of Bothriodontinae in North America and re-examine their relationships with Old World taxa. Based on these new finds, the rostral elongation and presence of tooth row diastemata characteristic of *Aepinacodon* were already present in the oldest forms. Further, these features are readily observable even in juveniles. The morphology slightly differs from that seen in juveniles of another rostrally elongate bothriodontine, African *Bothriogenys*, and suggests these features of cranial morphology are not simply a feature of advanced ontogenetic stages. Phylogenetic analysis confirms *Aepinacodon* is deeply nested within a clade of Old World bothriodontines and closest to the dentally similar (but cranially distinct) North American *Bothriodon* as well as less well-known bothriodontines from northern Asia. These relationships lend support to prior studies that suggest the presence of a pan-continental northern fauna that dispersed in a largely east-west fashion and was distinct from a more southerly fauna that dispersed along the shores of Tethys. However, better constraining the ages for most Asian and North American occurrences is necessary to meaningfully infer direction of dispersal or diversification times.

Technical Session XVI (Saturday, August 26, 2017, 8:30 AM)

PHYLOGENETIC RELATIONSHIPS OF *PATAGOSAURUS FARIASI* AND EVOLUTIONARY IMPLICATIONS FOR EARLY-MIDDLE JURASSIC SAUROPODS

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While the evolution and phylogenetic relationships of Triassic sauropodomorphs as well as Late Jurassic and Cretaceous neosauropods have been well-studied in recent years, the evolution and phylogenetic relationships of Early to Middle Jurassic sauropods received little attention. This is partly due to stratigraphic constraints; not many body fossils of sauropods exist from this time, save for notable examples from Laurasia (mainly China, but also Europe) and Gondwana. In Argentina, the fossils of the Early to Middle Jurassic non-neosauropodan sauropod *Patagosaurus fariasi* form one of the best preserved sauropod records from this period, outside of China. However, the taxon has not received critical osteological study since its first description in 1979, despite its presence in numerous sauropod phylogenies. After a thorough revision of all eight *Patagosaurus* individuals, several characteristics and autapomorphies were revealed, specifically on the axial skeleton. These were subsequently introduced as new phylogenetic characters and added to a combination of existing data matrices. More non-neosauropod taxa were also added to this matrix, including *Tazoudasaurus*, *Amygdalodon*, *Volkheimeria*, *Spinophorosaurus*, and Chinese taxa such as *Datousaurus* and *Bellusaurus*. The matrix consists of 80 taxa and 400 characters, and a strict consensus tree was generated based on maximum parsimony. The results retrieve *Patagosaurus* as sister-taxon to *Cetiosaurus*,

more derived than *Shunosaurus* and *Tazoudasaurus*, and more basal to both turiasaurs and mamenchisaurs. The traditional cetiosaurid triad of *Patagosaurus*, *Cetiosaurus* and *Barapasaurus* breaks apart in this analysis, as the Indian taxon is more basal than the first two. Moreover, a specimen previously assigned to *Patagosaurus*, which is now an unnamed new taxon, is recovered as a highly derived eusauropod, or even as a basal neosauropod. Finally, the Early to Middle Jurassic sauropod assemblage from Argentina, including *Volkheimeria*, *Amygdalodon* and unnamed taxa, shows a high phylogenetic diversity including both basal and more derived specimens. This implies an earlier diversification of sauropods in the Jurassic than previously assumed, and the time window for this event is now pushed back further to at least the Early Jurassic. The phylogeny of contemporaneous sauropods elsewhere in Gondwana show a similar diversification was also taking place. More sauropod taxa need to be studied, however, to confirm Laurasian sauropod diversification within the same time window as Gondwana.
Grant Information:
FH was funded by DFG grant RA 1012/13-1

Technical Session VIII (Thursday, August 24, 2017, 2:45 PM)

MODULES AND MOSAICS IN THE EVOLUTION OF THE *TETONIUS* - *PSEUDOTETONIUS* DENTITION

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The *Tetonius – Pseudotetonius* lineage of anaptomorphine omomyid primates shows a strong trend towards a compact dentition with reduction of the teeth between the central incisors and the cheek teeth (i2, c, and p3). Notable changes in the dentition involve the p3 and p4 teeth. The former shows a vast reduction in size resulting in a tooth indistinguishable from the canine and i2, while the latter becomes a robust tall cusped tooth. These trends have been argued to be a result of diversifying evolution, with the i2, c, and p3 evolving rapidly when compared to molars and the last premolar. Here, we explore trends in the bivariate correlation between tooth dimensions in multiple *Tetonius* lineage segments to test the hypothesis that p3 and p4 became decoupled, with p3 becoming less and p4 becoming more associated with the molars over time. We also test the null hypothesis that neutral evolution (as opposed to diversifying or stabilizing selection) can explain the phenotypic differences observed in tooth size across this lineage, using a rate metric based on the ratio between inter- and intra-species variances, controlling for generation time and scaled to a single generation, in length and width of p3, p4, m1, and m2. Our results show a decreasing correlation between p3 and the rest of the cheek teeth and an increasing correlation between p4 and the molars over time. We further found evidence of diversifying selection in length of p3, p4, and m2 and in width of p3, p4, m1 and m2 and of stabilizing selection in length of p3 and p4. These results support prior studies suggesting different rates of evolution at individual tooth loci in the *Tetonius – Pseudotetonius* lineage. This study was possible because of the stratigraphically dense sample of *Tetonius* and *Pseudotetonius* in the Bighorn Basin that includes multiple intermediates. When intermediate forms are unknown in the fossil record, a complex pattern combining intervals of rapid divergence and stasis across time may mimic the appearance of a gradual trend.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

EVOLUTIONARY HISTORY OF RARE MIOCENE APLODONTIID RODENTS FROM ASIA AND THE HISTORY OF BIOGEOGRAPHY IN THE APLODONTIIDAE

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Cenozoic immigration histories between North America and Eurasia are extensive and complex, as Holarctic species move back and forth between the New and Old World throughout much of the last 65 million years. Those immigration histories are ecologically selective, however, especially after the Eocene, when most of the terrestrial connections required immigrants to pass through the cold climates at high latitudes. While immigration histories are well-established for some mammalian clades such as primates and carnivores, rodents remain less studied. Aplodontiid rodents (including the living mountain beaver as well as over 100 fossil species) are a diverse clade of mostly North American rodents that range from the Late Eocene through the present and represent ecologies from extremely fossorial to arboreal and terrestrial. Eocene and Oligocene faunas in North America and Eurasia indicate several immigration events among aplodontiids, but exchange is much less extensive in the Miocene, leaving Eurasia with a number of species of basal, "prosciurine" aplodontiids, a few representatives of the derived allomyine and meniscomyine clades, and only a handful of Asian species attributed to the hypsodont mylagaulid and aplodontiine clades. Until quite recently, these enigmatic derived aplodontiids were known from such limited material that it was difficult to determine whether they represented derived members of the aplodontiine and mylagaulid radiations (and hence middle Miocene immigration events) or basal members of one or both groups that likely immigrated in the early Miocene. New material enables us to place the Asian species phylogenetically in the base of the hypsodont aplodontiid radiation, suggesting that the last species of aplodontiid rodents to immigrate from North America to the Old World arrived in Asia in the early Miocene. Whether a result of the greater ecological specialization of the derived aplodontiids or a reflection of changes in the habitats at high latitudes, aplodontiids do not appear to have participated in middle Miocene and later exchange events with Asia, suggesting that immigration between Asia and North America was significantly ecologically filtered by the middle Miocene.

Technical Session XIV (Friday, August 25, 2017, 3:45 PM)

INNER BONE ADAPTATION IN SEMI-AQUATIC AMNIOTES - QUANTITATIVE 3D ANALYSIS OF LONG BONE SHAFT MICROANATOMICAL AND GEOMETRICAL FEATURES IN MUSTELIDS AND PINNIPEDS AND COMPARISONS WITH FOSSIL SEMI-AQUATIC AND AQUATIC AMNIOTES

HOUSSAYE, Alexandra, CNRS/Museum National D'Histoire Naturelle, Paris, France

Major ecological changes impose selective pressures that strongly affect the musculoskeletal system. The latter thus reflects the constraints an animal faces during its lifetime and naturally shows convergences. Long bone inner structure and cross sectional geometry are known to display a strong functional signal. The aim here is to investigate these features in semi-aquatic animals that are subject to a great range of physical demands and thus assumed to display a compromised set of adaptations for both land and water that are two media with distinct mechanical properties. We analyzed humeri and femora of two groups of semi-aquatic mammals, mustelids and pinnipeds, illustrating various degrees and modes of adaptation to a semi-aquatic lifestyle (e.g., dependence to the terrestrial environment, swimming mode and depth). This enables to distinguish the convergences from the specific adaptive traits in the context of secondary adaptation to an aquatic lifestyle in these long bones. Contrary to previous studies that essentially relied on transverse sections, we performed 3D qualitative and quantitative analyses of the bone, using X-ray microtomography and image processing. This enabled a more detailed description of the structure and notably to take into consideration the variations along the diaphysis since the latter have recently been shown to be important in some aquatic forms. Analyzing these features in extant animals is especially important in order to better understand the initial stages of adaptation to the aquatic milieu. Through comparative analyses, these data enable to make more precise inferences about the lifestyle of key fossil taxa, whose paleoecology remains debated.
Grant Information:
ANR-13-PDOC-0011

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

POSTNATAL ALLOMETRIC LIMB GROWTH IN JUVENILE CAMELS FROM THE PLEISTOCENE OF RANCHO LA BREA TAR PITS

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Cursorial mammals, especially the long-limbed artiodactyls, are well known for their lengthened distal limb segments (radius-ulna, tibia, metapodials). Studies of the allometry of juvenile limbs in many cursorial artiodactyls suggest a faster rate of longitudinal growth. A large sample of juvenile limb bones of the extinct lamine camel, *Camelops hesternus* from the late Pleistocene of Rancho La Brea were measured to see what growth trends they may exhibit and if they are consistent with patterns associated with cursorial adaptations. Analysis of the measurements revealed that the allometry trend towards gracile, longer, more slender limbs; especially in the more distal elements like the radius-ulna and tibia. In fact, *Camelops* grows with a gracile trend more consistently than any other artiodactyl that has been studied.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW *LIAONINGORNIS* SPECIMEN FROM THE LOWER CRETACEOUS JEHOL GROUP OF NORTHEASTERN CHINA

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Liaoningornis longidigitrus is a bizarre taxon among the known Ornithothoraces from the Early Cretaceous Jehol Group in Northeast China. It is one of the earliest discovered birds from the Jehol Group, but only a fragmentary and poorly preserved material (IVPP V 11303) has been described so far. This taxon was first assigned to Ornithurae by Hou in 1997, but a recent restudy indicated it is a member of Enantiornithes (O'Connor et al., 2012). In fact, our understanding of the taxon is much less than other Ornithothoraces. Here we report on a new *Liaoningornis* specimen (PMol-AB00266a, b). The new specimen is a nearly complete and mostly articulated skeleton from the Lower Cretaceous Dabeigou Formation (about 131 Ma) of Fengning County, northern Hebei Province. It is a juvenile individual, as indicated by an incomplete fusion of the synsacrum and an incomplete ossification of the sternum. It has an unique morphology of the sternum, in which a caudal end of the xiphoid process is forked laterally as a goblet-like shape. So far, this feature only appears in *Liaoningornis longidigitrus* and the Spanish taxon *Eoalulavis hoyas* among all known Ornithothoraces. The new specimen is smaller in size than *Liaoningornis longidigitrus*, but it is similar in limb segment proportions and other morphological features to the latter. Therefore, it is briefly referred to *Liaoningornis longidigitrus*. The new specimen has some enantiornithine synapomorphies: Y-shaped furcula with long hypocleideum; proximal surface of humeral head centrally concave; minor metacarpal extending distally beyond major metacarpal; metatarsal II wider transversely than metatarsals III and IV, and metatarsal IV more slender than metatarsals II and III, to support the reassignment that *Liaoningornis longidigitrus* is a member of Enantiornithes. The new specimen has a pair of long ribbon-like tail feathers, which are tapered distally as a solid sheet. Many Early Cretaceous birds such as *Confuciasornis* and some enantiornithes have been known to bear a pair of ribbon-like tail feathers, but their tail feathers keep a constant width distally and form the barbs expanded outside at the distal end. The new specimen represents the most simple and primitive style of ornamental feathers in the fossil record. This style of the tail feather probably presented only in juvenile age and then would be replaced through moulting by the more complex style seen in *Confuciasornis* and enantiornithine adults.
Grant Information:
This research was supported by the National Natural Science Foundation of China (41172026) and Education Bureau Foundation (LR2012038) of Liaoning Province.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

TOOTH STRUCTURE FOUND IN THE BASAL ICHTHYOSAURIFORM *CARTORHYNCHUS LENTICARPUS*

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The basal ichthyosauriform *Cartorhynchus lenticarpus* Motani et al., 2015 was reported from the Lower Triassic Nanlinghu Formation (Spathian) at the second level of Majiashan Quarry, near downtown Chaohu, Anhui province, China. Its skeleton shows the combination of aquatic adaptations with some terrestrial features such as the short snout and minimal increase in dorsal vertebral count, which probably indicated possibilities of occasional amphibious habits. No teeth could be discerned from the skull after careful and mechanical preparation. Considering its extremely short and narrow snout, this animal was supposed to be suction feeder, different from ichthyopterygians. However, tooth dentition is not a guarantee of suction feeding.

In order to provide insight into the dental anatomy of this species, its skull was CT-scanned. The result of scanning reveals there are clear dental grooves on the dentary, premaxilla and a part of maxilla. Then the holotype, which is housed in Anhui Geological Museum (AGB6257), was re-prepared along the dentigerous margin. Three scattered small structures, relatively low and rounded and blunt, that may be identified as the teeth were revealed, seemingly planted on the dentary. These findings are helpful for understanding dental structure and feeding habits of *Cartorhynchus lenticarpus*.

Grant Information:
Project 201511054 from the Ministry of Land and Resources of China.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

OLDEST SMILODONTIN (FELIDAE, MACHAIRODONTINAE) SKULL FROM THE LATE MIOCENE OF NORTH AMERICA

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The recently discovered Montbrook site, Levy County, northern Florida, has produced many thousands of fossils of bony fish, freshwater turtles, and *Alligator*; including frequent articulated skeletons. With the notable exception of the gomphothere *Rhynchotherium*, fossils of terrestrial mammals are rare and tend to be isolated skeletal elements and teeth. Twelve of the 13 ungulate and carnivoran taxa present at Montbrook are shared at the species-level with the latest Hemphillian Palmetto Fauna, also located in Florida ca. 200 km to the south. One of the most notable finds at Montbrook is a relatively complete, but dorso-ventrally crushed, skull of a jaguar-sized machairodontine felid. Four slightly worn teeth are present in the skull: left canine (C1), right and left third premolars (P3), and right fourth premolar (P4). The C1 is only moderately flattened, bears no serrations, and is about half the height of those of *Megantereon* spp. and *Smilodon gracilis*. The P4 lacks an ectostyle and has a well-developed, but low protocone located at the level of the mesial border of the parastyle. The P3 is relatively long, with a small anterior cusp and disto-lingual basal expansion of the crown. A very small alveolus is located distal to the P4 for a single-rooted M1, but no alveoli are present between the P3 and C1. Additionally, the mesiodistal orientation of P3 is slightly offset from that of P4. To date, neither mandibles nor lower teeth referred to this taxon have been recovered from Montbrook. A similar-sized machairodontine from the Palmetto Fauna, *Rhizosmilodon fiteae*, was described based solely on mandibles, lower teeth, and limb bones. While direct comparisons cannot be made due to non-overlapping elements, the Montbrook skull is clearly from a machairodontine felid of similar size, and has complimentary morphology allowing for a relatively confident referral to *R. fiteae*. Previous absence of crania and upper dentition has contributed to different opinions regarding the phylogenetic relationships of *R. fiteae*; either as the basal most representative of the Smilodontini or as the sister taxon to Smilodontini+Homotheriini. The Montbrook skull provides a wealth of new information to evaluate this question. Results from cladistic analyses that include the new skull support the previous hypothesis that *R. fiteae* is a smilodontin. Further resolution of its relationships within that clade, however, requires a more detailed comparative analysis and scoring of additional cranial characters.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW INSIGHTS INTO *TENONTOSAURUS TILLETTI* (DINOSAURIA; ORNITHOPODA) FROM AN EXCEPTIONALLY PRESERVED SPECIMEN

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Tenontosaurus tilletti is one of the most completely known Early Cretaceous (Aptian-Albian) dinosaurs, represented by more than thirty partial skeletons. Even so, some questions remain about the morphology of this species. Herein, we present new observations from an exceptionally well preserved subadult specimen from the Antlers Formation of southeastern Oklahoma. OMNH 58340 preserves nearly every bone in articulation including the rarely preserved distalmost phalanges. The preservation of these distal manus elements reveals a phalangeal formula count of 2-3-3-2-2. With the complete hand morphology now known, only digits I and II are shown to terminate with a strongly arched claw-like ungual, while digits III, IV, and V are terminated by small sesamoid-like phalanges. In addition, this well-preserved specimen has numerous trauma-related skeletal pathologies. Inspection of other *Tenontosaurus* skeletons suggests that healed pathologies in this taxon are exceedingly rare. Computed tomography (CT) visualizations reveal the presence of a large internal abscess in pathologic metacarpal IV of OMNH 58340, suggesting a post-trauma osteomyelitic infection. The metacarpal also possesses an elongated bone spur on the left surface, characteristic of subperiosteal tissue deposition following trauma. The pathologies present on digit I include extreme exostosis around the shaft of the phalanx, likely resulting from post-traumatic infection. Furthermore, a series of four left dorsal ribs (L7-L10) possess swollen calluses that appear to have developed following fracture of those elements. Based on the location of the pathologies and the similar degree of healing, we hypothesize that this individual likely experienced the injuries as part of a single event (e.g., a fall or failed predator attack) which was not immediately fatal, but would have significantly affected the animal's locomotor abilities.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A MID PALEOCENE MAMMALIAN FAUNA FROM EASTERN MONTANA

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The Williston Basin in southwestern North Dakota and adjacent eastern Montana has produced fossil mammals from the Cretaceous (Lancian), early Paleocene (Puercan), and late Paleocene (Tiffanian) but, to date, only sparse finds from the mid Paleocene (Torrejonian). Here we report the occurrence of a small mammalian faunal assemblage in strata of the upper part of the Ludlow Member of the Fort Union Formation of eastern Montana, just north of the town of Ollie, which, on palynological, continental molluscan biostratigraphic, magnetostratigraphic, and radiometric grounds, are thought to broadly correlate with the mid Paleocene. The stratigraphic position of the Ollie North locality is further noteworthy in being approximately 18 m below a regionally extensive silcrete horizon, the so-called Rhame bed, associated with an unconformity of uncertain duration possibly lasting into late Paleocene (Tiffanian) time. The mammals of the Ollie North locality represent the youngest known mammalian fauna below this potentially significant erosional horizon. The Ollie North locality is exposed as wind deflation pockets in the ditches and adjacent areas on both sides of a secondary state highway; the matrix is an unconsolidated, fine-grained sandstone. Approximately 150 mammalian specimens have been recovered, a few by surface collecting but most by screen washing, in the late 1980s and early 1990s. The mammalian specimens represent a broad spectrum of small- to medium-sized multituberculates and eutherians, which, in itself, indicates some fluvial size sorting. Multituberculates comprise about half of the fauna in abundance, and include small neoplagiaulacids (?*Neoplagiaulax* and ?*Mesodma*) and a larger ptilodontid, tentatively identified as *Ptilodus wyomingensis* or a very similar form. Among the eutherians are a diversity of plesiadapiforms including a plesiadapid (?*Nannodectes* sp.), a picrodontid (*Picrodus* sp. cf. *P. silberlingi*), a paromomyid (possibly *Paromomys depressidens*), and a carpolestid (*Elphidotarsius florencae*). Other eutherians include pantolestans, "proteutherians," and the hyopsodontid condylarth *Litomylus dissentaneus*. Ollie North locality shares taxa with the classic late Torrejonian faunas from Gidley Quarry (Crazy Mountains Basin, Montana) and Rock Bench Quarry (Bighorn Basin, Wyoming) suggesting a similar age.

Grant Information:
Support for field work and stratigraphic studies was provided by National Science Foundation grants BSR-8406707 and BSR-8722539 to DWK and EAR-8804881 and others to JHH.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

EVALUATING THE ENIGMATIC EARLY CRETACEOUS ORNITHOMIMOSAUR RECORD IN NORTH AMERICA

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Ornithomimosaurs are well known from Asia during the Early Cretaceous, but are more enigmatic during the same time in North America. The oldest known ornithomimosaur from North America is represented by *Nedcolbertia justinhofmanni* from the Barremian-aged Yellow Cat Member of the Cedar Mountain Formation of eastern Utah. Both the holotype and paratypes specimens preserve numerous individuals from a single horizon in the upper Yellow Cat Member, including subadult and juvenile individuals. These discoveries allow the study of the species ontogeny, especially neoteny. Although considered a type of coelurosaur when originally described, additional published material has allowed for a more detailed comparison of this species with other known North American and Asiatic ornithomimosaurs, revealing this species to be a valid member of the Ornithomimosauridae clade on the presence of a subarctometatarsalian condition of the third metatarsal. Additional younger Early Cretaceous North American ornithomimosaurs include a specimen from the Aptian Trinity Group of Arkansas, as well as fragmentary material from the Albian/Aptian Cloverly Formation of Montana and the Aptian Arundel Formation of Maryland, appear to be unique species. The Cloverly material more strongly represents the late Cretaceous *Ornithomimus velox,* known from the Hell Creek and Lance Formations. *Nedcolbertia* and the Arkansas specimen are more basal than other Asiatic ornithomimosaurs of similar age, and correlate more strongly with the European Wealden fauna, indicating that an early dispersal event from Laurasia took place sometime before or during the Barremian. During the Aptian, species would have been able to move east-west across southern North America, which was not yet bisected into the ancestral Laramidia and Appalachia by the influx of the Skull Creek Seaway. This paleogeographic situation allows for the co-mingling of species across southern North America during the Early Cretaceous, and could have allowed for the ornithomimosaur *Nedcolbertia* to dispersed back to ancestral Appalachia, where later

forms evolved into the Arkansas specimen, or an existing Appalachian ornithomimosaur, more distantly related to *Nedcolbertia*, evolved into the Arkansas specimen.
Grant Information:
This work was supported by a grant from the David B. Jones Foundation.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

IMAGINE STEM: GIRL SCOUTS IN PALEONTOLOGY

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Enacted in 2009, the Paleontological Resources Preservation Act instructs the Secretary of the Interior to manage and protect paleontological resources on Federal Land using scientific principles and expertise, and to develop education and outreach opportunities that engage the public. Southeastern Utah is a wonderful region to teach place-based science to both the local community and the 2 million visitors' to the area each year. The Bureau of Land Management Canyon Country District Office in southeastern Utah partnered with the "Hands on the Land" program to hire a Teacher on Public Lands for 2017. This teacher developed a paleontology Girl Scout patch and associated lesson plans, specific to the region. Scouting is a popular with many Utah families, and an excellent way to get kids outside to experience their public lands. The patch is available to all Girl Scouts and only requires the completion of paleontology lessons that teach site stewardship, monitoring, and site-based science. The exercises are designed to promote the importance of stewardship to the natural world and the benefits of preservation, for current and future generations to have a better scientific understanding of past and present natural environments. These lessons include several options to fit Girl Scout troop goals, such as studying anatomy and geology, map orientation, and fossil exploration, with visits to important paleontological sites including the Mill Canyon Dinosaur Trail near Moab, or the Butler Wash Dinosaur Tracksite in the new Bears Ears National Monument.

Girl Scouting activities allow students to apply the scientific process using STEM skills, encouraging students to make discoveries and observations. This project is also in-line with the national Girl Scouts of America "Imagine STEM program". The lessons were also translated into Spanish to reach a broader local audience. Having a science - and stewardship - based Girl Scout patch helps to attract people who are interested in fossils, but are not sure how to appropriately engage with these resources. A common problem faced at publicly interpreted paleontology sites is damage to the fossils, either by direct removal of fossil material or by the improper replication of dinosaur tracks. These actions are often the result of a lack of appreciation about why these fossils are significant, as well as a lack of understanding about how to visit the sites, without damaging them. Through proper education and instruction, we can begin to raise a generation of youth that both understand and appreciate the fossil history of Utah.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

SIZE, NOT EVOLUTION OF NEW FUNCTIONS, MOST PARSIMONIOUSLY EXPLAINS PROLIFERATING CORTEX SHOWN IN AN ENDOCAST OF *CIVETTICTIS LEAKEYI*, AN EXTINCT LARGE EARLY PLIOCENE VIVERRID (MAMMALIA, CARNIVORA, VIVERRIDAE)

HURLBURT, Grant R., University of Calgary Qatar, Hamilton, ON, Canada; CHURCHER, Charles, Independent, Victoria, BC, Canada

Endocasts (endocranial casts) reproduce the morphology of the endocranial surface of vertebrate brain cavities. The endocranial surface is molded by the encased brain, and in most mammalian clades, including carnivorans, the sulci of the cerebrum and cerebellum are reproduced on this surface and therefore on endocasts. Sulci are folds in the neocortical sheet of the cerebrum that increase the sheet's surface area (SA). Larger mammalian brains are more fissurized than smaller mammalian brains so that the neocortical SA maintains a quantitative relationship with brain volume. This is because brain volume increases in proportion to the cube of brain radius, whereas neocortical SA increases in proportion to the square of the radius.

We made an endocast from an Early Pliocene fossil skull of *Civettictis leakeyi* LBW (51590A) from the Varswater Formation, Langebaanweg, South Africa. The *C. leakeyi* endocast possesses all sulci and in the same pattern as do the endocasts of the extant viverrid species *Civettictis civetta* and *Viverra tangalunga*. Both of these species possess an open sylvian sulcus consisting of two sulci proceeding dorso-posteriorly from the rhinal sulcus.

In addition, the *C. leakeyi* endocast reproduces a right and left entolateral sulcus, a left ectosylvian sulcus, and a join between the dorsal termini of the two branches of the open sylvian sulcus on both hemispheres. Together with the additional associated gyri, these broadly increase the neocortical surface area of the parietal and temporal brain regions. That this neocortical proliferation is size-related is consistent with the estimated volume of 80 ml for the brain of *C. leakeyi*, approximately twice that of the *C. civetta* endocast volume (36.97 ml). This is consistent with attributing the increased fissurization and neocortical SA to maintaining a relationship with increased brain volume. An affinity between *C. leakeyi* and *C. civetta* is supported by the endocasts of both having a straight cerebellar vermis, whereas that of *V. tangalunga* is kinked.

Our hypothesis is more parsimonious that the competing hypothesis that the increased cortical SA associated with a novel or specialized function. Were this true, we would expect more sulci in a specific area, as occurs in the somatic sensory region associated with the manus in *Procyon lotor*.

Podium Symposium (Wednesday, August 23, 2017, 10:15 AM)

TEARS FOR GEARS: THE EVOLUTIONARY BIOMECHANICS AND DEVELOPMENT OF PATELLAR SESAMOID BONES

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Sesamoid bones are those found in tendons or ligaments near joints. Tetrapod vertebrates have evolved many kinds of sesamoids, in bony or soft tissue forms, but the patella is the most studied of these structures. We present a synthesis of our studies on how the patella evolved, how it develops and what role(s) it plays in limb function. Evolution of an ossified patella exemplifies convergence, originating about five times in the mammal lineage (with complex homoplasy in marsupials), once or twice in lizards and *Sphenodon* (with losses in some deeper squamate clades), and once in birds (with bizarre homoplasy in ratites as well as other clades). Fossil data are critical for these inferences, revealing more ancient origins of bony patellae in mammals and birds than extant animals would indicate, as well as a need for data on the form of the patella in extinct lepidosauromorphs. Generally, patellae form via endochondral ossification, but we have seen instances of more metaplastic (and variable) ontogeny in lepidosaurs. Our mechanobiological analysis of forces influencing transformation of patellar tendon into fibrocartilaginous/bony tissue indicates that patellar ossification can be favoured by high compression and high shear environments, explaining their presence in some taxa—but their absences in other taxa remain unexplained by this mechanism alone. New experimental and modelling studies of patellar mechanics in birds (guineafowl and ostrich) show how the bony patella functions as a dynamic gear, assisting the knee extensor muscles in supporting the limb during ground contact and swinging it quickly during limb protraction. This gearing function also is evident in humans and may be fundamental to all bony patellae, meaning that knee extensor muscles cannot be assumed to act as simple levers. Together, our findings reveal how sesamoid tissues such as the bony patella form important components of the musculoskeletal system that demand further integration into growing understanding of evolutionary developmental biomechanics, including in palaeontology.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW DISSOROPHOIDS FROM THE CARBONIFEROUS-PERMIAN OF COLORADO, USA

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The Dissorophoidea are a successful clade of terrestrial temnospondyls that include a diversity of robust, armored (dissorophids/trematopids) and miniaturized (amphibamids/brachiosaurids) forms that are widely believed to include the most recent common ancestor of frogs and salamanders. The scarcity of stem-batrachian fossils in upper Permian and Triassic assemblages belies the rich Carboniferous-Permian (C-P) record of earlier dissorophoids, whose morphologic diversity and widespread geographic ranges have made them useful for understanding vertebrate biochronology in C-P continental systems of western Pangea. We report two dissorophoid specimens recovered during fieldwork in the Permian Paradox and Eagle basins of Colorado during 2014: a partial skull and semi-articulated skeleton of a small dissorophid from the undivided Cutler of Placerville and a skull, lower jaw, and partial postcranium of a diminutive amphibamid from the lower Maroon Formation of Eagle Basin. Previous records of Colorado dissorophoids were limited to a partial sail of the dissorophid *Platyhystrix rugosus* from the Placerville area and indirect trackway evidence throughout western and central Colorado (e.g., records of *Batrachichnium* in the Maroon Bells and in the better-known Lyons Sandstone). We performed an inclusive phylogenetic analysis with representatives of all major dissorophoid lineages to place the new specimens in the context of dissorophoid phylogeny. The new Placerville dissorophid specimen shows affinities to *Conjunctio*, supported by a nearly vertical embayment of the otic notch, broad posterior extension of the postfrontal, and jaw joint that is positioned far anterior to the tabular horns, among other features. This is the first record of the genus from Colorado and only the second dissorophid from the Placerville assemblage. The Maroon amphibamid is closely allied with *Doleserpeton* within a group of amphibamids considered near batrachians, a position supported by palatal and circumorbital morphology. The presence of a *Doleserpeton*-like amphibamid from the Permian of Colorado suggests that, as in dissorophids, the diminutive amphibamids were widely distributed in western Pangea and may be undersampled. Together, these Colorado records further contribute to an emerging understanding that vertebrate assemblages of these southwestern sites show similarities with those of the Artinskian of Texas and Oklahoma, but their implications for biochronology and paleobiogeography require further study.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

FRAGMENTARY MANDIBLES OF FOSSIL LIZARDS FROM THE UPPER CRETACEOUS OLDMAN FORMATION, DEVIL'S COULEE, SOUTHERN ALBERTA, CANADA

IKEDA, Tadahiro, Museum of Nature & Human Activities, Hyogo, Sanda, Hyogo, Japan; ZELENITSKY, Darla K., University of Calgary, Calgary, AB, Canada; OTA, Hidetoshi, University of Hyogo, Sanda, Hyogo, Japan; TANAKA, Kohei, University of Calgary, Calgary, AB, Canada; THERRIEN, François, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

Unlike other fossil localities from the upper Campanian Oldman Formation of southern Alberta, the Devil's Coulee locality is unique in that it yields abundant remains of dinosaur eggs, eggshells, and embryos. While such fossils are common at the site, other small vertebrate remains, such as those of mammals and lizards, are extremely scarce. Here we report on a fossil lizard from Devil's Coulee, a discovery that records the rare occurrence of iguanians in Cretaceous Alberta and sheds light on the paleofaunas of a dinosaur nesting site. The fossil lizard consists of three small mandibular fragments, which are distinct from all other fossil lizards previously reported from the Oldman Formation (e.g., *Odaxosaurus*, *Orthrioscincus*, *Leptochamops*, and *Gerontoseps*). Two of the three jaw fragments exhibit characters commonly found in iguanians: position of the anterior inferior alveolar foramen on the splenial and upfolded ventral margin of the

dentary. Comparison of these mandibular fragments with other fossil iguanians and their primitive relatives known from Cretaceous deposits worldwide reveals they are largely similar to the recently described iguanomorph *Magnuviator ovimonsensis* from the Egg Mountain locality in the Two Medicine Formation of northwestern Montana, a locality that is roughly chronologically comparable to the Devil's Coulee nesting site. Despite the geographic proximity and temporal similarity of the two sites, the Devil's Coulee specimen is readily distinguishable from *M. ovimonsensis* based on the position of the anterior mylohyoid foramen and the shape of the anterior portion of the splenial. Thus these mandibular fragments may represent a new taxon of a very early Iguanomorpha from North America, although further investigation is required to determine a precise taxonomic allocation for the specimen. This new lizard improves significantly our understanding of the origin and early dispersal of Iguanomorpha and Pleurodonta in the New World.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

FIRST METATHERIAN MAMMAL FROM JAPAN: PALEOBIOGEOGRAPHIC IMPLICATIONS

IKEGAMI, Naoki, Mifune Dinosaur Museum, Kumamoto Prefecture, Japan; TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan

Metatherian mammals achieved adaptive radiation mainly in Laurasia through the Cretaceous, but there has been no fossil record in Japan so far. The first fossil record of a metatherian mammal from Japan is reported here. The fossil occurred from channel-fill deposit in the Upper Formation of the Mifune Group, the same as the eutherian mammal *Sorlestes mifunensis*. Although it is an isolated and partly broken upper molar, the crown and three roots are preserved. The stylar shelf is widely developed and the ectoflexus is weak. Although the parastylar wing is enlarged, the metastylar wing is not developed, and the occlusal outline is an asymmetrical triangle. Among the three roots, the plate-like root under the parastylar wing is the largest. The height of each cusp of protocone, paracone, and metacone is unknown because of incomplete preservation. The parastyle and stylocone swell gently, and some small cusps are developed behind the stylocone. Metaconule and paraconule are almost the same height, and two small denticles align behind the metaconule. Based on these characteristics, it is suggested that the specimen can be identified as the left M3 of Deltatheroida, and it has features in common with *Sulestes* reported from the Bissekty Formation (Turonian) in Uzbekistan. The result of phylogenetic analysis indicates that the Mifune deltatheroid and *Sulestes* are occupying a basal position within the Deltatheroida.

Deltatheroida is a basal monophyletic group of metatherian mammals that were known from the Cretaceous in Asia and North America. The oldest fossil record of deltatheroid is reported from Aptian to Albian in North America. *Sulestes* is known as the oldest record in Asia at this point. *Deltatheroides* and *Deltatheridium* are known from the upper Cretaceous Djadokhta Formation (Campanian), and *Tsagandelta* from the Baynshiree Formation, Mongolia. In China, *Lotheridium* is reported from the upper Cretaceous Qiupa Formation in Henan Province. The age of the Upper Formation of the Mifune Group is still unclear, but it is presumed to be Cenomanian – Coniacian based on invertebrate fossils. There is a possibility that the specimen reported here is the oldest record of Deltatheroida in Asia, and it is indicated that the basal deltatheroids were distributed in coastal region of East Asia in the early Late Cretaceous.

Grant Information:
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Technical Session X (Friday, August 25, 2017, 8:15 AM)

A NEW SMALL-BODIED REPTILE FROM THE MIDDLE TRIASSIC OF GERMANY DOCUMENTS THE CURSORIAL TO AQUATIC EVOLUTIONARY TRANSITION IN A CLADE OF EARLY ARCHOSAURIFORMS

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Recent discoveries demonstrate that the stem lineage of archosaurs (early archosauromorphs) comprises a diverse assemblage of morphologically disparate taxa that occupied a wide range of ecological roles after the end-Permian mass extinction, with numerous dietary, locomotor, and habitat specializations. One such example is the Late Triassic archosauriform *Vancleavea campi* from western North America, which possesses a short-snouted skull similar to extant aquatic carnivoran mammals, heterodont dentition, a pangolin-like covering of imbricated leaf-shaped osteoderms, short limbs, and a long dorsoventrally tall tail. Its newly-discovered sister taxon, *Litorosuchus somnii* from the Middle Triassic of China, is very similar to *Vancleavea*, but with a longer skull and more robust limbs. Both of these taxa display a large number of features suggesting a predominantly aquatic lifestyle, but as is the case with many specialized early archosauromorphs, no fossils are known that document the lineage's evolutionary transformation from terrestrial ancestors.

We report here the discovery of a new early archosauriform taxon from the lacustrine Vellberg-Eschenau lagerstätte of the Middle Triassic (Ladinian) Erfurt Formation in Baden-Württemberg, southern Germany. This very small-bodied species (<30 cm length) is known from nearly a dozen associated partial skeletons, and is easily recognizable in the assemblage because of its ubiquitous *Vancleavea*-like leaf-shaped osteoderms. Similar to *Vancleavea* and *Litorosuchus*, the new taxon is covered in multiple imbricated rows of these osteoderms, has a skull covered in fine ornament, and a heterodont dentition that includes posterior maxillary teeth that have a convex distal margin. Like *Litorosuchus*, it retains some plesiomorphic features that *Vancleavea* lacks, such as a longer skull with antorbital and mandibular fenestrae. However, the new species differs from both taxa in possessing some rectangular osteoderms and relatively long gracile limbs, while lacking tall midline caudal osteoderms. Thus, the new animal combines a relatively plesiomorphic archosauriform skull, vertebral column, and limbs with an apomorphic dentition and armor. As such, it documents the evolutionary transition from cursorial terrestrial ancestors to the specialized aquatic ecology of *Vancleavea* and *Litorosuchus*. This suggests that disparate early archosauromorph taxa are likely end-members of larger evolutionary radiations that experimented with a variety of ecological roles during the Triassic Period.

Grant Information:
Alexander von Humboldt Foundation

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

EXPLORING ECOMETRIC RELATIONSHIPS IN THE VERTEBRAE OF NORTH AMERICA SNAKES

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As Anthropogenic climate change continues to transform the environment, understanding how these changes affect the ecology and evolution of organisms becomes increasingly critical for managing natural systems. Ecometrics is the study of functional traits at the community level and their relationship to environment through space and time. Some traits perform better in some environments than others, thereby sorting organisms with similar traits into similar environments, and playing a role in community assembly via selection and geographic sorting. As such, functional trait-environment relationships may transcend time, are applicable to both the modern and fossil record, and are an integrative method for examining long-term interactions of organisms during times of environmental change. Herpetofauna, including snakes, are suitable for studying environmental changes, as they are ectotherms that are sensitive to environmental perturbations and are currently experiencing global population declines. Snakes are closely connected to their macrovegetation, and their locomotion involves their vertebrae, which are the most common isolated elements composing the snake fossil record. Here, we conduct an extensive literature review of functional traits associated with vertebral shape in snake vertebrae, and we identified eleven potential ecometrics. Ratios of overall length, width, and height indicate different ecological specialization for arboreality, fossoriality, and aquatic locomotion. Zygapophyseal ridge prominence, zygosphene/zygantrum shape, ratios of centrum length-neural arch width, prezygapophyseal width-postzygapophyseal width, and distance between the zygapophyses, postzygapophyseal width-condylar width, and least width of the dorsal portion of the vertebrae are associated with the relative flexibility or rigidity requirements for locomotion such as swimming or cantilever in ecological specialists. Finally, the relative height of the neural spine and vertebral density are associated with snake substrate type and activity levels. Our study shows that these eleven traits warrant further investigation as potential ecometrics in future research.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

AN ENIGMATIC SCALE-LESS ACTINOPTERYGIAN FROM THE UPPER MISSISSIPPIAN BEAR GULCH LIMESTONE OF MONTANA, USA

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Aphol is a scale-less actinopterygian fish from the Upper Mississippian Bear Gulch Limestone of Montana, USA, whose systematic status has been, thus far, unresolved. As part of our study of this new taxon, we present here evidence of its osteology and functional morphology, focusing on shoulder girdle, fin and vertebral design. The dermal shoulder girdle consists of a short clavicle and a very slim cleithrum; a supracleithrum is represented only by its lateral line canal and is otherwise not connected to the cranium. A prominent scapulocoracoid projects posteriorly and bears a dorsally facing condylar fossa subdivided to accommodate the articulation of two elongate radials. A few additional radials occur distally. All pectoral radials support five vertically oriented, jointed, well-separated rays. The pelvic girdle and fin are not indicated in any of the 140 specimens. The long, low dorsal fin extends from close to the head to the beginning of the caudal skeleton. An anal fin is lacking. The vertebral column exhibits monospondylous centra composed of an intercentrum and pleurocentrum that constrict the prominent notochord. Progressing into the caudal region, successive hemicentra grow closer together. In the mid-body region and into most of the caudal are tall, flared, and angled neural and haemal spines which articulate on the hemicentra through their respective arches. Unlike other known Paleozoic actinopterygians, each mid-body neural arch of Aphol exhibits median and lateral zygaphophyses. We find these features may have been responsible for restricting lateral vertebral movement (functionally stiffening the main axis of support). Caudally, the vertebral column transitions to an abbreviate heterocercal tail with extended pterygiophores and jointed fin rays. Differential growth and skeletal mineralization is evident among the specimens, with regard to pectoral and vertebral design. Collective information is evaluated in terms of Aphol's habitus, including mode of swimming.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

TOOTH ERUPTION AND POSSIBLE DIMORPHISM IN *TRICONODON MORDAX*

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The early Cretaceous eutriconodont *Triconodon mordax* is known by an exceptional ontogenetic series of lower dentitions, for which sequential replacement pattern of ante molar teeth was inferred. The m4 is known to form far distal, on the lingual side of the ascending ramus.

For this study we used micro computed tomography (µCT) at the NHM to reinvestigate the series. An unerupted m4 in PV OR 47764, previously hidden by the coronoid process, was located; in this early developmental stage only enamel caps of cusp a–c are present. Since they are nearly the same height or slightly higher as fully erupted anterior molars, the eruption of m4 is solely caused by the tooth shifting mesially from its crypt, with little or no upward movement. Based on the µCT data, it appears that movement was initiated when the roots were not yet fully formed. The erupting c and p4 of PV OR 47763 b were segmented and now may be fully compared to the deciduous dentition for the first time. The permanent canine is larger and more massive than dc; it remains unclear whether it was double or single rooted. We suggest that eruption of the posterior molar lingual to the coronoid is a derived condition, potentially linked to a secondary increase in molar count.

The matter of sequential premolar replacement remains unresolved, as no specimen preserves evidence of replacement at p1–3 loci. With p1–2 being small and elongate, an alternative hypothesis is that replacement did not occur at one or more of the anterior premolar positions.
PV OR 48935 differs from other specimens in its antemolar dentition: the premolars are relatively smaller and the canine is much more slender. Two hypotheses are possible: Simpson interpreted the dentition as completely permanent, which is suggested by the lack of discrete anatomical differences from other specimens, and (in the scan) a lack of clearly identifiable gems of replacing teeth. The second hypothesis posits an alternative interpretation of tooth positions, wherein the most posterior molar of PV OR 48935, just emerging mesial to the ascending ramus, is m3 instead of m4. In this case, both m3–4 would originate on the lingual side of the coronoid. This is supported by the morphology of the antemolar dentition and the fact that some specimens bearing three erupted molars show the distal part of the last molar behind the lingual side of the coronoid. Due to the lack of clearly identifiable gems of replacing teeth, we tentatively lean toward the conservative interpretation, which leaves *Triconodon* with a considerable (?sexual) dimorphism in premolar and canine morphology.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

LOCOMOTION IN STHENURINE KANGAROOS: DID THEY USE THEIR ARMS?

JANIS, Christine M., University of Bristol, Bristol, United Kingdom; BILLINGHAM, Coral, University of Bristol, Bristol, United Kingdom; MARTIN-SERRA, Alberto, University of Oxford, Oxford, United Kingdom

Sthenurines (Sthenurinae: Macropodidae) were the "short-faced giant kangaroos" of the Australian Pleistocene. It has been proposed that they used bipedal striding locomotion, in part because their morphology was apparently poorly adapted for the slow pentapedal locomotion of large extant kangaroos. This anatomy, including a stiff lumber region and highly specialized long-fingered hands, has been interpreted as reflecting browsing in a bipedal posture. What osteological evidence could throw light on whether or not sthenurines routinely bore weight on their forelimbs in the manner of modern kangaroos?
The morphology of the proximal humerus is indicative of weight-bearing on the forelimbs. Terrestrial mammals have larger humeral tuberosities than arboreal ones, for the rotator cuff muscles that stabilize the body over the limb. We used 2-D landmark geometric morphometrics to obtain data on the proximal humerus of 74 species of extant mammals (including 10 kangaroos) and 8 extinct kangaroos (6 sthenurines and 2 protemnodontines [Pleistocene large kangaroos within the Macropodinae]). The reference group of extant mammals included 3 other marsupials, and placentals within the size range of extant kangaroos (approximately 3 – 80 kg) from the orders Carnivora, Primates, and Rodentia (caviomorphs only): 14 arboreal, 16 scansorial, and 23 terrestrial species.
Canonical Variates Analysis on the non-macropodid mammals grouped by locomotor mode provided 82% correct classification. Arboreal species were significantly different from the others, but terrestrial and scansorial ones could not be distinguished from each other. Extinct and extant kangaroos entered as unknowns tended to cluster mainly as arboreal or scansorial. When extant kangaroos were included as a known group, and arboreal plus scansorial species grouped as a single category, 74% were correctly classified, and all three groups could be statistically distinguished from each other. When the extinct kangaroos were entered as unknowns, none grouped with the extant kangaroos and all but one were assigned to the arboreal+scansorial group. These results show that the extinct kangaroos were using their forelimbs in a different fashion to the extant ones, and strengthens the hypothesis that sthenurines were not practicing pentapedal locomotion. Protemnodontines also falling outside of extant kangaroos shows that this difference cannot simply be ascribed to the proposed feeding behavior of sthenurines. Protemnodontine anatomy has its own peculiarities and remains to be explained.
Grant Information:
Marie Curie Incoming Fellowship

Technical Session VI (Thursday, August 24, 2017, 8:45 AM)

THE PERMIAN "MICROSAUR" *BATROPETES* AS A MODEL FOR THE ORIGIN OF FROGS

JANSEN, Maren, Museum fur Naturkunde, Berlin, Germany; MARJANOVIC, David, Museum fur Naturkunde, Berlin, Germany

Micro-CT data from a postcranial skeleton of an adult *Batropetes palatinus* from the Asselian or Sakmarian of the Saar-Nahe Basin, western Germany, reveal a thin, solid cortex and extensive spongiosa in limbs, girdles and vertebrae, confirming previous interpretations of the known ontogenetic stages of *Batropetes* as terrestrial. A mixture of adaptations to walking (e.g. very short trunk, robust girdles and limbs) and digging (e.g. subterminal mouth) has led to the hypothesis that *Batropetes* searched for food in leaf litter and perhaps topsoil. We interpret *Batropetes* as having used its forelimbs for this purpose, standing on both hindlimbs and one forelimb while using the other to shove leaf litter aside: the forelimbs are unusually large compared to the hindlimbs, the trunk and the small head; the first metacarpal and digit in the short (but not broadened) hand are more robust than the others; the terminal phalanges are very similar to claws. The small, vertically mobile head with the slightly subterminal mouth and large eyes enabled *Batropetes* to snatch up tiny arthropods it uncovered.
The latest publications on the Triassic stem-group frog *Triadobatrachus massinoti* concluded that early salientian evolution was not driven by specialization for efficient jumping, as *Triadobatrachus* morphologically still lacked the ability to jump off, even though it had the forelimb strength necessary to withstand the impact of landing after a jump. We postulate that these forelimb features are exaptations from forelimb-based digging, for which *Batropetes* may represent an analog or possibly a homolog.
Among frog relatives (lissamphibians), the albanerpetids are considered head-based leaf-litter diggers (with lateral as well as dorsoventral mobility for the head and a reinforced snout roof), and the caecilians are head-first burrowers; digging behavior is not ancestral for salamanders, but the salamanders may be ancestrally neotenic, creating difficulties for homologizing their postmetamorphic morphology and behavior. The closest relatives of *Batropetes* with a known postcranium, the lysorophians, were head-first burrowers. We evaluate the possibility of homology between any or all of these digging lifestyles, as well as those of the head-first burrowing ostodolepidid, gymnarthrid and other elongate "microsaurs", in an enlarged phylogenetic analysis which also touches on other questions in the phylogeny and evolution of early tetrapods.

Technical Session XVIII (Saturday, August 26, 2017, 8:00 AM)

CRANIAL ONTOGENETIC PATTERNS IN PERMO-TRIASSIC BASAL CYNODONTS FROM SOUTHERN AFRICA

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The cranial ontogeny of *Thrinaxodon liorhinus* and *Galesaurus planiceps*, basal epicynodonts from the Early Triassic of South Africa, was recently documented. These comprehensive studies using qualitative and quantitative analyses revealed the ontogenetic trends within each taxon. Nine cranial features divided the large sample of *Thrinaxodon* into four ontogenetic stages; whereas eight craniomandibular features in *Galesaurus* separated the comparatively smaller sample into three ontogenetic stages. Several of the ontogenetic changes were related to the development of the adductor musculature. A new study of *Procynosuchus delaharpeae*, a basal cynodont from the Late Permian, allows comparison to the cranial ontogenetic trends previously described in the two basal epicynodonts.
More than forty specimens of *Procynosuchus* from southern Africa were included in the qualitative analysis; however, poor preservation and deformation of several skulls limited the sample size for the quantitative analyses. A few unequivocal changes were documented in the skull and mandible, which separated the sample of *Procynosuchus* into immature and adult stages. The adult stage of *Procynosuchus* is characterized by the development of the posterior sagittal crest, masseteric fossa, and nasofrontal protuberance. The development of the posterior sagittal crest was also documented in the basal epicynodonts *Galesaurus* and *Thrinaxodon*, although it developed relatively earlier in the ontogeny of *Thrinaxodon*. There are fewer ontogenetic changes recognized in *Procynosuchus* in comparison to the basal epicynodonts, possibly due to the poor preservation of small and intermediate size specimens. The most significant finding is the discovery of sexual dimorphism in adult *Procynosuchus*, with differences in the snout, temporal region, and canine. The presence of sexual dimorphism in *Procynosuchus* and the basal epicynodont *Galesaurus* suggests that this condition might be more widespread in basal non-mammaliaform cynodonts.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THE LAST OF THE NORTH AMERICAN DROMAEOSAURIDS (THEROPODA: DROMAEOSAURIDAE), BASED ON A NEW MAASTRICHTIAN SPECIMEN FROM NEW MEXICO

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Dromaeosaurids (Theropoda: Dromaeosauridae) from the Maastrichtian of North America have a poor fossil record. Two previously named taxa both come from the richly fossiliferous Hell Creek Formation in the northern United States. Until now, Campanian–Maastrichtian dromaeosaurids from south of Montana have been known exclusively from isolated and undiagnostic material. The recent discovery of a partial dromaeosaurid skeleton from the Naashoibito Member (Ojo Alamo Formation) in New Mexico represents the first diagnostic dromaeosaurid from the Maastrichtian of the southern United States (southern Laramidia). Recovered material includes: small questionable skull fragments; a tooth; portions of the forelimb (including a partial humerus, ulna, and a manual ungual); portions of a hindlimb (including an incomplete femur, multiple crushed and incomplete metatarsals, and a pedal ungual); several incomplete ribs and vertebrae. This specimen is differentiated from other dromaeosaurids based on features of the forelimb and axial skeleton, including: the morphology of the deltopectoral crest of the humerus; the lateral grooves on the manual ungual; and the mid-caudal vertebrae. In addition, the ulna appears to bear ulnar papillae, suggesting secondary feathers on the forelimbs. Also preserved are pathologic features, including a gouge and puncture of the right manual ungual II and a partial break with bone regrowth in an incomplete rib. The phylogenetic relationships of the New Mexico specimen are somewhat problematic. However, it is distinct from both the North American Maastrichtian *Acheroraptor* and *Dakotaraptor*. This suggests at least two distinct lineages of dromaeosaurids were present in North America at the end of the Cretaceous.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ARVICOLINE RODENTS FROM PERSISTENCE CAVE, WIND CAVE NATIONAL PARK, SD

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Exploration of a previously unknown cave (Persistence Cave) in Wind Cave National Park (Black Hills, SD) resulted in the discovery of a rich, diverse assemblage of fossil and subfossil animal remains, including macro- and microvertebrates, gastropods, and insect remains. Exploration of the cave continues, but initial recovery of vertebrate remains included remains of both horse and camel, indicating that a Pleistocene component was preserved in the cave. To further evaluate the broad chronologic and taxonomic character of deposits preserved in the cave, we targeted components of the small mammal fauna for identification, specifically arvicoline rodents. We focused our efforts on arvicolines because other Pleistocene deposits in the southern Black Hills preserve records of voles and lemmings that do not represent part of the living biota of the region (e.g., *Lemmiscus*, *Dicrostonyx*).
Identifications focused primarily on the lower first molar (m1), that tooth being the most diagnostic within the arvicoline dentition. In some instances other cheek teeth are

taxonomically informative and were also evaluated (e.g., M3 of *Lemmiscus*). Total samples size was n=210. Identified taxa include *Lemmiscus curtatus* (n=10), *Microtus* cf. *M. ochrogaster* (n=32), *Microtus* sp. (five-triangle morphotypes; n=96), *Myodes gapperi* (n=51), *Ondatra* sp. (n=1), *Phenacomys* sp. (n=1), and *Synaptomys cooperi* (n=1). Other specimens are tentatively identified or require additional analysis, but do not appear to represent taxa other than those reported here. Even in small numbers, the presence of *Lemmiscus curtatus*, *Phenacomys* sp., and *Synaptomys cooperi* are notable given the absence of those taxa in the modern biota of the region. Collectively, they are suggestive of late Quaternary biogeographic influences on Black Hills from the east (*Synaptomys cooperi*), west (*Lemmiscus curtatus, Phenacomys*), and possibly north (*Phenacomys*).

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE APPENDICULAR SKELETON OF A MID-CRETACEOUS LIZARD (SQUAMATA: SCINCOIDEA?)

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New squamate material provides another example of the past diversity of tropical lizards from the mid-Cretaceous (99 Ma) deposits of the Hukawng Valley, Northern Myanmar. This new amber fossil preserves the entire integument, and although specimen is mostly void of soft tissue and does not contain remains of the axial skeleton, the bones of the appendicular skeleton are mostly intact and articulated. We obtained a high-resolution computed tomography scan, and created a 3D model of each limb bone, including rarely preserved elements such as the sesamoids (e.g., the patella and pisiform). This allows morphological comparison with living and extinct lizards. The body shape and limb morphology indicate skink affinities and similarities with other amber fossils from the same locality that also include skull material. The degree of the development of the limbs suggests this animal could have been either a ground-dweller or a semi-arboreal lizard.

Grant Information:
This project is funded by Sam Houston State University.

Technical Session VI (Thursday, August 24, 2017, 9:45 AM)

PATTERNS OF CHONDRIFICATION AND OSSIFICATION IN THE HYOBRANCHIAL APPARATUS OF CRYPTOBRANCHOID SALAMANDERS

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Cryptobranchoids (Cryptobranchidae and Hynobiidae) are a basal clade of crown-group salamanders, consisting of 69–71 living species in 11–13 genera and more than 30 Mesozoic-Cenozoic fossil taxa. Members of this clade are either metamorphosed or neotenic, with adults living in aquatic, semi-aquatic, or terrestrial environments. This study investigates the developmental patterns (chondrification and ossification) of the hyobranchial apparatus (HA) during early and late development in cryptobranchoids to understand how morphogenesis of HA affects its morphology, and how of the HA responds to the adaption for breathing and feeding in different living habitats. Cleared and stained embryos and hatchlings of the ambystomatid, *Ambystoma mexicanum* (stage 29-56) were used herein to compare with that of two cryptobranchoids (*Onychodactylus*, *Andrias*), as documented by previous studies, to analyze the early chondrification patterns of the HA. Fossil and CT scanned living specimens of cryptobranchoids (*Andrias*, *Cryptobranchus*, *Onychodactylus*, *Hynobius*, *Batrachuperus* and the Early Cretaceous hynobiid-like taxa *Sinerpeton* and *Nuominerpeton*) at larval-juvenile-adult stages were compared to reveal ossification patterns of the HA during late development.

Comparative study shows that, during early development, *Ambystoma* and cryptobranchoids share similar early chondrification sequences from hyal arches to branchial arches along the anteroposterior axis and from ceratohyal/ceratobranchial to hypohyal/hypobranchial along the proximodistal axis. Basibranchial II chondrifies in *Ambystoma* and starts to bifurcate posteriorly from stage 52, whereas it is absent in *Onychodactylus* and *Andrias*. During late development, hypobranchial II ossifies earlier than ceratobranchial II before metamorphosis in all investigated taxa; ceratobranchial II ossifies earlier than ceratohyal in *Batrachuperus*, but no ossification of ceratohyal are detected in the remaining taxa; basibranchial II is ossified before (*Hynobius*) or after (*Batrachuperus*, *Nuominerpeton*, *Sinerpeton*) metamorphosis, but is absent in *Onychodactylus* and cryptobranchids.

This study shows that the chondrification and ossification patterns of certain elements of the HA (e.g. branchial arches) in cryptobranchoids are evolutionarily conserved, whereas that of other elements (e.g. basibranchials, hyal arches) are diversified and probably related to different feeding modes and living environments of different taxa.

Grant Information:
Funded by National Natural Science Foundation of China (grant 41072007/41272016) and China Scholarship Council.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW ANKYLOSAURID DINOSAUR FROM THE EARLY LATE CRETACEOUS OF ZUOYUN, SHANXI PROVINCE, CHINA

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Ankylosauridae is a clade of quadrupedal armoured ornithischians with advanced members possessing a unique tail club that may serve as a defensive weapon. Recent study revealed that ankylosaurids may acquire this uncommon tail modification in a stepwise fashion in which handle-like distal caudal vertebrae evolved preceding the enlargement of terminal co-ossified osteoderm knob. Proving or disproving this hypothesis requires more ankylosaurid specimens with relatively complete tail region from mid-Cretaceous. Palaeontological investigation in Zuoyun of Shanxi Province, China had experienced stagnation since C. C. Young's first report on dinosaur remains in 1958, but significant hadrosauroid materials have been unearthed and baptized in recent years. Here we report a new ankylosaurid from Zuoyun of Shanxi Province, China. The material, excavated from early Late Cretaceous Zhumapu Formation in 2011, is represented by two individuals: a less complete small-sized one with a small tail club, and a larger one with nearly complete skeleton and osteoderms in situ.

Preliminary observation shows that the distal ends of neural spines of proximal caudals in the small individual expand tremendously to a heart-shaped morphology, with width to height ratio of 0.49-0.91 in 1st to 8th caudals, significantly greater than those in other ankylosaurs. The right-sided major osteoderm of tail club shows a semi-oval morphology in dorsal view. The bigger individual possesses two cervical half rings, with unique form, markedly differing from those of other ankylosaurids. The basic form is dorsoventrally flattened triangular osteoderms fusing to an underlying bony band. Two pairs of osteoderms occur on the first cervical half ring, while three pairs exist on the second with basal margins snugly adjacent to each other. The apices of the spike-shaped medial osteoderms direct anteriorly and the laterally positioned osteoderms slightly ventrolaterally. The thoracic and pelvic lateral osteoderms are characterized by a potentially distinguishable imbricate arrangement with apices of the osteoderms directing posterolaterally. The aforementioned combination of characters indicates a new ankylosaurid genus, which increases the diversity of the dinosaur fauna of Zhumapu Formation. Our results show that the small individual represents the oldest and most basal ankylosaur known to own terminal osteoderms enveloping the tail end and support the "handle-first hypothesis".

Grant Information:
Funding for field excavation, preparation of the specimen and other research activities was provided by Department of Finance of Shanxi Province.

Technical Session XXI (Saturday, August 26, 2017, 2:00 PM)

DIRECT EVIDENCE OF REPTILE PREDATION BY A LARGE MIDDLE TRIASSIC ICHTHYOSAUR FROM XINGYI OF SOUTHWESTERN CHINA

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The monophyletic Ichthyosauromorpha, containing Mesozoic marine top predators, comprises Hupehsuchia, Nasorostra, and Ichthyopterygia. The early evolutionary history of its feeding ecology has been addressed from functional and morphological analyses, and hupehsuchians likely contained lunge feeders, nasorostrans were suction feeders and ichthyopterygians probably ram feeders. Ichthyopterygians were known from shell-eating predators, such as some mixosaurs, to coleoid-consumers such as the deep diving *Ophthalmosaurus*. It is unlikely that Early Triassic ichthyosauromorphs, especially hupehsuchians and nasorostrans, could prey on other reptiles. Shastasaurid ichthyopterygians are the large Middle-Late Triassic ichthyosaurs whose skeleton may reach 5 to more than 20 m long. Previous study suggested the Late Triassic shastasaurid *Guizhouichthyosaurus* from Guanling of China might eat small fishes and shells, judged by the stomach contents.

A new 5.3 m long complete skeleton of *Guizhouichthyosaurus* was excavated from the Ladinian (Middle Triassic) Zhuganpo Member of Falang Formation at Xingyi, Guizhou, southwestern China. Its skull is 98 cm long with 56 conical teeth on the upper and lower jaws per side. The exposed part of the largest tooth may reach 27 mm long and 15 mm wide at the base. In its abdominal region, a block of packed bones appears between the right and left ribs. The block is about 42 cm long and 15.5 cm high anteriorly, although the height decreases posteriorly. In the block, the bones are morphologically different from those of the ichthyosaur, and it is probably the stomach contents. The orientation and arrangement of the bones hint that it was the remains of a reptile preyed on by *Guizhouichthyosaurus*. The bones inside could be recognized as the possible scapula, clavicle, interclavicle, humerus, and some ribs and vertebrae, which resemble those of the thalattosaur *Xinpusaurus xingyiensis* found from the same site and horizon. The vertebral size suggests that the prey individual was smaller than the holotype of X. xingyiensis, whose preserved length is 2.1 m with a body trunk 75 cm long. That *Guizhouichthyosaurus* captured *Xinpusaurus* enlarges our knowledge about the ichthyosaur's feeding ecology, although the feeding mechanism require further studies.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE STATUS OF *TYLOSAURUS NEUMILLERI* FROM SOUTH DAKOTA AND A REASSESSMENT OF TYLOSAURINE MOSASAURS FROM THE MIDDLE-LATE CAMPANIAN OF NORTH AMERICA

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The specimen SDSM 75705 described as *Hainosaurus neumilleri,* was recovered from the DeGrey Formation of the lower Pierre Shale of Gregory County, South Dakota, USA. The specimen was diagnosed as *Hainosaurus* based on characters such as the position of the parietal foramen and the shape of the maxillopremaxillary suture; however, *Hainosaurus* was synonymized with *Tylosaurus* when its type species from Belgium was re-assessed as *Tylosaurus bernardi*. The specimen of *T. neumilleri* from the Pierre Shale of South Dakota includes a fragment of premaxilla attached to both left and right maxillae, a left quadrate, and a block with cranial elements including the parietal, left coronoid and angular, and right articular. The material was reanalyzed and compared with the slightly older *T. pembinensis* from the Pierre Shale of Manitoba, Canada, and the coeval and stratigraphically equivalent *'T. saskatchewanensis'* from the Bearpaw Formation of Saskatchewan, Canada. The results indicate that *T. neumilleri* material is not diagnostic at the species level, since all the characters shown are highly variable and likely shared with other tylosaurine species, and thus must be considered a nomen dubium. The materials included in the original holotype, such as the parietal block, left quadrate, and premaxilla/maxillary fragment, are not diagnostic on their own of a new species, though the preserved elements show similarities to *'T. saskatchewanensis'* from similarly aged rocks (upper Campanian) in the Bearpaw Shale, and to the somewhat older *T. pembinensis* from the Pierre Shale of Manitoba. Morphological characters shared between them include the shape of the parietal, morphology of the quadrate elements, and

the tooth ornamentation. The quadrate conch, the thin tympanic ala, and the rounded mandibular condyle resemble more those of *'T. saskatchewanensis'* rather than *T. pembinensis*. The results suggest a far more restricted concept of North American tylosaurines than previously proposed. This result does not affect the previously suggested North Atlantic Circle Basin distribution of the genus in North America and Europe.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A UNIQUE LATE JURASSIC MICROVERTEBRATE ASSEMBLAGE FROM A DINOSAUR NESTING SITE

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Excavation of a dinosaur egg site in the upper Brushy Basin Member of the Morrison Formation in the Garden Park Fossil Area (GPFA), Colorado resulted in the recovery of numerous small vertebrate remains. Targeted screen washing of matrix from the site has since produced abundant and significant vertebrate remains with a bias toward sub-millimeter sized fossils. Microvertebrates identified thus far include the teeth of goniopholidid crocodiyiforms, ornithopod and theropod dinosaurs, sphenodontians, and ceratodontid and semionotid fish; lepisosteid scales; prosobranch and pulmonate gastropods; and *Prismatoolithus coloradensis* dinosaur eggshell. Most significant is the recovery of twenty-nine mammal teeth, most measuring around 500 microns, that include multituberculate taxa referable to *Ctenacodon* and *Psaladon*, the paurodontid *Paurodon valens*, dryolestoids, and the first documented occurrence of triconodontids from the Colorado Front Range.

Microvertebrate assemblages are not uncommon in the GPFA, a richly fossiliferous region of the eastern Morrison Formation, typically yielding docodontid and dryolestid mammals. The stratigraphically lower Marsh-Felch Quarry, located in a coarse, fluvial sandstone with large dinosaur fossils, has produced small elements of fishes, crocodyliforms, and turtles in addition to the mammals *Docodon* and *Amblotherium*. The Small Quarry has produced a variety of microvertebrate remains including dryolestids and two well-preserved jaws of *Docodon apoxys*. In contrast, the eastern Colorado Plateau Fruita Paleontological Area (FPA) typically produces the remains of multituberculates and triconodontids. Docodontids are rare at this site and elsewhere on the Colorado Plateau. Faunal similarities between the Egg Gulch site and the FPA, particularly similarities between mammals, may reflect a taphonomic bias toward smaller taxa. Alternatively, the taxa recovered may represent a typical floodplain pond assemblage adjacent to the primary fluvial channels and well drained areas. This is supported by the presence of many small freshwater taxa (hatchling crocodyliforms, fishes, gastropods) and mammals typically considered to be scansorial or arboreal.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

EVOLUTIONARY RELATIONSHIPS AND BIODIVERSITY OF MACHIMOSAURINI (THALATTOSUCHIA, TELEOSAURIDAE)

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Thalattosuchia was a unique group of marine crocodylomorphs that flourished during the Mesozoic Era, evolving a range of wide feeding specializations and environmental adaptations. One of the two major groups within Thalattosuchia is Teleosauridae, a semi-aquatic clade that ranged from the Early Jurassic to the Early Cretaceous (~182-132 million years ago). While their fossils have been known since the 18th Century, their morphological, alpha taxonomy and phylogenetic relationships are still largely uncertain. However, the macrophagous/durophagous sub-clade. Machimosaurini is becoming increasingly well-understood. This sub-clade consists of *Machimosaurus*, '*Steneosaurus*' *obtusidens* and indeterminate Moroccan material from the Bathonian. Machimosaurini is well-supported, with at least 9 synapomorphies (including parallelogram-shaped supratemporal fenestrae; dentition that is serrated, has heavily ornamented enamel and blunt apices; and socket-like reception pits along the maxillae and dentaries). While Machimosaurini was common in the Late Jurassic of Europe, they were much rarer in the Middle Jurassic. One major locality which yields abundant teleosaurid fossils is the Oxford Clay Formation (OCF) of the UK. Our first-hand study of little examined OCF teleosaurids (including the little-studied *Steneosaurus hulkei* from the NHMUK) suggests more than one species of Machimosaurini was present, hinting at greater morphological diversity in this sub-clade than previously realised. They exhibit unique dental morphologies and a range of body sizes. However, OCF machimosaurins occupied a very specific biological niche, unlike their slender-toothed counterparts.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

NEW COELUROSAURIAN REMAINS (DINOSAURIA: THEROPODA) FROM THE CENOMANIAN MUSSENTUCHIT MEMBER OF THE CEDAR MOUNTAIN FORMATION, UTAH, USA

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The Cedar Mountain Formation (CMF) is a Cretaceous terrestrial rock unit exposed in central and eastern Utah, USA. Its six members span from at least the Barremian to the Cenomanian and are rich in non-avian dinosaur fossils, including remains of ankylosaurs, marginocephalians, ornithopods, sauropods, and theropods. Published records suggest that the dinosaur fauna in the lower part of the CMF is comprised of endemic lineages and taxa with European affinities, whereas the fauna of the upper part, notably the Mussentuchit Member, includes many lineages with Asian representatives. The dinosaur taxa found from the Mussentuchit Member include several ornithischians, but only a single theropod, the charcharodontosauroid *Siats*, has been named although other lineages such as tyrannosauroids and dromaeosaurids are recognized from isolated teeth. Here we report on small theropod remains collected by the Field Museum of Natural History in the *Siats* holotype quarry. These include a scapula, humerus, and radius found in close proximity. Both size and details of the anatomy are consistent with these elements deriving from a single individual. The scapula is missing its distal end, but has a narrow, strap-like, and gently arced blade. The humerus is nearly complete with a length of 13.5 cm. The deltopectoral crest extends for almost one third of its length, the shaft is sigmoid, and the distal condyles are moderately expanded but less than twice the width of the shaft. The internal tuberosity is separated from the humeral head by a notch. The radius is missing a section of its shaft, with a flat proximal articulation and a rounded distal one. The scapula differs from an undescribed CMF caenagnathoid in lacking a prominent lateral ridge marking a caudoventral extension of the everted acromion process. The humerus is distinguishable from ornithomimosaurs in its curved shaft and large deltopectoral crest, and from therizinosauroids in its narrower distal articulation. It differs from paravians in having an internal tuberosity off set from the humeral head. The radius differs from tyrannosaurids in having a rounded distal articulation. Although the phylogenetic position of these coelurosaurian remains is uncertain, they provide evidence for a novel taxon in the body fossil record of the CMF where theropods in general, and small ones in particular, are rare.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

AGE, AFFINITY, AND SUCCESSION OF STEGODONTID PROBOSCIDEANS FROM MIDDLE MIOCENE-LATE PLIOCENE FORMATIONS OF THE SIWALIK SEQUENCE IN SOUTH ASIA

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The Siwalik Group of South Asia is remarkable for the completeness of its Neogene terrestrial sedimentary sequence, representing >20 myr. Among the mammalian assemblages of the early Miocene-mid Pliocene formations are diverse proboscidean taxa such as deinotheres, gomphotheres, mammutids, and stegodontids. Our study focuses on taxonomy and chronology of stegodontids in the sequence, originally endemic to Asia and comprised of successive genera *Stegolophodon* and *Stegodon*. First appearance of Stegodontidae in the Siwaliks is documented at 13.67 Ma. Undescribed gnathodental elements of stegodontids from the Siwaliks were examined and their morphometric data combined with observations from prior studies. Standard measurements and observations for proboscidean teeth were made, including lamellar number, conelet pattern in each half-lamella, distribution of accessory conules, lamellar frequency (LF, lamellar number per 100 mm), length, width (W), height (H), enamel thickness, and hypsodonty index (HI, H x 100/W). Comparison of sample specimens in the Chinji and Nagri Fms., dated to 11.4-10.1 Ma, with Asian stegodontids indicates the presence of a primitive *Stegolophodon* species, similar to *St. nasaiensis* from Thailand. These specimens have a small number of lamellae, few small mesoconelets per lamella, low HI, M2 with massively thick enamel (7.5-7.7 mm), very low LF (3.25-3.5), and posterior accessory conules in lamellae 1-2 of M2. Dhok Pathan Fm. stegodontids in the sample, dated to 9.4-7.2 Ma, appear to be more common and diverse, identifiable to three species. These include *St. stegodontoides*, with large, very brachyodont molars, thick enamel, low LF, accessory conules as posterior as lophid 4, and an m3 lophid formula of x6x; an extremely advanced *Stegolophodon* that may be in the sister group to *Stegodon*, with proliferation of conelets in lamellae, accessory conules throughout molars, and pentalophodonty of intermediate molars; and a species similar to *S. zhaotongensis* from China, with an m3 lamellar formula of x8x and odd distribution of accessory conules on the lateral margin of transverse valleys. If this species belongs in *Stegodon*, it marks the first appearance of the genus in South Asia at 7.4 Ma, previously documented as no older than 6.7 Ma in the Siwaliks. Our results indicate multiple migrations of stegodontids into South Asia from Asia during the Mio-Pliocene, and continued availability of forested habitats favorable for these proboscideans in Siwaliks ecosystems into late Pliocene Dhok Pathan times.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

CHANGES OF THE CRANIO-DENTAL MORPHOLOGY OF SPOTTED HYAENA (*CROCUTA CROCUTA*, ERXLEBEN 1777) IN BRITAIN FROM THE EARLY MIDDLE PLEISTOCENE TO MARINE OXYGEN ISOTOPE STAGE 3

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Currently restricted to sub-Saharan Africa, spotted hyaenas (*Crocuta crocuta*) had a widespread distribution in Eurasia during the Pleistocene. Within Britain, their remains have been found in deposits attributed to the early Middle Pleistocene, and Marine Oxygen Isotope stages (MIS) 9, 7, 5e, 5c and 3, after which point *C. crocuta* became locally extinct. During this period, they experienced diverse environmental pressures, including changes in climate, vegetation, competition, and prey species. One way in which mammals frequently respond to environmental fluctuation is through changes in body size and shape. This study focuses on cranio-dental morphological changes of British fossil *C. crocuta*, using linear measurements to establish the degree of ecophenotypic change present and the possible drivers behind this. Recent body mass data of *C. crocuta* across Africa were drawn from the literature. Corresponding present-day environmental data were also sourced from the literature and the influences of these variables upon modern body mass were assessed. These results aided interpretation of the fossil data. It is hypothesised that *C. crocuta* body size increases with cooler conditions. The largest Pleistocene specimens are therefore predicted to be from MIS 3.

The Pleistocene results indicate that (i) teeth from MIS 9 are smallest, those from MIS 7 are often the largest, and the early Middle Pleistocene teeth plot within the range of the Late Pleistocene samples, (ii) *C. crocuta* from MIS 3 are more clearly distinguished from those of MIS 5e and 5c age in the size of the lower than the upper dentition, (iii) where distinctions are made, teeth from MIS 3 are often significantly larger than those from MIS 5e and 5c, except for the lower 2nd premolar, where the relationship is reversed, (iv) where available, the mandibular measurements generally do not show clear differentiation in size between different periods in the Pleistocene.
Although sample sizes were small, the results of the modern study suggest that temperature, distance from the equator and precipitation are the variables that are most strongly correlated with *C. crocuta* body mass. Contrary to the hypothesis, the results suggest that body size increases with warmer temperatures. Therefore, where the fossil cranio-dental measurements reflect overall body size, they were potentially influenced by a combination of temperature and precipitation changes through the Pleistocene.
Grant Information:
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Technical Session XVIII (Saturday, August 26, 2017, 11:15 AM)

A QUANTITATIVE APPROACH TO SYNAPSID VERTEBRAL EVOLUTION AND IMPLICATIONS FOR MAMMALIAN ECOLOGICAL DIVERSIFICATION
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The vertebral column is a critical portion of the mammal locomotory apparatus, and yet is understudied relative to the appendicular skeleton. Mammals are distinctive in their anatomical differentiation of the posterior dorsal vertebrae into a ribless lumbar region capable of significant sagittal bending, which is recruited during high-speed asymmetric gaits (e.g., gallop, bound). While regionalization of the mammal column is well established, recent work suggests similar but subtler patterns are shared by other amniote groups, likely reflecting a common underlying developmental framework. To understand the evolutionary origin of the mammalian dorsal regions, we quantitatively compared vertebral morphology across Synapsida, including extinct non-mammalian synapsids, with extant sauropsids displaying varying regionalization patterns.
We used geometric morphometrics to capture vertebral morphology of 16 species of non-mammalian synapsids and 47 extant amniotes. Forty-eight 3D landmarks were taken on five vertebrae per specimen (vert n=324), selected to represent equivalent vertebral positions regardless of meristic variation. Landmarks were subject to GPA and PCA in order to summarize the variation in vertebral anatomy across the sample.
A multivariate analysis of covariance indicates there is a significant difference in vertebral morphology between mammals, sauropsids and non-mammalian synapsids, and significant allometric effect at every vertebral position. However, the distinction between the groups is greatest when all five positions are considered simultaneously, indicating that along-column variation is also a key component of the differences among clades. Evolution of the mammalian vertebral column from non-mammalian synapsids took place along two primary morphological axes: 1) craniocaudal shortening with coronalization of the zygapophyses in the anterior column; and 2) elongation, dorsoventral compression with sagittalization of the zygapophyses in the posterior column. Thus selection for divergent functions at different loci along the column may have driven increasing regional disparity in the synapsid lineage and associated ecological diversification.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW SPECIMENS OF *CHIROMYOIDES* (MAMMALIA: PLESIADAPIDAE) FROM THE LATE PALEOCENE OF WYOMING ILLUMINATE RELATIONSHIPS AMONG NORTH AMERICAN AND EUROPEAN SPECIES OF THE GENUS
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Plesiadapids are typically among the most common mammals found in Paleocene faunas from North America and Europe. As a result, plesiadapids (and particularly species of *Plesiadapis*) are often employed for biostratigraphic correlation on both intracontinental and intercontinental scales. In contrast to the wealth of information available for *Plesiadapis*, the plesiadapid genus *Chiromyoides* remains relatively poorly known. *Chiromyoides* is notable for its robustly constructed upper and lower central incisors, surprisingly small cheek teeth and deep dentary. Five species of *Chiromyoides* have been described from the Tiffanian and Clarkforkian of western North America, largely on the basis of isolated incisors and molars. In contrast, only the genotypic species *Chiromyoides campanicus*, represented by a complete dentary, a maxillary fragment bearing P^4-M^2 and isolated upper central incisors and cheek teeth, is known from the Cernay, Berru and Rivecourt faunas of late Paleocene age in the Paris Basin of northern France. Recent phylogenetic analyses of *Chiromyoides* species yielded a basal polytomy, providing no resolution of relationships within the genus. Here we report new fossils of *Chiromyoides caesor* and *Chiromyoides major* from the late Paleocene of southwestern Wyoming. The new specimens include the most nearly complete maxilla of *Chiromyoides* currently known as well as multiple isolated incisors and cheek teeth. A character analysis based on this new material identifies previously undescribed autapomorphies in both *C. caesor* and *C. major*, indicating that the evolution of *Chiromyoides* was more complicated than simple stratophenetic analyses have implied. Within *Chiromyoides*, there is strong character support for a clade that includes European *C. campanicus* and the two youngest (Clarkforkian) North American species, *C. major* and *C. gingerichi*. Available data therefore suggest that *Chiromyoides* originated in North America and dispersed to Europe relatively late in the Paleocene, perhaps sometime near the Tiffanian-Clarkforkian boundary.
Grant Information**:**
This research was supported by a grant from the David B. Jones Foundation.

Technical Session XVII (Saturday, August 26, 2017, 8:45 AM)

LATE QUATERNARY EXTINCTIONS IN SOUTH ASIA
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The megafaunal extinction was one of the most significant faunal events of the Quaternary. The causes of this extinction are unclear. Both humans and climate change have been implicated. While much research on this event has been conducted on other continents, South Asia has rarely been studied in this context. Here, using the largest compilation of Indian mammal occurrences from the last 100,000 years, I investigate changes in diversity through time in order to understand patterns of extinction in this region. Faunal lists and ages were collected from published literature. Herbivores are best represented in the Indian fossil record, so analyses were restricted to artiodactyls, perissodactyls, and proboscideans. Pleistocene collections of taxa were binned into marine isotope stages, while Holocene collections were divided into tree bins: 10ka-4ka, 4ka-2ka, 2ka-present. Alpha diversity was estimated for each bin. Additionally body mass, and diet were determined for the taxa. Body mass distributions were used to determine if there was size selectivity in the extinctions. The dietary categories of the extinct taxa were compared to the survivors. Finally, these patterns were compared to changes in the intensity of the southwest monsoons. Of the taxa sampled, two proboscideans, one species of hippo, and one species of horse go extinct. However, these extinctions are staggered. Both species proboscideans go extinct after MIS3, while the hippo and horse persist until the latest Pleistocene. A species of *Bos* undergoes domestication, and is therefore not considered extinct in this study. The Indian rhinoceros is extirpated from the peninsular region after 2000ybp. Overall, the Indian peninsular region and Gangetic plain retained 70% of its herbivores and the extinction magnitude is similar to that seen in Africa. Analyses of body mass showed that large bodied taxa did preferentially go extinct, but several equally large taxa persisted. Dietary comparisons showed no selectivity. Correlations with monsoon intensity show that the proboscideans go extinct at the onset of, or soon into MIS2, which is characterized by a weakening of the SW monsoons. While the hippos persisted through this interval, they go extinct soon after during the Younger Dryas, another dry period. It can be hypothesized that these taxa were more water dependent, and could not survive prolonged stretches of weak monsoons. Further investigations and comparisons with similar records in Southeast Asia will shed more light on these intriguing patterns of large mammal extinctions.

Technical Session VI (Thursday, August 24, 2017, 11:15 AM)

REASSESSMENT OF EARLY PERMIAN REPTILE "*CAPTORHINIKOS PARVUS*" SUGGESTS HERETOFORE UNKNOWN DENTAL AND BIOGEOGRAPHIC COMPLEXITY IN THE BASAL EUREPTILIAN FAMILY CAPTORHINIDAE
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The Late Paleozoic family Captorhinidae is generally considered the basal-most clade of the Eureptilia. Though Late Pennsylvanian and Early Permian members are exclusively North American, the group achieved a global distribution by the Middle Permian. Captorhinids are well known for the development of multiple rows of maxillary and dentary teeth in some, though not all, members. Traditionally Captorhinidae have been characterized as generalized reptiles with a fairly conservative morphology, suggesting they are a useful model as a basal amniote. Recent phylogenetic analyses have suggested multiple tooth rows likely developed more than once and greater diversity of dental structure than previously realized. Reanalysis of the cranial structure and phylogenetic relationships of a series of well-preserved skulls from the Early Permian of Oklahoma assigned by Olson to "*Captorhinikos parvus*" now indicates captorhinid structural diversity and interrelationships are even more complicated than previously thought. "*C. parvus*" is a very small captorhinid reptile, but is confidently interpreted as mature/adult by the highly interdigitating cranial sutures. Despite its small size, it possesses three well-developed rows of maxillary and dentary teeth. Significantly, it lacks a supratemoral bone, a condition otherwise found only in the Late Permian South African *Saurorictus*. A phylogenetic analysis combining data bases from the previous twenty years of captorhinid research recovers the following hypothesis of relationships for Captorhinidae: [*Protorothyris*[*Paleothyris*[*Thuringothyris*[*Concordia*[[*Romeria prima*, *Romeria texana*][*Protocaptorhinus*[*Reiszorhinus*[*Rhiodenticulatus*[[*Saurorictus astralis*, "*Captorhinikos parvus*"],[[*Captorhinus laticeps*[*Captorhinus aguti*,*Captorhinus magnus*],["*Captorhinikos chozaensis*"[*Labidosaurus*, Moradisaurinae]. Notably, "*Captorhinikos parvus*" is most closely related to *Saurorictus*, likely a new species within that genus. This would expand the temporal and geographic ranges of *Saurorictus* dramatically, and demand that multiple tooth rows developed within Captorhinidae at least three times.

Technical Session IV (Wednesday, August 23, 2017, 3:00 PM)

HARMONIOUS COLLABORATION OF DENTAL MICROWEAR ANALYSES BY STEREOMICROSCOPY AND SCANNING ELECTRON MICROSCOPY: THE CASE OF OLIGOCENE SLOTHS (MAMMALIA, XENARTHRA)
KALTHOFF, Daniela C., Swedish Museum of Natural History, Stockholm, Sweden; GREEN, Jeremy L., Kent State University at Tuscarawas, New Philadelphia, OH, United States of America
Microscopic scars on the occlusal surfaces are used to garner information on feeding ecology in extinct and extant mammals. Typically, only one of three established techniques (stereomicroscopy, scanning electron microscopy, or confocal microscopy) is applied at a time. Here, we used both stereomicroscopy and scanning electron microscopy (SEM) to evaluate dietary habits in 16 molariforms of the extinct

mylodontids, *Orophodon hapaloides* and *Octodontotherium grande*. These taxa are from the Deseadan (late Oligocene) of Patagonia and count among the earliest definite sloths. We tested two hypotheses: 1) microwear in Oligocene sloths is different from browsers such as extant *Bradypus* and *Choloepus*; 2) microwear features are similar to those of one or more taxa of stratigraphically younger, previously sampled ground sloths. Analyzing similar spots on the same teeth, results from the respective techniques were independently interpreted and then compared to each other and, in the case of SEM, to previously published data from other sloth taxa. To control for interobserver variation, only one user counted features within each method (DK for stereomicrowear and JG for SEM). At 70 x, stereomicroscopic microwear found wear surfaces in *Orophodon* and *Octodontotherium* to be dominated by coarse features such as large pits, coarse scratches, puncture pits, and gouges with no overlap with *Bradypus* and only little overlap with *Choloepus*. SEM analysis at 500x found similar coarse features in *Orophodon* and *Octodontotherium* and that both Oligocene taxa are different from other fossil or extant sloths (including *Bradypus*, *Choloepus*, *Megalonyx*, *Thinobadistes*, *Acractocnus*, and *Megatherium*) studied to date (analyzed by the same user, JG, under the same methodological conditions) in showing higher scratch and pit counts. Both independent approaches support hypothesis 1, while SEM does not support hypothesis 2, and simultaneously reveal a coarse wear surface in Oligocene sloths that reflects an herbivorous diet with a variety of food items of medium to high intrinsic toughness (e.g., foliage, twigs, grass, seeds) plus an intake of exogenous items like dust and grit, the latter witnessed by frequent gouging. These conclusions foster earlier hypotheses that regard both taxa as wide-muzzled ground feeders in savanna-like, open habitats. Our study also suggests that the independent application of two methodologies on identical material leads to more objective and robust interpretation of feeding adaptations via microscopic wear features.

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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MORE THAN LENGTH AND WIDTH: A NEW TECHNIQUE FOR DISTINGUISHING BROWN BEARS (*URSUS ARCTOS*) AND BLACK BEARS (*U. AMERICANUS*) IN NORTH AMERICA

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Fossils of *Ursus arctos* and *U. americanus* from the late Pleistocene of North America have been difficult to differentiate. A lack of strongly diagnostic characters has necessitated identifications based on general morphological patterns and the size of the upper second molar (M2). Some *U. americanus* individuals achieved greater sizes during the Pleistocene than at present; sizes which were sometimes comparable to *U. arctos* from that time. This overlap in size range means that a reliable diagnosis is sometimes difficult. To address this issue, we did a morphometric analysis of the M2 occlusal surface in both bears, and isolated features that are diagnostic for the species. By focusing on the shape and size of the cusps, similarities in overall size can be avoided and the teeth can be distinguished with a higher level of accuracy. This new technique aids in the identification of newly discovered specimens as well as confirming the identification of previously described specimens. Increased confidence in diagnoses and corrected identifications may help in better understanding the spread of Pleistocene *U. arctos* across North America and its geographic range over time. Preliminary study of Pleistocene specimens has revealed misidentifications, and more are expected to be discovered.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

VARIATION IN ORTHODENTIN MICROWEAR ALONG THE TOOTH ROW IN THE CARNIVORE-OMNIVORE *EUPHRACTUS SEXCINCTUS* (XENARTHRA, CINGULATA)

KARAUS, Michael D., Kent State University, Kent, OH, United States of America; GREEN, Jeremy L., Kent State University at Tuscarawas, New Philadelphia, OH, United States of America

Orthodentin microwear is an established proxy for broad-scale feeding ecology in xenarthrans. Although multiple studies have emerged in recent years, the majority of research has been devoted to tardigrades, with an emphasis on reconstructing paleodiet in ground sloths. Much less attention has been paid to cingulates (extant armadillos and extinct glyptodonts and pampatheres) in this regard. Scanning electron microscopy (SEM) at high magnification can distinguish microwear patterns between insectivorous and carnivorous-omnivorous cingulates, yet how such fine-scale patterns vary across the tooth row (both within and among different teeth) within a species and how much this variation is influenced by tooth function and feeding behavior remains untested. We fill this gap in knowledge by asking the question: Do microwear patterns vary by tooth position in a cingulate species with known feeding ecology? We here test the hypothesis that high-magnification microwear patterns vary significantly between successive tooth loci in the extant carnivore-omnivore, *Euphractus sexcinctus*. The upper and lower tooth rows of 2 adult individuals were molded and cast for SEM analysis, following established protocols. At 500× (20 kV operating voltage, secondary electrons), 19 digital images were captured on the outer orthodentin band on the mesial surface of the first five upper and lower molariforms. Four variables [scratch number (S), pit number (P), relative degree of parallel orientation of features (R), feature width in µm (FW)] were counted in a 100µm×100µm square area by only one of us (MDK) using the semi-automated software Microware 4.02. We observed a directional trend of increased mean R (0.58 to 0.81), decreased mean FW (4.67 µm to 1.75 µm), and decreased mean P (5 to 0.33) moving posteriorly. Mean S was highest at the second molariform (17.5), but decreased to 7.67 at the fifth tooth. These results reveal a differential change in microwear along the tooth row, supporting our hypothesis. Higher R values (i.e., more parallel orientation of scars) in the middle of the tooth row suggest these teeth were used more for grinding compared to anterior teeth. The latter may serve more of an initial biting function for larger items, as reflected in greater P and FW. Increased sampling will clarify the consistency of this pattern. Differential microwear reflecting tooth function in a living armadillo with a highly variable diet is promising and may serve as a baseline for testing hypotheses of paleodiet in extinct cingulates.

Preparators' Session (Thursday, August 24, 2017, 9:00 AM)

COMBINING ALL DIMENSIONS: INTEGRATED 3D MODELS OF DINOSAUR BONEBEDS

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Digital three-dimensional (3D) models are widely used in museology and vertebrate paleontology. However, these models are almost exclusively used for visualizing and archiving the surface of specific bone elements or single specimens. Here, we propose to apply sophisticated 3D techniques from archaeology and geodesy to create integrated and georeferenced 3D models of entire dinosaur excavation sites. These 3D models serve as a solid framework to combine all existing paleontological, geochemical and geological data from the field and the lab to solve questions regarding sedimentology, taphonomy and paleobiology.

Since 2013, the National Natural History Museum of the Netherlands, Naturalis Biodiversity Center in Leiden, is actively involved in the excavation and study of a new *Tyrannosaurus* specimen from Montana and multiple *Triceratops* skeletons from Wyoming, USA. Both fossil sites are visualized as a 30m x 30m x 10m large digital elevation model, derived from high resolution LiDAR imaging. The ongoing *Triceratops* excavation is also recorded by aerial photogrammetry allowing daily reports of the progress and stratigraphic correlation with nearby exposures. A (robotic) total station and GPS rover are used to accurately document the x, y and z position of every bone element and lithostratigraphic section. This replaces the traditional 2D grid mapping of bonebeds. Finally, prepared bones are scanned with a handheld 3D scanner to place them volumetrically correct in their original burial position.

By integrating all these techniques, it is possible to develop an interactive, multi-layered 3D model which is coupled to a GIS (spatial) database that aids research, bone preparation in the lab, online collection registration, and educational and outreach purposes. Recording the elevation of every element is fundamental for taphonomic reconstructions, especially when dealing with complex bonebed structures with stacks of multiple disarticulated skeletons, as is the case for the Naturalis' *Triceratops* site. New components within this 3D model are high resolution quantitative sedimentological and geochemical records, e.g. laser diffraction grain-size, bulk organic content and µXRF data. Mapping the lateral and vertical variability of these components sheds light on distinct taphonomic, diagenetic and paleoenvironmental patterns throughout the bonebed. Together with paleohistological data, this can be employed to match specific bone elements to specific individuals and to unravel the taphonomic history of this dinosaur graveyard.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

"BONES -- YOUR INNER ANIMAL", EVOLUTIONARY CONCEPTS TAUGHT TO K-8 STUDENTS BY COMPARATIVE VERTEBRATE ANATOMY STUDENTS

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Although evolution is a central unifying concept in biology and is required by state curricula to be taught throughout K-8 grades, it is often neglected in these grades in favor of "fact list" type of science teaching. Since 2010, a service-learning unit was incorporated into a university *Comparative Vertebrate Anatomy* course in order to create an interesting way to focus on evolutionary concepts using irresistibly fascinating animal skeletons and fossils. University students used a collection of diverse skeletons and fossil replicas to prepare a series of 8-minute presentations demonstrating homology, adaptation, relatedness, natural selection, and other evolutionary themes using fascinating animal examples displayed on themed tables, such as "Backbones", "Birds and Dinosaurs", "Mammal Skulls", "Limbs", "Mystery Bones" (matching game) and "Hominid Skulls". Biology students developed appropriate narrative and interactive activity for the different age groups, which helped the CVA students fully internalize the essential elements of the concept, as well as practice speaking clearly and simply to the public about complex science topics. They presented to approximately 500 schoolchildren, most from 3rd to 8th grades, in southern Massachusetts. Since the concepts were presented repeatedly as the children rotated to different tables with different skeletons, the main message was loud and clear – all life is related. Teachers reported that the conceptual introduction from this program helped them focus other lessons for the rest of the year. CVA students, in their reflections, reported it as a highly memorable and fun experience, helpful to their own conceptual understanding, useful for explaining concepts to their family members, and useful as experience to add to their resumes for post-graduate employment.

Technical Session VIII (Thursday, August 24, 2017, 3:30 PM)

A NEW PRIMATE FROM THE EARLY MIOCENE OF THE AMAZON BASIN, PERU

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Results of two field seasons of exploration along the Alto Río Madre de Dios in Amazonian Peru have yielded a fauna of micromammals including some of the smallest caviomorph rodents, marsupials, interatheriid notoungulates, fish and lizards and invertebrates. The material comes from a cut on the left bank of the river below Atalaya, Madre de Dios Province, Peru, ~ 12.8° South. In this region, the river transects a syncline and is mapped as Yahuarango Formation on geologic maps. New U/Pb dates on detrital zircons constrain the age at between 18.9 ± 0.7 and 17.1 ± 0.7 Ma, making the fauna age-equivalent to that from the Pinturas Formation and the older parts of the Santa Cruz Formation of Patagonian Argentina (Santacrucian *sensu lato*). Of particular interest is an unworn upper molar of a new primate that is distinctively different from any late Oligocene or Miocene primate in a combination of characters, the most salient of which is exceptional small size (equivalent in size to extant *Cebuella pygmaea*, the smallest living or fossil platyrrhine taxon) but with a prominent hypocone, unlike extant callitrichines, in lacking molar conules, having a weakly developed postprotocrista, and in the presence of a prominent stylar shelf with a cristiform mesostyle. Based on the development of the buccal crests, this animal likely had a diet similar to that of extant callitrichines, especially *Cebuella* with a combination of gum and fruit, with serendipitously encountered insects. The phyletic position of the new taxon is uncertain, especially given the autapomorphic character of the tooth as a whole. The distinctive morphology of this primate hints at a wholly original and hitherto unknown Amazonian fauna and reinforces the impression of the geographic isolation of the Amazonian tropics from the more southerly parts of the continent in Early Miocene times.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

GIANT LAMNIFORM SHARKS FROM THE LATE APTIAN AUSTRALIAN TETHYS

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Lamniform sharks radiated globally as large-bodied marine predators during the mid-Cretaceous. Estimates of their maximum body size are spectacular, with some exceeding six meters. Ecological interpretations have used the Great white shark (*Carcharodon carcharias*) as a modern analogue, and proposed opportunistic scavenging, as well as adaptation to macrophagous diets that potentially rivalled coeval pliosaurid plesiosaurians and mosasaurid squamates as apex carnivores. The stratigraphically oldest documented examples of gigantic lamniforms are based on recently identified isolated vertebral centra from Albian epeiric sediments in the Western Interior Seaway of North America. However, an obscure report of similarly sized, but as yet undescribed large lamniform vertebrae recovered from late Aptian strata of the Darwin Formation in northern Australia was made almost 25 years ago. Here we re-evaluate these Australian giant lamniform fossils within the context of other late Aptian marine vertebrate finds from the Darwin Formation. These include a diverse middle trophic-level assemblage of ophthalmosaurid ichthyosaurians resembling the endemic species *Platypterygius australis*, indeterminate elasmosaurids and remains compatible with the small-bodied Australian leptocleidian plesiosaurian *Umoonasaurus*, a large pachycormiform fish, and teeth attributable to the cosmopolitan hexanchid shark *Notidanodon*. Calculations of maximum body length using linear regressions and a comparative dataset of lamniform taxa yielded a size estimate of 5.9 meters from the largest Darwin Formation selachian centrum, which is 125.1 mm in diameter. Such dimensions parallel the upper size range of extant Great white sharks, and suggest that lamniforms had not only achieved huge sizes early in their evolution, but also that they likely occupied top predator niches in multiple marine ecosystems throughout much of the Cretaceous. Furthermore, the Darwin Formation depositional setting records a nutrient rich continental shelf platform that bordered the Austral Tethys. Its vertebrate assemblage may therefore be more oceanic in compositional aspect, perhaps explaining why gigantic lamniforms are apparently absent from adjacent Aptian epicontinental basins, which were otherwise dominated by predatory marine reptiles.

Technical Session VIII (Thursday, August 24, 2017, 3:15 PM)

MAMMALIAN EYE ORIENTATION: COMPARISONS OF BONY ORBIT CONVERGENCE AND SOFT TISSUE MEASURES FROM DICE-CT SCANS

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Among mammals, forward-facing eyes and increased size of the binocular visual field may represent an adaptation for improved depth perception, as binocular depth cues are more precise than monocular depth cues. Conversely, laterally directed eyes maximize total visual field size at the expense of the binocular field, which may facilitate an improved ability to detect predators. Eye orientation is thus an important component of a species' visual ecology, and data on the orientation of the bony orbit is often used as a proxy for eye orientation in studies of fossil crania. However, our understanding of the relationship between orbit orientation and eye orientation, and therefore our ability to reconstruct visual field size for fossil specimens, is limited by the lack of reliable data on eye orientation. The last comparative study that measured mammalian eye orientation directly was conducted nearly a century ago. Here we present a new method for measuring optic axis orientation directly from the soft tissues of fluid preserved mammalian specimens, and compare these results with orbit orientation in the same specimens.

We applied diffusible-iodine contrast enhanced CT (dice-CT) methods to visualize soft tissues in high resolution micro-CT scans. The optic axis of each eye was defined in Avizo using optically significant morphological landmarks and the angle between the two optic axes was subsequently measured. This optic axis divergence angle is expected to correlate negatively with neural mapping estimates of binocular field size, as smaller optic axis divergence angles indicate more forward facing eyes. To allow comparisons with previous measures of orbital convergence, we determined the orientation of the plane normal to the optic axis, then calculated optic axis convergence as the dihedral angle between that plane and the midsagittal plane. All calculations were performed in R using the base package. In the two species for which neural mapping estimates of binocular field size are available, optic axis divergence angle correlates negatively with binocular field size as predicted. Results from four species show that orbital convergence estimates exceed optic axis convergence by 5.4- 20.6 degrees. This discordance between orbit orientation and optic axis orientation is similar to results obtained for birds using visual perimetry. These data suggest that dice-CT methods may be used to measure of optic axis orientation and that orbital convergence alone may not be a reliable proxy for eye orientation or binocular field size in mammals.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NO FOSSILS WERE HARMED DURING THE TRAINING OF THIS PREPARATOR: USING 3D MODELS TO TEACH PROPER PREPARATION TECHNIQUES

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Individual fossils have unique properties that make assessment of trainee proficiency difficult if specimens differ in quality of preservation, fragility, and relative hardness of matrix or bone. We sought to design a robust new method to teach budding preparators basic fossil preparation techniques without risking damage to fossils, while also adding a level of technical rigor beyond that associated with prior methods (e.g., plastic toys buried in plaster). Here, we propose using 3D models to 1) standardize training, 2) assign meaningful benchmarks and develop gated difficulty levels, and 3) cater to specific fossil projects. Our ultimate goal was to create a standardized teaching module with controlled variables in order to teach the basics of fossil preparation.

Four variables were modified according to increasing complexity: 1) matrix hardness (plaster, ~2:1 sand:plaster), 2) technical difficulty (a theropod claw, a disarticulated tyrannosaurid skeleton), 3) bone color contrast (blue, brown), and 4) fragility (thin- and thick-walled). 3D prints were created using vibrant yellow PLA filament and painted to establish a grading metric according to number and severity of errors (chips and scratches) made to the paint. Errors were assigned value based on severity and subtracted from an initial score of 100. Students (n=12) were provided a brush, dental tools, and 3D models buried in matrix randomly assigned from one of the four variables. A control group (n=3) was given a pair of identical specimens.

As predicted, most students showed an increase in number and size of marks on specimens as complexity increased. This change was quantified as a decrease in grades for matrix hardness (60% to 54%), technicality (83% to 73%), rigidity (98% to 91%), and coloration (63% to 35%). The control group was consistent across specimens (50% to 47%). These data highlight the value of this technique, which standardizes and controls for more variables than traditional methods.

Printing inexpensive 3D models allows us to create teaching modules that gradually increase in difficulty, from beginner (bright colors, soft matrix, pliable, predictably-trending) to expert sets (realistic colors, hard matrix, rigid, unpredictably-trending). Unlike store-bought toys, 3D prints can be customized to include specific taxa or themes. Furthermore, standardizing training materials ensures accurate and consistent assessment of quality of work, restricting difficult projects to those who pass quality benchmarks – all without the risk of damaging fossil material.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE GIGANTIC TITANOSAURIFORM SAUROPOD FROM THE EARLY CRETACEOUS KHOK KRUAT FORMATION IN THE NORTHEASTERN OF THAILAND: A PRELIMINARY REPORT

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Here is a preliminary report on the most recent find of an immense sauropod from the Early Cretaceous Khok Kruat Formation at Ban Pha Nang Sua, Nong Bua Rawe District, Chaiyaphum Province, Northeastern Thailand. In early March 2016, a local villager found an exposed of a sauropod sacrum at the bank of pond in the village. Later, geologists from the Department of Mineral Resources have investigated and started a systematic excavation during April-June 2016, discovered several post-cranial specimen from an individual sauropod comprising an axial skeleton (dorsal vertebra and sacral vertebrae) and an appendicular skeleton (a complete well-preserved right humerus, 1.78 m in length, a large dorsal ribs, a partial small rib, two pieces of partial right femur, pelvic girdle and many bone fragments), found associated with several isolated teeth which belong to Allosaurid and Spinosaurid theropods. Associated faunas include Hybodont shark *Heteroptychodus* sp. and crocodilian teeth. According to a preparatory study on humeral morphological features suggested that this new find possibly belong to

a new taxon of giant titanosauriform sauropod dinosaur from the Khok Kruat Formation of Northeastern Thailand
Lithostratigraphically, the sequence of the Khok Kruat Formation at the Pha Nang Sua dinosaur site, can be divided into nine units i.e., Units 1-9, having approximately 3.96 m thick. Dinosaur bones and fragments are found in the lower part of the sequence consisting mainly of reddish brown sandstones and siltstones with conspicuous climbing ripple lamination of Units 1-3. The top of this part consists of a thin layer (Unit 4) of calcrete paleosol. Sandstones from Units 5-9 display various directions of cross bedding and the bones are absent. This may indicate that the dinosaur bones are found in the crevasse splay layers and the channel and channelized sandstone are represented by the sandstones of the upper part of the sequence. The rocks are interpreted as having been deposited by the meandering rivers for Khok Kruat Formation in semi-arid to arid paleoclimate.
More details on anatomical and phylogenetic studies and further excavations are essential to complete and compare with other vicinity sauropods. The measured section and faunal assemblage from Ban Pha Nang Sua dinosaur site is not only useful for lithostratigraphic and faunal correlations to other vertebrate sites. This new dinosaur locality will also shade light and figure out more understanding on sauropod evolution, distribution and paleoenvironment in this region.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

BRIDGING THE GAPS: A NEW NATIONAL MUSEUMS OF KENYA-PALEONTOLOGICAL APPROACHES TO BRINGING RESEARCHERS, STUDENTS AND GENERAL PUBLIC TOGETHER

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With over seven decades of paleontological research, Kenya is unrivaled in its contribution to research in the disciplines of paleontology, archaeology, and paleoanthropology. However, in Kenya, researchers in these fields have often lacked the resources to fully engage with local collaborators and communities. Although it is common for researchers to engage field assistants from the local community to participate in research tasks, communities are less often engaged in learning about the research outcomes, and often never learn what becomes of the natural and cultural heritage data and objects that they assist in assembling. Additionally, upcoming students from Kenyan Universities are often unaware of how to contact researchers for valuable training opportunities. At the same time, international researchers often lack an avenue for reaching out to engage with Kenyan students. In February 2017, the Paleontology Section of the National Museums of Kenya launched a new Research Engagement Initiative aimed at bridging the gaps between museum-affiliated researchers, students and the general public. A pilot program engaging 20 Kenyan students is underway with workshops, seminars and journal clubs designed to prepare students for research in the field, laboratory, and museum collections settings. Outcomes of the new approach include increased student-researcher engagement, organized community tours of paleontological collections and exhibits, and an enhanced public outreach program. Further educational research is required to determine the long-term impacts of this initiative in developing young Kenyan scientists.

Podium Symposium (Wednesday, August 23, 2017, 10:45 AM)

SELECTIVE REGIMES AND FUNCTIONAL ANATOMY IN THE MUSTELID FORELIMB: DIVERSIFICATION TOWARDS SPECIALIZATIONS FOR CLIMBING, DIGGING, AND SWIMMING

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Locomotor anatomy often exhibits specializations for ecological niche, suggesting that locomotor specializations may constitute selective regimes acting on locomotor traits. To test this, I sampled 41 species of Mustelidae, encompassing climbing, digging, and swimming specialists, and determined if trait variation reflects locomotor specialization by performing a principal components analysis on 18 traits of the forelimb skeleton. Three models of selective regimes were applied to PC scores describing trait variation among mustelids: one without *a priori*--defined phenotypic optima, one with optima based upon locomotor habit, and one with a single phenotypic optima. PC1, which explained 78.6% of trait variance, exhibited considerable overlap among locomotor specializations, suggesting that much of forelimb trait variation may be influenced by the need to engage in multiple locomotor modes. PC2, which explained 8.5% of trait variance, distinguished between scansorial and remaining mustelids, representing a trade-off in long bone gracility and deltoid ridge length vs. long robustness and olecranon process length. Best fitting trait diversification models are selective regimes associated with deep divergences within Mustelidae (PC1) and a selective regime differentiating between scansorial and non-scansorial mustelids (PC2). Phylogenetic half-life values suggest that phylogeny has a stronger influence upon the trait variation represented by PC2. However, simulations of likelihood ratios suggest that the best fitting models are not fully adequate to explain morphological diversification within extant mustelids. The inclusion of fossil mustelids may strongly improve model adequacy and provide a more robust understanding of locomotor system diversification in Mustelidae.
Grant Information**:**
Deutsche Forschungsgemeinschaft (ID #: KI 1843/3-1)

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

COLLECTION AND PREPARATION OF A SUB-ADULT *PROSAUROLOPHUS* (ORNITHISCHIA: HADROSAURIDAE) FROM THE BEARPAW FORMATION (LATE CAMPANIAN) NEAR LETHBRIDGE, ALBERTA, AN EXAMPLE OF EXPEDITED LARGE-SCALE EXCAVATION IN AN INDUSTRIAL SITE

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In September of 2016, a sub-adult hadrosaur was discovered during industrial excavation in an ammolite mine (Korite SM4), 25 km south of Lethbridge, Alberta. The specimen derives from the Muddy Unit 1 of the open marine, Late Cretaceous (late Campanian) Bearpaw Formation. Following site reconnaissance the same day as the initial report, a four person crew from the Royal Tyrrell Museum of Palaeontology, Drumheller, was sent to collect the specimen in an expedited manner, facilitated by the heavy machinery at the mine. Excavation revealed the specimen to be a nearly complete, semi-articulated/associated, and well-preserved sub-adult hadrosaur, including fossil skin, in a host rock of dark grey shale. Shovels, rock hammers, and an electric jackhammer were used to dig trenches around the specimen, which was collected in two very large blocks (1,860kg and ~1,400kg) encased in fieldjackets constructed of fiberglass reinforced plaster (FGR) and burlap, and reinforced by lengths of 4x4 lumber. Completed jackets were flipped and transported out of the mine using a John Deere 470G excavator operated by mine staff. Despite muddy conditions from torrential rain, the use of mining equipment facilitated the collection process, reducing the time from initial report to jacket removal from three to four weeks (as seen in a non-industrial setting) to 10 days. Preparation of the specimen was accomplished using hand tools, sodium bicarbonate air abrasion, and an ultrasonic water bath for select, well-preserved elements. The posterior half (mid-dorsal and posterior) is partially articulated, while the anterior half is largely disarticulated, but concentrated. The cranial elements uncovered consist of a left nasal (diagnostic to *Prosaurolophus*), right jugal, postorbital, squamosal, splenial, and dentary, left articular and angular, and left and right maxillae. To date the postcranial elements uncovered include the left and right coracoids, scapulae, femora, tibiae and fibulae, right humerus, left sternal plate, a radius, ulna, and several metacarpals and phalanges, several cervical, dorsal, and caudal vertebrae, ribs, and ossified tendons. Much of the posterior of the skeleton remains to be uncovered, but discoveries in the field and lab suggest isolated patches of preserved skin. This occurrence marks the third diagnostic semi-articulated/associated hadrosaur specimen to be collected from the marine Bearpaw Formation in southern Alberta, all of which are juveniles or sub-adults of the genus *Prosaurolophus*.
Grant Information**:**
Funding: Royal Tyrrell Museum of Palaeontology, Royal Tyrrell Museum Cooperating Society, and the Drumheller & District Chamber of Commerce

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

PRELIMINARY STUDY ON THE NEW PTEROSAUR FOOTPRINTS FROM THE EARLY CRETACEOUS HASANDONG FORMATION OF HADONG-GUN, GYEONGSANGNAM-DO, SOUTH KOREA

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New pterosaur footprint fossils were discovered on the surface of an isolated block from the Early Cretaceous Hasandong Formation in Hadong-gun, Gyeongsangnam-do, South Korea. They occur as concave epirelief or cast filled with fine-grained sandstone on greenish gray calcareous very fine-grained sandstone to siltstone. The footprints consist of two of left manus and pes imprints. The average length and width of the manus imprints are 94.6 mm and 60.8 mm, respectively. The manus imprints are tridactyl and strongly asymmetric in digit shape. Digit I and III have exterior claw marks and there is a clear differentiation between the prints of the claws and the digital pad. The average length and width of the pes imprints are 78.5 mm and 30.6 mm, respectively. The pes imprints are elongate and fully plantigrade. The rounded heel impressions are deep and clear, while the impressions of the digits and claw marks are indistinctive. The pterosaur footprints described here are distinguished from the small pterosaur tracks, *Pteraichnus koreanensis,* previously documented from the Hasandong Formation in morphology and size. They are also different in morphology and size from other pterosaur footprints reported in the Cretaceous deposits of South Korea. Therefore, the pterosaur footprints found in this study are deemed to be a different type from established ichnotaxa in South Korea. Considering various occurrence of pterosaur tracks (*Haenamichnus uhangriensis*, *Haenamichnus gainensis*, *Pteraichnus koreanensis*, and *Pteraichnus* isp.) in the Cretaceous continental deposits of South Korea, the new discovery of pterosaur tracks from the Hasandong Formation suggests that diverse pterosaurs inhabited during the Cretaceous in South Korea.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ONE TINY JAW, A BIG DEAL: A NEW EOMYID GENUS FROM THE MIOCENE MIZUNAMI GROUP OF GIFU, CENTRAL JAPAN

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Eomyids are small to medium-sized fossil rodents that are considered to occupy similar niches to extant dormice, inhabiting forest environments. They were widely distributed in the Holarctic until the family went extinct by the end of the Miocene in North America and by the beginning of Pleistocene in Eurasia. Despite the long research history of the family in other areas, the discovery of eomyid rodents was first reported from Asia in 1991. Since then, the geographic importance of Asia has been emphasized for understanding the evolution of eomyids. Almost concurrently, a small eomyid specimen of the mandible with p4 and m1 was found from the early Miocene (18.5 Ma by K-Ar dating) fluvial deposits in Gifu Prefecture, central Japan. Because the Japanese eomyid possesses a combination of dental characters that is rare for the family (the presence of four roots in m1; the hypolophid extending anteriorly to connect to the posterior ectolophid), this specimen was temporarily attributed to *Pseudotheridomys* sp. However, more detailed identification was impossible at the time due to the scarcity of eomyid fossils in Asia. More than a decade later, several species of *Asianeomys* have been successively discovered from North China, Mongolia, and Kazakhstan. Chinese species that were previously identified as *Pseudotheridomy* were transferred to this genus.

Considering the present state of knowledge, we revisit the Japanese eomyid specimen for direct comparison with *Asianeomys* and report that the mandible belongs to a new genus. In addition to a descriptive study, we examined the phylogenetic relationship between the new genus, *Asianeomys*, *Keramidomys*, and *Pseudotheridomys* by means of a cladistic analysis of tooth morphology. Our results confirm that the Japanese eomyid specimen is outside a monophyletic group of *Asianeomys*. The new genus is distinguished from *Asianeomys* by a combination of following characters: (1) more bunodont pattern with lower lophids yet transverse lophids are complete, (2) two rooted p4, rather than three roots, (3) synclinids I of m1 shorter than half the length of synclinid IV, (4) synclinid II of m1 as short as half the length of synclinid III. These differences resulted in a more basal position of the new genus. Although the fossil locality was considered to be part of the coastal margin of continental Asia during the early Miocene, we suggest that the area was well isolated from more internal regions for small mammals, like eomyids, to have separate habitats and eventually evolve independently.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

MEDIAL MESOZOIC PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING OF BUREAU OF LAND MANAGEMENT (BLM) LANDS IN THE BLUE HILLS AREA, EASTERN UTAH: DOCUMENTING PALEONTOLOGICAL RESOURSES THAT HAVE BEEN LOVED TO DEATH

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In 2016, the Utah Geological Survey (UGS) partnered with the BLM to conduct a paleontological inventory of the Blue Hills area, northwest of Moab, Utah. This area was chosen because the State Paleontological Database, managed by the UGS, indicated that few sites have been recorded in an area frequently visited by avocational rock collectors. Fossiliferous rocks of Upper Jurassic Morrison Fm. (MF) and Lower Cretaceous Cedar Mountain Fm. (CMF) are well-exposed in this area. During 10 days of field work, UGS personnel recorded several dozen new fossil localities. Several sites with bone scatters were found in the Tidwell Mbr. at the base of the MF. Several dinosaur bone localities and tracksites were found in the Salt Wash Mbr. of the MF. Many localities were noted in the Brushy Basin Mbr. of the MF which is well-known for containing abundant vertebrate fossils.

Many vertebrate bone sites in the Brushy Basin Mbr. were vandalized and subjected to unauthorized collecting (none of these sites had been reported to the BLM). One area visited by Kirkland in the late 1980s and again in early 1990s had subsequently been intensively picked over, such that all known isolated bones are now represented by empty excavation pits. Most petrified logs were gone and acres of bone, petrified wood, and agate fragments paving the flats between the neighboring hills have been cleared ("vacuumed") of anything interesting. Only one large stratiform "marsh" site was left intact enough to yield potentially scientifically significant material. A large site in another area had at least 10 cubic meters excavated illegally and numerous bone fragments litter the slope and spoils pile. CMF sites included another large illegally excavated vertebrate site and many large petrified log sites in varied condition. Conversations with rock hounds we encountered resulted in complaints that there were no more easily collected logs near the roads. A CMF crocodilian tracksite and an extensive vertebrate feeding trace site were apparently overlooked by rock hounds. Finally, a wetlands site low in the CMF is exceptionally rich in ostracods and conchostracans and has the potential to yield pollen and microvertebrates, appears to have been too subtle to gain notice.

It will take generations for this area to return to an equilibrium state as in the 1980s, if left completely untouched. The BLM plans to increase patrols by Law Enforcement and Site Stewards to help curtail illegal collection, as well as increase educational efforts regarding responsible legal collecting of common fossils vs. vertebrate remains.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SPECIES RECOGNITION IN THE MESOZOIC? TESTING HYPOTHESES OF ELABORATE STRUCTURES IN CERATOPSIAN DINOSAURS

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Among dinosaurs, ceratopsians are known for their exaggerated and often elaborate horns and frills. Many explanations have been proposed for the origin and evolution of these structures, from predator defence to socio-sexual dominance signalling and, more recently, species recognition. A key prediction of the species recognition hypothesis is that two or more species possessing divergent display structures should have lived in at least partially overlapping geographic and temporal environments. Here, for the first time, we test this hypothesis in ceratopsians by conducting a pairwise comparison of the morphological characters of 46 ceratopsian species known from relatively complete remains. A total of 350 ceratopsian characters were categorised according to whether they contributed to external morphology. These were further subdivided into 'display' (i.e. non-functional exaggerated) and 'non display' external characters, allowing for the comparison of patterns of diversity between internal and external characters across all possible ceratopsian species pairs. The level of divergence of the non-functional exaggerated display characters of sympatric and near-sympatric species pairs were found to not differ significantly from the same characters of non-sympatric species pairs, regardless of phylogenetic distance. The prediction of the species recognition hypothesis thus has no statistical support among known ceratopsians.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

PALAEONEUROLOGY OF A TITANOSAURIAN SAUROPOD FROM THE LATE CRETACEOUS OF FOX-AMPHOUX-MÉTISSON (SOUTHERN FRANCE) AND ITS SYSTEMATIC SIGNIFICANCE

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Over the last decade, our knowledge of the palaeoneurology of titanosaurian sauropods has dramatically improved. While the endocranial morphology of titanosaurian sauropods has long been known only in *Jainosaurus septentrionalis* from the Maastrichtian of India, a considerable amount of new data on the endocranial and inner ear morphology in Late Cretaceous taxa from Argentina, Spain, Uzbekistan, and India have recently been gathered. However, a number of braincases have not yet been explored from a palaeoneurological viewpoint, thereby neglecting significant data to help assess the diversity of titanosaurs. This holds especially true for the Late Cretaceous of Europe.

In light of this, we digitally reconstructed the endocranial and labyrinthine cavities of a previously described, but undiagnosed braincase from Fox-Amphoux-Métisson (Campanian of southern France). The endocast is marked by a strong dorsoventrally elongated depression dorsal to the oculomotor nerve (III), which separates the cerebral region of the endocast, rostrally, from the midbrain-hindbrain complex, caudally. The hindbrain does not bear any remarkable dural expansion. A relatively developed dorsal-head/caudal-middle-cerebral vein (CVCM) system manifests dorsolaterally on the endocast, dorsal to the trigeminal nerve (V). The courses of most cranial nerves could be reconstructed, including those of the oculomotor nerve (III), the expectedly large trigeminal nerve (V), the abducens nerve (VI), the slender facial nerve (VII), the complex metotic group (IX-XI), and the single hypoglossal nerve (XII). The labyrinth shows an average development compared to that of the other titanosauriforms in which it is known.

The presence of a CVCM system on the endocast of the titanosaur from Fox-Amphoux-Métisson suggests that the taxon was more primitive than *Jainosaurus septentrionalis* and the two specimens from the site of Lo Hueco (Campanian or Maastrichtian of Spain). On the other hand, the titanosaur from Fox-Amphoux-Métisson appears to be more closely related to the latter than to *Sarmientosaurus musacchioi* (Cenomanian of Argentina) and the specimen from Dzharakuduk (Turonian of Uzbekistan) in the lack of prominent dural expansion and the distinct caudoventral orientation of the pituitary fossa. It shares many (but not all) of its endocast features with *Bonatitan reigi* (Campanian or Maastrichtian of Argentina). The titanosaur from Fox-Amphoux-Métisson is, therefore, likely a member of Lithostrotia, although not one of the most derived ones.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

A LARGE ARCHOSAURIFORM (?ERYTHROSUCHIDAE) MAXILLA FROM THE MIDDLE TRIASSIC MOENKOPI FORMATION SHEDS LIGHT ON THE BIOGEOGRAPHY OF LARGE BODY SIZE EVOLUTION DURING THE POST-PERMIAN ARCHOSAURIFORM RADIATION

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The end-Permian extinction was the most devastating in Earth's history, but the subsequent recovery saw the adaptive radiation of a diverse group of reptiles, the Archosauriformes, a group that includes living crocodylians and birds, and also contains the largest ever terrestrial animals (e.g. titanosaurs). There is an excellent global record of large archosauriforms in the Late Triassic, (e.g., six meter long pseudosuchians), but the record of large archosauriforms from the Early and Middle Triassic is sparse and primarily from present-day Russia, China, and South Africa, all of which were located at high latitudes during the Triassic Period. The only large archosauriform from lower latitudes before the Late Triassic was the poposaurid *Arizonasaurus babbitti* (~3 meters long), but tracks from the Moenkopi Formation (e.g., *Isochirotherium marshalli*) indicate that larger archosauriforms were present in equatorial Pangea at least as early as the Olenekian Stage. Here we describe maxillae from the Anton Chino Member of the Moenkopi Formation, New Mexico, which belong to a large, carnivorous reptile. The presence of an antorbital fenestra, tooth serrations, and thecodont dentition places this animal within Archosauriformes, but the presence of a large foramen on the anterolateral portion of the lateral surface excludes it from Archosauria. The convex curve of the ventral edge supports its placement within Erythrosuchidae, a group of large predators with large heads relative to body size. However, all specimens are missing the dorsal process, a portion of the maxilla important for diagnosing early archosauriform clades. Using data from maxilla to skull ratios of large archosauriforms (e.g., erythrosuchids), we estimate that the skull of this animal was at least 60 cm in length, comparable to that of contemporary archosauriforms from high latitudes (e.g., *Shansisuchus*). This confirms that large, carnivorous archosauriforms were not restricted to higher latitudes and were present in ecosystems in the tropics during the Middle Triassic. Additionally, the large body sizes in archosauriforms were already globally distributed by the Middle Triassic and therefore, occurred over a wider ecological and geographical range than was previously thought.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

ORIGIN AND DISPERSAL OF TRUE SEALS (FAMILY PHOCIDAE) BASED ON RECENT FOSSIL EVIDENCE

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Although classification of the Family Phocidae (=True seals) remains contentious, fossil evidence supports the existence of three extant subfamilies (Phocinae, Monachinae and Cystophorinae) and one extinct subfamily (Devinophocinae). The discovery of *Afrophoca libyca* (subfamily Monachinae, ~ 21 Ma) further demonstrates that the origin of true seals was in the Paratethyan/Mediterranean basins, occurring no later than the Late Oligocene. Seals widely dispersed during the Middle and Late Miocene, crossed the Atlantic Ocean westward and practically ceased to exist in Europe by the Early Pliocene. Representatives of the subfamily Cystophorinae (two species of the genus *Pachyphoca*) also supports an origin in the Paratethys, followed by westward migration (~ 11.2 Ma) before dividing into two modern genera (*Cystophora* and *Mirounga*). Cranial material (*Devinophoca claytoni* and *D. emryi*) and the first record of mandibles/postcranial bones (*D. emryi*) of the subfamily Devinophocinae from the Central Paratethys (Vienna Basin; 13.8-16.5 Ma) presents unique, primitive characters as well as mixed characters with the other three subfamilies, demonstrating the possible ancestral morphotype for all four subfamilies. *Leptophoca amphiatlantica* (subfamily Phocinae) originated on the coast of Western Europe (16.4-15.8 Ma), dispersed across the Atlantic westward to the eastern shore of the North Atlantic in Calvert time (~ 15 Ma) and then spread southward in St. Mary's time (~10.5 Ma). Currently, Early-Middle Miocene phocines (*L. lenis*) and two new monachine species of a new, yet to be described genus have been found on the eastern shore of the United States. The fossil record from Miocene deposits of Europe and North America supports a North Atlantic-Paratethyan origin of true seals, contradicting the widely accepted hypothesis of a North Pacific origin. The North Pacific record of fossil Phocidae is relatively late, represents only a few genera and provides no evidence about the earlier evolution of the Family Phocidae.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW PROTOCOL FOR THE STUDY OF POLYPHYODONT DENTITIONS WITH MULTIPLE REPLACEMENT TEETH

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Intensifying interest in the internal structure of teeth and dentigerous bones necessitates developing a common set of protocols and standards. Here we present a comprehensive descriptive framework for the study of polyphyodont dentitions with several generations of replacement teeth by combining existing contributions with new metrics. Characterizations include external crown morphology, internal tooth structure, wear, developmental, and replacement patterns. We focus specifically on sauropodomorphs although these data are generally applicable to other vertebrate clades.

Multiple discrete trait characterizations of functional tooth morphology include labial/lingual grooves, general tooth form, enamel ornamentation (crests/flutes, grooves, pits and reticulated sections), presence of carinae, and position, size, and shape of denticles. Here we present a unified framework for applying these standards to sauropodomorph dentitions, including proposing novel terminology for tooth shape in the clade, herein defined as: conustylodont, sphenostylodont, and phylodont. Continuous variables include denticle count, tissue formation times and rates (e.g. Dentine Growth Rate (DGR)), replacement rates, and Slenderness Index (SI; crown height/maximum crown width). We propose new continuous variables including Crown Expansion Index (CEI; maximum crown width/average root width) and a new protocol for quantifying the degree of crown concavity/convexity, and degree of apical tapering. We further provide a protocol for standardizing wear facet morphology based on quantification relative to the long axis of the tooth and quantifying tooth replacement patterns using a trigonometric equation based on tooth formation times and tooth position. Lines parallel to trendlines of trigonometric plots (Formation Time Slopes (FTS)) are used to define developmental stages of replacement teeth. Combined with wear facets in functional teeth, these stages are used to plot Zahnreihen diagrams and from them z-spacing is calculated. Using unerupted replacements as part of the Zahnreihen is a new approach that permits the detection of z-spacings even if no functional teeth are present.

Preparators' Session (Thursday, August 24, 2017, 8:00 AM)

AT THE CUTTING EDGE OF PALEONTOLOGY: THE DIAMOND TIPPED CHAINSAW – ADVANTAGES AND DISADVANTAGES COMPARED TO THE CONCRETE CUT-OFF SAW

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Tools are often adopted from their intended application to be used in paleontological fieldwork. Concrete saws are often used for cutting away sterile rock, making large specimens manageable for collection. The Royal Tyrrell Museum of Palaeontology (RTMP) frequently uses a 4.8kW cut-off concrete saw fitted with a diamond blade for this purpose. The circular blade of this saw imposes some limitations on the directionality and depth of cuts. The maximum blade diameter is 35cm, which restricts the maximum cut depth to 12.5cm. The saw is relatively heavy (9.7kg) and is used most safely while oriented vertically, which limits the type of cut it can perform, and usually requires a hammer and chisel to complete rock removal. In addition to the cut-off saw, the RTMP has recently started using a 4.3kW diamond tipped concrete-cutting chainsaw to trim excess rock from stabilized blocks during preparation. The chainsaw's guide bar is 40cm long and is capable of cutting while completely submerged in the rock up to the rubber housing. This enables cutting to more than three times the depth of the cut-off saw, and the full length can be used to cut in many different orientations. The use of a multidirectional tool has many applications for fieldwork including making transverse cuts to facilitate extracting fossils from bedrock, and shedding excess weight from large blocks so they can be removed safely. The chainsaw can perform plunge cuts directly into the rock face, without the resistance or kickback of a wood-cutting chainsaw. The comparatively lighter weight (7.6kg) and the broad range of cutting angles allow this tool to make precise cuts closer to the specimen than the cut-off saw. The chainsaw's maneuverability makes it more comfortable and safer to operate since kickback is less likely, and also circular blade failure can be more hazardous than chain failure. The water-cooled chain cuts through rock faster than the cut-off saw blade, however the short lifespan and cost of the chain are liabilities. A new chain can range from $500 to $700 and must be replaced every 12-24 linear metres of cutting. The saw requires water at a minimum pressure of 22psi during operation; pumps can supply this, but field localities are not always located near water sources. The purchase and operation costs are greater for the chainsaw but can be partially offset by the time saved. If cost and location are not limiting factors, the diamond tipped chainsaw is a more effective and safer tool for paleontological applications.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DINOSAUR FOOTPRINT ASSEMBLAGE AND ITS GREGARIOUS BEHAVIOR FROM THE LOWER CRETACEOUS KHOK KRUAT FORMATION, KHORAT GROUP, NORTHEASTERN THAILAND

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The Upper Triassic to Lower Cretaceous Khorat Group, which consists of non-marine sedimentary rocks, crops out widely in northeastern Thailand. The Khorat Group is subdivided into eight formations, which are (from oldest to youngest) the Huai Hin Lat, Nam Phong, Phu Kradung, Phra Wihan, Sao Khua, Phu Phan, Khok Kruat, and Maha Sarakham formations. The upper Lower Cretaceous (Aptian-Albian) Khok Kruat Formation is the upper part of the Group. Many dinosaur footprints have been known from the Khok Kruat Formation at the Huai Dam Chum (Tha Uthen) site, northeastern Thailand. Gregarious behavior has been suggested for a number of dinosaur taxa, including ceratopsids, ornithopods, theropods, and sauropods on the basis of dinosaur bone and footprint fossils. On the other hand, there has been no previous study of the ichnotaxonomic classification or quantitative community analysis of the dinosaur footprint assemblage at the Tha Uthen site. In this study, we systematically describe tracks and conduct quantitative analysis of theropod track assemblage from the upper Lower Cretaceous Khok Kruat Formation.

The tracks described herein are preserved at the Huai Dam Chum site (N17°71'30.01", E104°38'15.76"), Ban Lao Nat, Tha Uthen District, Nakhon Phanom Province, northeastern Thailand. Approximately 600 tracks occur in thin mudstone layer of the northern part of the outcrop at the Huai Dam Chum track site. Two types of footprints, small-sized theropod and crocodylomorph are imprinted with mud cracks and ripple marks on the thin mud layer. Most of footprints are referred to cf. *Asianopodus*, and are imprinted by small-sized theropoda, probably ornithomimosauria. Theropod tracks are mainly separated into two groups, Group A and Group B. From ichnological viewpoints, the small-sized theropod track assemblage indicates the herd behaviour and its idiosyncratic group composition. In particular, the histogram of size-frezuency measurements of Group A shows the anomalous bimodal distribution. We consider that there are two hypotheses; the first one is due to the male-female difference, and the second is a result of the different growing stage.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

FIRST POSTCRANIAL REMAINS OF MULTITUBERCULATES (ALLOTHERIA, MAMMALIA) FROM GONDWANA

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Multituberculates (Allotheria) are generally regarded as the evolutionarily most successful and longest-lived (?Middle or Late Jurassic to late Eocene) clade of Mesozoic and early Paleogene mammals. Despite this "reputation" and the fact that the group is particularly well represented in both taxonomic diversity and relative abundance on Laurasian landmasses during the Cretaceous and Paleocene, it is exceedingly poorly represented on the southern supercontinent Gondwana. Previous records on Gondwanan landmasses have been based on fragmentary dental remains and all except the three most recently published (each represented by a single isolated tooth or fragment of tooth) have been disputed and allocated to either Haramiyida or Gondwanatheria. Furthermore, several previous records, disputed or not, are based on fragmentary dental remains of a type (plagiaulacoid) that has evolved convergently several times in mammalian evolution.

Here we place on record a multituberculate femur from the Upper Cretaceous (Maastrichtian) Maevarano Formation of the Mahajanga Basin, Madagascar. This specimen, although fragmentary as well, exhibits a number of features common to all multituberculate femora: neck cylindrical in cross section and set apart from shaft; greater trochanter prominent, extending proximally beyond head, inclined dorsally, and separated from neck by deep incisure; lesser trochanter prominent, terminating abruptly (rather than extending into a ridge), and protruding ventrally; posttrochanteric fossa present on ventral aspect, lateral to lesser trochanter; subtrochanteric tubercle present on dorsal aspect, distal to incisure between greater trochanter and neck; diaphysis straight, elliptical in cross section (slightly compressed dorsoventrally); and third trochanter absent. Three of these features (prominent, ventrally placed lesser trochanter that terminates abruptly; presence of posttrochanteric fossa; presence of subtrochanteric tubercle) are derived features found only in multituberculates and are thus autapomorphic for the clade. This specimen therefore not only independently and conclusively confirms the presence of the clade on Madagascar—previously based on a tiny molar fragment—but on the entire supercontinent as well.

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Technical Session II (Wednesday, August 23, 2017, 12:00 PM)

DIVERSITY DYNAMICS ARE LINKED TO CLIMATE CHANGE IN CARTILAGINOUS FISHES (CHONDRICHTHYES, HOLOCEPHALI ELASMOBRANCHII) FROM THE EOCENE OF ANTARCTICA

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It is widely accepted that global climate change affects marine fish diversity patterns although the extent and severity still are ambiguous. To test long-term climatic effects on marine fish assemblages, we analyzed diversity dynamics of Eocene chondrichthyans from Antarctica combined with detailed stratigraphic and paleoecological data, because the Eocene was one of the most important time intervals in global climatic developments with short thermal maxima at the Paleocene-Eocene boundary (PETM), in the early Eocene (EECO) and in the middle Eocene (MECC) resulting in greenhouse conditions during the early and middle Eocene. This was superseded by a late Eocene transition to icehouse conditions resulting in extended Antarctic glaciations at the end of the Eocene (EOT, ca. 33.7 MA).

The material for this study includes ca. 4,500 chondrichthyan remains from TELMs 1–7 (acronym for Tertiary Eocene La Meseta) of the La Meseta Fm. (late Ypresian to the late Priabonian) of Seymour Island (Antarctic Peninsula). The Eocene Antarctic assemblage, which represents the most complete and diverse collection of Paleogene chondrichthyans from high-latitudes includes mostly globally distributed taxa on genus level but displays a high amount of endemic species (all orectolobiforms and squaliforms, most carcharhiniforms and batoids, some chimaeroids and lamniforms). The standing diversity in local assemblages increases from the late Ypresian (six species) towards the Lutetian (43 species) correlating with an increase in sea-surface temperatures. This high diversity equals that of contemporaneous lower latitude faunas (e.g., Morocco, UK). A gradual decrease in species diversity occurred in the Bartonian and final disappearance of chondrichthyans at the end of the Priabonian is linked to the establishment of Antarctic ice sheets. Diversity indices (e.g., Shannon-Weaver index) are highest in TELMs 5 and 6 (Lutetian, Bartonian), although the standing diversity in TELM 6 is rather low (13 species). Low evenness values in TELMs 4 and 5 indicate an unequal distribution of individuals across genera demonstrating the dominance of several taxa over others (mainly the lamniform shark, *Striatolamia*). Rarefaction analyses indicate that collecting biases are most pronounced in the lowest parts of the section (TELMs 1 and 2) but negligible for TELMs 4–7. The results thus strongly support that diversity patterns and taxonomic composition of Eocene chondrichthyans of Antarctica are linked to climatic changes.

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Technical Session III (Wednesday, August 23, 2017, 3:00 PM)

THE OLDEST CROWN CLADE PENGUIN: OSTEOLOGY, JAW MYOLOGY, AND NEUROANATOMY OF *MADRYNORNIS MIRANDUS*

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Madrynornis mirandus, a penguin known from a single nearly complete skeleton dated to 10.0+/-0.3Ma, provides crucial data for reconstructing the evolution of modern penguins. Restudy of the holotype reveals previously overlooked morphological features that support a new phylogenetic placement, allows reconstruction of the muscles of the jaw, and permits generation of a nearly complete and undistorted endocast.

The skull of *Madrynornis* is characterized by widely separated temporal fossae, a weakly bowed jugal, and a long and narrow retroarticular process. Reconstruction of the jaw musculature suggests an overall conformation intermediate between the fish-specialist *Spheniscus* (banded penguins) and *Eudyptes* (crested penguins), which consume a higher proportion of invertebrates. The brain endocast shares many derived features with extant penguins including a “heart-shaped” telencephalon, highly reduced olfactory bulbs, and a lack of cerebellar folds. However, the endocast differs from extant penguins in the less caudally-extended Wulst and stouter flocculus.

Originally described as the extinct sister taxon of *Eudyptes* (crested penguins), *Madrynornis* has subsequently been considered to be a stem penguin or the sister taxon of *Eudyptes* + *Megadyptes* (yellow-eyed penguins) by various authors. Our re-analysis suggests *Madryornis* is certainly a crown penguin (a position supported by six synapomorphies), but occupies a deeper branch basal to the divergence between *Eudyptes* + *Megadyptes* and other extant penguins. Following stratigraphic revisions that shift the age estimate for *Spheniscus muizoni* from ~12Ma to 9.1 Ma, *Madrynornis* is now recognized as the oldest crown penguin taxon. Our results thus support both a recent replacement of archaic penguins by crown taxa and a South American origin for several extant clades.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

KINEMATIC FUNCTION OF ARCTOMETATARSUS OF ORNITHOMIMOSAURS AND THEIR CURSORIAL ADAPTATION

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Adaptation for cursorial locomotion provides significant advantage and efficiency of foraging preys or escaping from predators. Some theropod dinosaurs such as ornithomimids, tyrannosaurids, and toodontids, have a high cursoliality with proportionately long distal elements in hind limb with an unusual foot design, called arctometatarsus. Previous phylogenetic analyses demonstrated that the acquisition of arctometatasus was convergent in these three clades because basal forms of each clade show no arctometatarsal condition. It has been suggested that theropods with arctometatarsus enhanced cursoriality, although kinematic function of arctometatarsus has not been fully understood yet. This study focuses on ornithomimosaurs, which are known as the fastest-running dinosaurs, and examines the biomechanical and histological differences between non-arctometatarsus in non-ornithomimid ornithomimosaurs (*Harpymimus* and *Garudimimus*) and arctometatarsus in ornithomimids.

Biomechanical analysis based on inner structure and measurements of the second moment of area shows that arctometatarsus is more resistance for bending stress anteroposteriorly than non-arctometatarsus. On the contrary, non-arctometatarsus has higher strength by increasing its massiveness than arctometatarsus. CT data in transverse cross-sections of metatarsus show a thin or no cortex in margins with other metatarsal contacts. This unique cortex distribution is present only in arctometatarsus of ornithomimids and indicates that three metatarsals might be functioned as a single unit. Histologically, cross-section of a distal part of the third metatarsal of an ornithomimid shows high density of secondary osteons posteriorly. The anterior border of this highly dense area approximately matches to a kinematic boundary between compressive and tensile strains obtained by biomechanical analysis, suggesting that the high density of secondary osteons was a result of remodeling by a tensile strain. This indicates that the third metatarsal bend anteroposteriorly under high loadings on their foot, and this movement may absorb a stress. These features also imply that arctometatarsus may enhance durability to withstand a stress related to a high speed running.

Technical Session XIII (Friday, August 25, 2017, 2:15 PM)

FIRST ASSEMBLAGE OF EGGSHELLS AND SKELETAL REMAINS OF THE ALVAREZSAURID DINOSAUR FROM LAURASIA (UPPER CRETACEOUS, CHINA)

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Alvarezsaurid dinosaurs are small bipedal, likely feathered, non-avialan theropods known from Asia, North and South America. The first association between eggshells and skeletal remains of an alvarezsaurid dinosaur from Laurasia were collected from Uppermost Cretaceous of the Qiupa Formation in Henan Province, China. The eggshells bear irregularly distributed circular and oval nodes along with less frequent and randomly occurring ridges on the outer surface. Two structural layers have been recognized: 1) the prismatic layer exhibits incremental texture and consists of 75 microns wide prismatic columns visible under circular polarized light; and 2) the layer of mammillary cones with pronounced tabular texture and formed by radiating acicular crystallites. Some of blade-like crystallites grade into the long, splayed wedges that may extend deeper into the prismatic layer. Mean value of the thickness ratio for the two layers is around 2.6:1. Sinusoid interface between the prismatic and mammillary layers gets obvious using fluorescence excitation. Pore system can be assigned to the obliquicanaliculate and angusticanaliculate type.

The above eggshell parameters significantly differ from those that characterize the eggs of *Bonapartenykus ultimus*: the alvarezsaurid dinosaur from Upper Cretaceous of the Allen Formation in Río Negro Province, Argentina. These eggs from Gondwana, known as *Arriagadoolithus patagoniensis*, were described as three-layered, 1 mm thick, tubocanaliculate and obliquicanaliculate with cavitated canals, and the prismatic/mammillary ratio 4.7:1 (mean).

We propose that the structural disparity of the contemporaneous Gondwanan and Laurasian alvarezsaurids is due to either distant paleogeographic occurrence or/and diverse phylogenetic relationship (Patagonykinae versus Parvicursorinae) rather than due to an accidental occurrence of the Chinese alvarezsaurid skeletal remains with eggshell fragments that belong to a different dinosaur.

Grant Information:
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Romer Prize Session (Thursday, August 24, 2017, 8:30 AM)

THE DINOSAUR SCALE – ICHNOLOGY MEETS SOIL MECHANICS FOR WEIGHT ESTIMATION OF SAUROPOD DINOSAURS BASED ON THEIR TRACKS

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Footprints of sauropod dinosaurs are globally distributed in Mesozoic deposits and are of remarkable size owing to their gigantic trackmakers. Sauropod body mass estimates range in excess of 80 tonnes and are based either on the reconstruction of the body volume or on scaling relationships between stylopodial measurements and body mass in extant quadrupedal tetrapods. Discrepancies between these two estimation methods are assumed to be related to the low specific density of the sauropod body (~800 kg/m³), which is inferred from extensive postcranial skeletal pneumaticity and other evidence for a bird-like lung. Hence, a new method is required for estimating body mass independently from skeletal material and for testing the low body density hypothesis.

In a novel interdisciplinary approach combining ichnology and soil mechanics, such a method is developed by estimating the weight of a trackmaker from its tracks. Here, I demonstrate the method with sauropod dinosaurs because they are easily approximated in terms of kinematics and foot anatomy with the example of the well-known "turning sauropod" trackway from the Copper Ridge tracksite (also known as Valley City site) in the Upper Jurassic Morrison Formation near Moab, eastern Utah, USA. The basic principle is that each footstep of a trackmaker deforms the substrate and that this deformation can be quantitatively modeled using soil mechanical finite element analysis (FEA). For the FEA, trackway parameters and footprint dimensions were obtained from photogrammetric 3D models. Properties of the deformed substrate were analyzed in petrographic thin sections, and experimental soil mechanical input parameters were derived from comparable recent unconsolidated river sediments. Next, several loading

conditions were applied in the FEA to model the substrate deformation as observed in the Copper Ridge footprints. To calculate body weight from a single footprint, weight distribution among the limbs during locomotion has to be taken into account, which was inferred from the footfall pattern in the trackway. The weight estimate for the Copper Ridge trackmaker is approximately 16 tonnes, which is in good agreement with weight estimates for probable trackmakers known from body fossils, such as the common Morrison sauropods *Diplodocus* and *Camarasaurus*. By offering a novel approach for estimating the weight of extinct tetrapods, this study extends the range of paleobiological information contained in vertebrate tracks.

Grant Information:
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

RANGE OF MOTION AND MUSCLE ATTACHMENTS IN A CYNODONT PECTORAL GIRDLE AND FORELIMB

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The diverse forms of the therian pectoral limb constitute a classic example of adaptive radiation, a dizzying array of wings, flippers, struts, and manipulators sharing a common anatomical scaffold. Tracing the evolution of limb function along the synapsid line is key to locating the roots of therian forelimb plasticity and ecological success. The Permian to Jurassic radiation of non-mammalian cynodonts presents an intermediate stage of appendicular evolution, yet the lack of clear osteological constraints has led past workers to arrive at conflicting interpretations of function. The sequence of transformations that preceded the acquisition of adducted therian limb function from the ancestral abducted pattern remains unresolved. We revisited this classic problem by reconstructing the pectoral limb of the Triassic traversodontid *Massetognathus pascuali* in 3D, combining skeletal anatomy with shoulder muscle attachments derived from an extended extant phylogenetic bracket. We tested maximum theoretical range of motion in the pectoral girdle and forelimb, and found evidence of girdle mobility as well as substantial range of motion at the glenohumeral, humeroulnar, and humeroradial joints. Simulating thicker articular cartilage significantly increased range of motion about all axes, consistent with past studies showing that joint mobility in taxa with unossified epiphyses is sensitive to assumptions of joint space. Integration of osteological correlates of muscle attachment with the extant phylogenetic bracket yielded a nearly-therian complement of eleven muscles crossing the shoulder joint, with all but three recovered as robust level I inferences. *Massetognathus* is likely to have had an incipient rotator cuff, together with well-developed deltoid and pectoralis complexes.Triassic non-mammalian cynodonts had extensively mobile forelimbs capable of great range of motion and fine positional control. The present study creates a framework for repeatable future analyses, which will incorporate musculoskeletal modelling to impose soft-tissue constraints on the postural envelope, and further elucidate forelimb function along the mammal stem.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW SHUVOSAURID TAXON (ARCHOSAURIA, PSEUDOSUCHIA) FROM THE LATE TRIASSIC HAYDEN QUARRY OF NEW MEXICO, USA

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Shuvosauridae is an unusual clade of Triassic bipedal poposauroid pseudosuchians from current-day North and South America that includes *Shuvosaurus inexpectatus* (Dockum Group, TX - Norian), *Effigia okeeffeae* (*Coelophysis* Quarry, NM - late Norian-Rhaetian), and *Sillosuchus longicervix* (Ischigualasto Formation, NW Argentina - Carnian). Gracile bodied and edentulous, these pseudosuchians appear grossly convergent with ornithomimid dinosaurs. Here we report multiple postcranial specimens, including associated material, from the Late Triassic (middle Norian; ~212 Ma) Hayden Quarry (HQ) (Petrified Forest Member, Chinle Formation) of New Mexico, USA, that represent a new species of shuvosaurid. The new shuvosaurid is represented by an associated femur, tibia, fibula, humerus, two radii, and a partial vertebra, as well as isolated fragmentary coracoids, an ischium, and two more vertebrae. The associated specimen preserves several autapomorphies that diagnose it as a distinct taxon, including a sharp “teardrop” shape of the humeral head and a proximodistally oriented groove on the anterior aspect of the fibula medial to the iliofibularis trochanter.

Phylogenetic analysis of 85 archosauriform taxa and 417 morphological characters supports the placement of the HQ shuvosaurid in a clade with *Effigia* and *Shuvosaurus*, to the exclusion of *Sillosuchus* and other poposauroids. The HQ shuvosaurid shares several unambiguous synapomorphies with *Effigia* and *Shuvosaurus*, including: the proximal portion of the humerus is expanded less than twice the width of the midshaft (also shared with *Sillosuchus*); the anteromedial tuber of the femur is large and hooked posteriorly; and the posterolateral portion of the femoral head is ventrally descended. In addition to autapomorphies, a unique combination of character states present in the limbs distinguish the HQ taxon from other shuvosaurids. The HQ shuvosaurid shares a distal projection of the posteromedial condyle of the tibia with *Effigia* but not *Shuvosaurus*. The HQ shuvosaurid and *Shuvosaurus* both have subequal distal condyles of the humerus and a groove crossing the proximal surface of the humeral head, unlike *Effigia*. In contrast to the HQ shuvosaurid, both *Effigia* and *Shuvosaurus* lack the anterolateral tuber on the head of the femur. This find adds to a growing consensus that isolated bones and even partial skeletons of *Shuvosaurus*-like animals represent different species of a diverse, but not very disparate, clade.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

USING NON-DESTRUCTIVE RAMAN SPECTROSCOPY AS A TOOL TO INVESTIGATE SUB-FOSSIL AND YOUNG FOSSIL DIAGENESIS

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Diagenetic alteration of skeletal remains is an inherent part of the fossilization process, though it can be mitigated by the conditions of preservation. Increasing use of fossil remains for geochemical research has necessitated methods of assessing the extent of alteration to ensure original material for analysis. Here we employed Raman spectroscopy as a non-destructive means of gauging the quality of sub-fossil and fossil specimens. This approach allows for the examination of bone mineral, bone carbonate, and collagen content without preparation, particularly for small or rare samples. For our study, we analyzed specimens with a 1064 Benchtop Raman with Orbital Raster Scanning abilities from Snowy Range Instruments.

Bone fragments from two sites – a Holocene-aged archaeological midden (Buldir Island, Alaska) and a late Pleistocene rock shelter (Last Canyon Cave, Pryor Mountains, Montana) – were selected for this study. Human modification of remains at the two sites varied from negligible at the rock shelter to extensive (e.g., butchering and burning) at the midden site. Prior carbon and nitrogen isotope and elemental analyses conducted on these specimens were used as an independent metric of preservational quality. Samples were binned into three categories based on how closely carbon to nitrogen ratios (C:N) of specimens matched expected C:N values for well-preserved bone collagen: excellent (C:N = 3.2 to 3.5), good (C:N = 3.5 to 3.7), and poor (C:N ratio >> 3.7). Based on this metric, preservation appeared most variable within remains from the midden site. The combination of these sites provided a brief view in to diagenetic processes, including both in-site variation and changes across time.

Preliminary results revealed that heavily burned specimens (those of the Buldir Island midden) easily fluoresced under the laser, suggesting a change in crystal structure. Unfortunately, details of composition are obfuscated by fluorescence, which made it difficult to retrieve additional information. For Last Canyon Cave specimens, Raman spectroscopy yielded a significant decrease in the *v1* phosphate peak relative to the carbonate peak, suggesting the dissolution of phosphate and secondary calcite mineralization. Relative to modern bone reference peaks, peaks for fossil bone appear to narrow and have shifted to the left, suggesting incipient recrystallization of bone crystallites and ion substitution within crystal lattices. These findings suggest that the stages of early diagenesis are detectible by Raman spectroscopy.

Grant Information**:**
NSF CMMI 1537858

Preparators’ Session (Thursday, August 24, 2017, 11:45 AM)

TRIDACTYL DINOSAUR FOOTPRINTS: SHAPE AS A FUNCTION OF SIZE

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The pes is a crucial functional unit in tridactyl dinosaurs (theropods, some ornithischians), supporting the weight of the animal and allowing for an efficient locomotion. The high selection pressure acting on the pes skeleton reduces variability across taxa. Assuming isometric growth, footprint area increases with the second power of linear measurements, while body mass increases with the third power. Thus, the weight-bearing function of the pes becomes more and more important with increasing body size. To reveal size-related changes in pes shape, we performed geometric morphometric analysis on a large sample (n=201) of tridactyl theropod (excluding birds) and ornithischian dinosaur (ornithopods etc.) footprints taken from the literature. Our sample includes footprints from more than 114 track sites from 27 countries, covering the Triassic, Jurassic, and Cretaceous fossil track record. Analyses were performed on 20 landmarks, capturing most of the shape information of the footprint outline. Selected measurements were taken from the Procrustes-fitted landmarks and tested for possible correlations with log centroid size.

Some of the most variable shape features in our sample are strongly correlated with footprint size. Smaller footprints tend to be narrow with an elongated digit impression III (strong mesaxony), while larger footprints tend to be wider with a proportionally shorter digit impression III (weak mesaxony). The correlation of both parameters with size is equally strong when theropod and ornithischian footprints are analyzed separately. A third parameter, the width of the digit impressions, is strongly correlated with size in ornithischians but not in theropods. Our results show that tridactyl dinosaur footprints carry less phylogenetic information than is often assumed. They also add to our understanding of the functional morphology of tridactyl dinosaur pedes. Strong mesaxony, where digit III supports most of the animal’s weight, can be probably regarded as an adaptation for a cursorial lifestyle. A wider foot with weak mesaxony results in a more equal distribution of the animal’s weight on the digits, allowing for the support of greater body masses.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW MATERIAL OF NON-AVIAN DINOSAURS FROM THE LATE CRETACEOUS OF JAMES ROSS ISLAND, ANTARCTICA

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The fossil record of non-avian dinosaurs from the Cretaceous of Antarctica is exceedingly poor relative to those of most other continents. Only a handful of fossils representing five major groups (Ankylosauria, non-hadrosauriform Ornithopoda, Hadrosauridae, Titanosauria, and Theropoda) have been recovered to date. All come from Upper Cretaceous (Coniacian–Maastrichtian) marine to nearshore sediments belonging to the Gustav and Marambio groups of the James Ross Basin of the northern Antarctic Peninsula. The bulk of these finds have come from the Campanian–Maastrichtian Santa Marta, Snow Hill Island, and López de Bertodano formations of James Ross and Vega islands. In this context, discoveries of any non-avian dinosaur remains from the Cretaceous of Antarctica, no matter how fragmentary, are of significance. Here we report new ornithopod and non-avian theropod material from the lower Maastrichtian (~71 Ma) Cape Lamb Member of the Snow Hill Island Formation of the Naze peninsula of James Ross Island. The majority of the specimens were discovered by Antarctic Peninsula Paleontology Project expeditions in 2011 and 2016. The ornithopod fossils include the distal end of a pedal phalanx, preserving the articular condyle, plus unidentified fragments. The material was found at what is believed to be the locality that yielded the holotypic incomplete right hind limb of the non-hadrosauriform ornithopod *Morrosaurus antarcticus*. Intriguingly, the *Morrosaurus* holotype includes only a single pedal phalanx (phalanx III-1) that is missing its distal end. Given its corresponding provenance and morphology, the extreme rarity of non-avian dinosaurs in the Cape Lamb Member, and its lack of anatomical overlap with the holotype, we suspect that the new material pertains to the same *Morrosaurus* individual. Similarly, the new theropod fossils—comprising a partial tooth, possible craniodental fragments, and part of a pedal ungual—were recovered from the same locality that produced the partial skeleton of a medium-sized possible deinonychosaur in 2003, and almost certainly pertain to this specimen. Additional, undescribed craniodental fragments of this theropod individual collected during that year, initially thought missing, were recently relocated in the collections of the South Dakota School of Mines and Technology. Collectively, the new materials augment the preserved morphology of two incompletely represented taxa, thereby improving understanding of the non-avian dinosaurs that inhabited Antarctica at the close of the Mesozoic.

Grant Information**:**
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SCALING PATTERN IN RODENT PARAFLOCCULI: IMPACTS OF LOCOMOTION AND ACTIVITY PATTERN

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The paraflocculi are lobes of the cerebellum that occupy a distinct cavity in the cranium (subarcuate fossa) in several vertebrate orders. This means that it is possible to isolate them in endocranial reconstructions. The paraflocculi regulate several functions associated with vision including the stabilization of visual images on the retina, and smooth pursuit and velocity control of eye movements. Because of their functional significance, and distinctiveness in endocasts, study of the paraflocculi is possible in fossils, and may provide ecological information. To actualize on this potential, study of a diverse comparative sample of living forms is needed.

At present, there is little known about the evolution of the paraflocculi, especially in terms of variation within groups of mammals. Here, the scaling patterns of the paraflocculi from 30 extant rodents are examined to determine if ecological factors such as locomotor/positional repertoire and activity pattern play a role in the volume of these structures. Virtual endocasts were produced for five rodent suborders including Sciuromorpha (n=21), Castorimorpha (n=1), Myomorpha (n=4), Anomaluromorpha (n=2), and Hystricomorpha (n=2). Bivariate least squares regression analyses were performed in which log10 paraflocular volume (mm3) was plotted against log10 endocranial volume (mm3) according to one of three categories: Suborder, Activity Pattern, or Locomotor type.

Some ecological patterns in the scaling of paraflocculi are identifiable. Diurnal rodents generally have relatively larger paraflocculi than nocturnal rodents, which is consistent with the prediction that they would be larger in more visually dependent taxa. The sole fossorial taxon also has very small paraflocculi, which is not unexpected given that they live in a relatively lightless environment. However, contrary to predictions, gliders and arboreal rodents were not found to have substantially larger paraflocular volumes than terrestrial rodents. This is surprising, as these locomotor types presumably should require the greater image stabilization afforded by larger paraflocculi. These results suggest that there may be some ecological signal in paraflocular size, but that other factors (such as cranial shape) may mediate this relationship.

Grant Information**:**
Supported by NSERC discovery grant to MTS

Technical Session X (Friday, August 25, 2017, 9:00 AM)

NEW DINOSAUROMORPHS AND RADIOISOTOPIC AGES FROM THE LATE TRIASSIC SANTA MARIA AND CATURRITA FORMATIONS, SOUTH BRAZIL

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U-Pb geochronology of detrital zircon from two classical fossil sites has for the first time provided maximum depositional ages for the Late Triassic deposits of south Brazil. These closely match previously proposed ages based on transcontinental correlation of tetrapod faunas, suggesting that they represent good estimates of true depositional age. The dates obtained for Santa Maria Formation in the Waldsanga site, which yielded the sauropodomorph *Saturnalia tupiniquim*, correspond to the mid-Carnian of the currently accepted (long Norian) Triassic time scale. Further, an early Norian age has been obtained for the Caturrita Formation at the Linha São Luis site, which yielded the saurischian *Guibasaurus candelariensis*. Tuned by these geochronology data, new fossil discoveries are helping to better understand the tempo and mode of the early radiation of dinosaurs in Gondwana. Along with the recently described lagerpetid *Ixalerpeton polesinensis* and dinosaur *Buriolestes schultzi*, other new dinosauromorph finds from the Santa Maria Formation include a large-bodied herrerasaurid (c. 30 cm long femur), an almost complete skull of *B. schultzi*, a small-bodied saurichian (12 cm long femur), fragmentary silesaurid remains, and a medium-sized sauropodomorph (over 20 cm long femur). The later taxon fills an interesting anatomical gap between the Carnian members of the group and latter "prosauropod-grade" taxa. Previously known forms have also been more thoroughly investigated with the aid of new techniques. This includes the CT-scan of the skull of *Sa. tupiniquim*, which revealed an endocranial anatomy compatible with a feeding behavior based on small prey items, that match its small head and long neck. This may represent a case of exaptation in the context of the evolution of sauropodomorph herbivory. As for the Caturrita Formation, an exquisitely preserved set of three sauropodomorph skeletons has recently been unearthed. These may correspond to new specimens of *Unaysaurus tolentinoi* or to a previously unknown sauropodomorph. The new discoveries in the Santa Maria Formation reveal a high dinosauromorph diversity, including nearly ten different taxa. Only about one-third of that diversity has been recorded in the Caturrita Formation. This pattern is more likely the result of preservation biases, rather than a real diversity loss, but the presence of "prosauropod-grade" sauropodomorphs and possible theropods may anticipate the prevalence of these groups in the mid-late Norian of Argentina and Laurasian areas.

Grant Information:
FAPESP grant #2014/03825-3

Technical Session XI (Friday, August 25, 2017, 10:45 AM)

HOW TO MAKE A WHALE: FIRST COMPLETE DEVELOPMENTAL SEQUENCE OF THE SKULL OF THE HUMPBACK WHALE AND ITS IMPLICATIONS FOR THE EVOLUTION OF MYSTICETES

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Baleen whales (Mysticeti) offer an extraordinary opportunity to investigate the connection between evolution and development given their unique cranial morphology and extensive fossil record. Extant mysticetes share a distinct suite of adaptations to perform bulk filter feeding, such as a kinetic rostrum and mandible and the complete loss of adult dentition in favor of baleen plates. However, mysticetes still develop tooth buds during ontogeny. In the fossil record, multiple groups document the transition from ancestral raptorial feeding to filter feeding. Evidence points to a stepwise transition between the two feeding styles. Fetal specimens give us the incredible opportunity to observe how this transition occurs during gestation.

We used iodine-enhanced and traditional CT scanning to visualize the internal anatomy of 14 fetuses of 5 extant balaenopterid species. Among those were 5 specimens of humpback whale representing the first two-thirds of gestation. Here we combine our newly acquired dataset with previously published reports on this species as well as other cetaceans to provide the first comprehensive qualitative description of the sequence of developmental changes that characterize the skull and dentition. We also employ quantitative methods based on 3D landmarks to investigate the shape changes in the fetuses in relation to the adult and juvenile cranial morphologies, as well as to compare the skull shape with other species of similar gestational age.

Humpback whale fetuses show a characteristic shape beginning in early ontogeny, which portends the distinctive morphology of this species. However, we expect to find similarities in the sequence between skull development and ossification patterns of the humpback and other cetaceans, given the functional constraints that characterize ontogeny. We also note changes in the number and size of tooth buds during development. This developmental sequence confirms that the tooth-to-baleen transition occurs in the last one-third of gestation.

We use these results to inform the interpretation of fossils by noting similarities between the sequence of development and the first appearance of traits in extinct lineages. For example, we hypothesize that the mandible will reach an adult morphology before the rostrum, as is seen in the fossil record. In light of this work, we will build similar developmental sequences for other species. The acquisition of specimens from the last one-third of gestation to birth will enable us to complete our documentation of the teeth-to-baleen transition.

Romer Prize Session (Thursday, August 24, 2017, 9:15 AM)

DIETARY INFERENCE AND EVOLUTION IN EXTINCT FAUNIVOROUS REPTILES USING AN ECOMORPHOLOGICAL MODEL OF VARIATION IN THE DENTAL APPARATUS OF VARANID LIZARDS

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The evolutionary history of dietary preferences has not been extensively explored in fossil reptiles. Although ecomorphological relationships of teeth and jaws have been used to infer diet in extinct organisms based on modern analogues and/or biomechanical principles, considerable uncertainty exists as to the dietary preferences of fossil organisms, and no quantitative ecomorphological study has incorporated proportional gut content data from living reptiles into studies of diet in extinct species. In this study, linear and geometric morphometric data are combined with dietary relative abundances derived from gut contents in extant varanid lizards to investigate ecomorphology of dietary preference and develop a framework that can be used to predict diet in extinct ziphodont reptiles. Redundancy analysis between morphometric and dietary datasets produced a model which predicted a relationship between body size and preference for small prey (invertebrates and small vertebrates) as well as the absence of tooth denticles and aquatic prey. Using this predictive model, I test for the coincidence of dietary shifts to major phylogenetic radiations within coelurosaur dinosaurs, successful archosaurs previously hypothesized to include to both vertebrate carnivorous and herbivorous taxa. Results demonstrate that important distinctions in dietary preference can be determined from morphological data using this model, and that these distinctions roughly correspond to known fossilized gut contents in coelurosaurs. Application of the ecomorphological model indicates that a dietary shift at the origin of Paraves towards smaller prey was important to the diversification of this clade. Similarly, the origin of avialans coincides with a dietary shift to incorporate more aquatic prey. These results indicate that dietary information that can be reliably inferred from body size and tooth morphology, and provide a robust predictive framework for future paleoecological analyses.

Grant Information:
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Podium Symposium (Wednesday, August 23, 2017, 9:15 AM)

USE OF EXPERIMENTAL ATAVISMS TO ESTIMATE SOFT TISSUE RECONSTRUCTIONS OF THE EARLIEST TETRAPOD LIMBS

LARSSON, Hans C., McGill University, Montreal, QC, Canada; KHERDJEMIL, Yacine, Institut de Recherches Cliniques de Montréal, Montréal, QC, Canada; KMITA, Marie, Institut de Recherches Cliniques de Montréal, Montréal, QC, Canada

The fish-tetrapod transition 400 million years ago involved extensive anatomical and physiological transformations. Most evidence of evolutionary transformations about this transition are based on the preserved skeletal fossil record. Soft tissue and physiological reconstructions are limited to comparisons of relevant extant taxa about this transition. These include extant coelacanths, lungfish, and amphibians. Although some musculoskeletal comparisons have been made, they are hindered by the extreme disparity between these taxa. One potential solution to this problem is to examine experimental atavisms. Although there are many caveats to this approach, it does present an intriguing avenue of evidence by altering developmental processes to yield seemingly plesiomorphic morphologies. We use a recently engineered *Hoxa11* antisense regulation mouse mutant. These mutants express varying degrees of polydactyly with remarkable similarity to some digit morphologies present in the earliest tetrapods. Using soft tissue enhanced staining and a nano-focus X-ray microscope, the entire soft tissue patterns are reconstructed for these mutant mice limbs. Reconstructions of the vasculature, nerves, muscles, tendons, ligaments, cartilage, and ossified skeleton are compared to controls and to the fossil record. The soft tissue patterns are remarkably consistent among the experimental limbs, suggesting a conserved patterning mechanism for these tissues. Using this conserved architecture as a guide, these soft tissues are reconstructed for fossils about the fish-tetrapod transition. The reconstructed morphologies suggest a complex muscular organization in early tetrapods and yet maintaining a relatively simple neurovascular pattern. Muscular patterning in subsequent tetrapods with the reduced pentadactyl pattern are hypothesized to have reduced only the pre- and post-axial muscles. Although the use of natural and experimental atavisms have a long history in evolutionary biology, current sophisticated genetic engineering offers novel methods to explore the relationship between developmental processes and macroevolutionary transitions.

Grant Information:
NSERC Discovery Grant, Canadian Foundation for Innovation

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

A PHYLOGENETIC REVIEW OF THE HETEROSTRACAN FAMILY CYATHASPIDIDAE

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The Heterostraci are an order of jawless vertebrates in which the head was completely sheathed in bony armor. They were diverse, with more than 300 species described to date, and inhabited shallow marine and brackish environments around the Old Red Sandstone Continent (now North America, the Canadian Arctic, and Western Europe) from the Early Silurian (Wenlock) to the Late Devonian (Late Frasnian). The bony armor generally consists of a series of plates, the number and morphology of which varies among the different heterostracan taxa. Although a wide variety of taxa are known, the paucity of anatomical data has made it extremely difficult to understand the phylogenetic relationships within and between the main groups because no specimen shows any evidence for internal anatomy beyond the impressions made on the visceral surfaces of the plates by internal organs that abutted them. The best known and most common heterostracans are the Cythaspidiformes and the Pteraspidiformes and, consequently, they have been used to exemplify the group. However, until recently no attempts had been made to develop an analysis of relationships within them using modern cladistic methods. This is particularly true of the cyathaspids although they were constituted as a family in the early 1900s. In this study, we analyze the relationships of the taxa included within the family Cyathaspididae. A series of recent papers have added new taxa to the family (e.g. the subfamily Boothiaspidinae) and so this is the first comprehensive treatment of relationships within the family. Based on our study, it is clear that the Cyathaspididae as originally constituted is not monophyletic. In particular, the Ctenaspidinae are shown to form a separate family with probable relationships to *Ariaspis*, a species that is also removed from the Cyathaspididae. Additionally, a review of *Allocryptaspis* and new material of *Listraspis* shows characters indicating that they should also be excluded. Although this is a step towards establishing relationships within one family of the Heterostraci, understanding the relationships of the main taxa to each other still awaits study.

Technical Session XVIII (Saturday, August 26, 2017, 11:30 AM)

RETENTION OF CRANIAL FUNCTION ACROSS THE CYNODONT-MAMMALIAN TRANSITION

LAUTENSCHLAGER, Stephan, University of Bristol, Bristol, United Kingdom; GILL, Pamela, University of Bristol, Bristol, United Kingdom; LUO, Zhe-Xi, university of Chicago, Chicago, IL, United States of America; FAGAN, Michael, University of Hull, Hull, United Kingdom; RAYFIELD, Emily J., University of Bristol, Bristol, United Kingdom

The evolution of modern mammals from cynodonts is a key event in vertebrate history and is characterized by a number of modifications of the cranial skeleton. This is most prominently expressed in the emergence of a novel, secondary jaw joint and the reduction of the seven-component lower jaw in cynodonts to a single tooth-bearing bone in crown mammals. The evolutionary origins of this transformation date back more than 220 million years to the Late Triassic and were paralleled by a suite of correlated structural innovations rooted in modifications of the cranial skeleton, the feeding apparatus and the auditory systems. These skeletal changes occurring across the cynodont-mammaliaform transition are generally thought to be allied with increasing structural integrity and strength of the cranium, supposedly in response to the increased force generated by a more powerful and complex jaw musculature, and the evolution of a more 'efficient' feeding system. However, the central question exists as to how the jaw hinge and cranial skeleton were able to remain viable, while the modification of load-bearing structures must surely have compromised functionality in transitional stages.

Using an integrated suite of digital reconstruction, visualization and quantitative biomechanical modelling techniques (finite element analysis, multibody dynamics analysis), we studied six key taxa (including *Thrinxaodon*, *Probainognathus*, *Morganucodon*, and *Hadrocodium*) across the cynodont-mammaliaform. This allowed testing the hypothesis that during feeding the cranial skeleton of cynodonts and mammaliaforms experienced progressively lower magnitudes of stress and strain and increased bite forces as it became more 'mammal-like'.

Results of the biomechanical analyses show a slight decrease in average stress, and strain magnitudes across taxa, but do not support a large-scale trend for the increase of cranial strength across the cynodont-mammaliaform transition. However, the results also demonstrate that, in spite of a number of morphological transformations and modifications, cranial stability and efficiency was not compromised. This suggests that presumed changes in the loading regime did not trigger the emergence of a novel jaw joint. Rather, miniaturization and the retention of cranial function provided an evolutionary environment in which substantial morphological modifications and experimental stages were possible.

Grant Information:
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Technical Session V (Wednesday, August 23, 2017, 3:15 PM)

OCCUPANCY MODELING IN PALEOECOLOGY

LAWING, A. Michelle, Texas A&M University, College Station, TX, United States of America; MCGUIRE, Jenny L., Georgia Institute of Technology, Atlanta, GA, United States of America; MAGUIRE, Kaitlin, USGS FRESC, Boise, ID, United States of America; GORING, Simon, University of Wisconsin-Madison, Madison, WI, United States of America; BLOIS, Jessica, University of California Merced, Merced, CA, United States of America

Ecological dynamics operate over relatively short time scales to shape population and species responses that emerge over longer time scales. Biotic responses to climate change are mostly inaccessible to direct observation, so paleoecological data from the recent geological past are invaluable for understanding ecological dynamics. The late Quaternary fossil record provides abundant, broadly distributed data to investigate how species and communities respond to climate change. Still, there are several challenges to analyzing even very abundant fossil data. One major unresolved challenge is the imperfect detection of fossils, which hinders reconstruction of past communities.

This study uses the fossil pollen record to develop a method that will identify factors responsible for variation in the detectability and abundance of taxa as they respond to environmental change (factors include physiographic, edaphic, and climatic variation, as well as community composition). Mammalian responses to climate change are mitigated by vegetational changes and so understanding what factors influence the detection and abundance of fossil pollen through time provides insight into vegetation, and thus mammalian responses to changing environments. Occupancy models coupled with paleoecological data were used to simultaneously estimate abundance and detectability of 31 taxa in a spatially and temporally explicit manner that also accounted for imperfect detection. We found that physical geography, soil, and climate factors are responsible for variation in the detectability of most species during most time periods in the late Quaternary fossil pollen record. AIC model ranks are highly consistent across taxa, but consistency degrades with time. Maximum temperature of the warmest quarter, average yearly potential evapotranspiration, and average yearly actual evapotranspiration are important observation covariates to determine detection probabilities; although, these

matter less the further back in time the fossils were deposited. All other covariates matter for some taxa, but they don't seem to have consistent temporal dynamics.
This work advances the integration of ecological and paleontological sciences by examining the paleontological record to identify the influences on the abundance and detectability of fossils as climate shifts through time. This versatile method will be invaluable to spatial analyses of vertebrate taxa for estimating probability of occurrence and detectability of vertebrate species given taphonomic biases.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW LARGE-BODIED TURTLE FROM THE LATE CRETACEOUS JUDITH RIVER FORMATION OF MONTANA

LAWVER, Daniel, Montana State University, Bozeman, MT, United States of America; FREEDMAN FOWLER, Elizabeth A., Dickinson State University, Dickinson, ND, United States of America

The Late Cretaceous (Campanian) Judith River Formation of Montana preserves a diverse population of turtles: Axestemys splendida, Aspideretodies sp., Plastomenus sp., Neurankylus eximius, Plesiobaena, Adocus sp., and Basilemys sp. Here we describe a new large-bodied turtle (MOR 775) from the Egg Roll locality in the Upper Judith River Formation of Hill County, Montana. In addition to the new turtle specimen, this locality has produced numerous clutches of lambeosaurine eggs. MOR 775 is based on a nearly complete right scapula, two nearly complete to partial costal plates and two peripherals, as well as numerous shell fragments corresponding to both the carapace and plastron. The scapular process is broken distally and has a horizontal oval cross section. The acromial process is complete, but slightly crushed, and 12.5 cm long. The articulation for the coracoid is roughly triangle-shaped and the glenoid facet exhibits a nutritive foramen approximately 1 cm from the coracoid articulation. Each costal exhibits a pleural sulcus, as well as low-relief ornamentation reminiscent of Basilemys that fades away distally into shallow grooves. Fragmentary peripherals exhibit little to no ornamentation suggesting that ornamentation is most prominent towards the center of the carapace. The plastron exhibits unique surface ornamentation that ranges from deep narrow pits to elongate wavy ridges that occasionally bifurcate. Intermediate ornamentations also occur and exhibit high relief tubercles with either blocky or sharply inclined peaks.
The new specimen is most similar to Basilemys in size and shell thickness. However, it can be distinguished from this genus by the nutritive foramen present in the glenoid facet and its unique plastral ornamentation. Additionally, shell ornamentation differs from Adocus and trionychids by the presence of densely packed, high relief tubercles and elongate wavy ridges. The new specimen also differs from Naomichelys by the lack of rounded pustules that are easily broken off. MOR 775 likely represents a new taxon and adds to the overall turtle diversity of the Judith River Formation.

Romer Prize Session (Thursday, August 24, 2017, 10:15 AM)

HETEROCHRONY AND THE ORIGIN OF THE MAMMALIAN TOOTH ATTACHMENT SYSTEM

LEBLANC, Aaron R., University of Alberta, Edmonton, AB, Canada

The study of mammalian dental evolution has focused on the origins of tooth crown complexity and diphyodonty, the hallmarks of their dentition. By comparison, few studies have addressed the origin of the mammalian tooth attachment system, which supports each tooth and anchors it to the jaw. Mammals uniquely possess a periodontal ligament that suspends each tooth within its socket. By anchoring into the root cementum and the alveolar bone, the periodontal ligament prolongs the life of each tooth, providing a compliant attachment of the teeth to the jaws and a cushioning effect during occlusion. Most non-mammalian amniotes supposedly differ in possessing a single bone of attachment tissue that fuses the tooth to the jaw. Evolutionary hypotheses that address the transition from a single-tissue to a complex three-tissue attachment system seen in mammals predict that bone of attachment differentiated into the mammalian compliment of tooth attachment tissues. To date however, no comparison of tooth attachment across the 300 million-year evolutionary history of Synapsida exist and our understanding of the origins of this vital part of the mammalian dentition is extremely limited.
Using thin sections and CT scans, I provide the first detailed comparisons of tooth development and histology across Synapsida, from the Permo-Carboniferous "pelycosaurs" to crown mammals, to determine when and how the mammalian tooth attachment system arose. These comparisons reveal a surprisingly complex evolutionary history of tooth attachment within Synapsida. Instead of possessing bone of attachment, all synapsids had the three mammalian tooth attachment tissues, but vary in the duration of the ligamentous phase of attachment, before the tooth fused in place. Even taxa with teeth fused to the jaws possessed a periodontal ligament, which is preserved as a network of Sharpey's fibers that are entombed in the surrounding bone. Thin sections also reveal that some members of the Therocephalia and Gorgonopsia retained a permanent ligamentous tooth attachment, similar to mammals. Using these data, I propose a new hypothesis: the stereotypically mammalian tooth attachment system is paedomorphic relative to early synapsids in that mammalian teeth delay the calcification of the periodontal ligament. The evolution of the mammalian tooth attachment system is therefore not a result of step-wise increases in dental complexity, but an elegant example of heterochrony.
Grant Information**:**
NSERC (PGSD3-410211-2011), Queen Elizabeth II/Dr. F. M. Hill and Queen Elizabeth II/Pfizer Graduate Scholarships in Science and Technology

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A PRELIMINARY REPORT OF UNUSUAL DINOSAUR NESTING GROUND, EASTERN GOBI, MONGOLIA

LEE, Hang-Jae, KIGAM Geological Museum, Daejeon, Korea, Republic of (South); LEE, Yuong-Nam, Seoul National University, Seoul, Korea, Republic of (South); KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; TSOGTBAATAR, Khishigjav, Institute of Paleontology and Geology, Ulaanbaatar, Mongolia

A new dinosaur egg site was discovered from the lower Upper Cretaceous Bayanshiree Formation (Cenomanian-Santonian) at Khongil Tsav, 60 km southwest from Sainshand Town, eastern Gobi, Mongolia by a GDS (Gobi Dinosaur Supporters) expedition in 2016. Four nests were found in massive siltstone on the top (the area is 15 m^2) of a small mound (diameter is 12 m) with many eggshell fragments on gentle slopes. The nests are several meters away from each other. The first nest consists of four asymmetrical eggs of which the short diameter is 5 cm. The eggshell thickness is 0.78 mm on average, and the surface is covered with tiny pores and pits, belonging to Prismatoolithidae. The second nest consists of three elongated eggs whose long and short diameters are 20.3 cm and 14 cm, respectively. The eggshell thickness is 2.0 mm on average. The outer surface of two eggs is ornamented with a series of ridges and nodes on the shell surface, belonging to Elongatoolithidae. The third egg is weathered with small pits on the surface. The clutch shows a donut-like arrangement. Elongatoolithids have been frequently found in the Djadokhta, Baruungoyot, and Nemegt formations, but not reported in the lower Bayanshiree Formation in Mongolia. The third and fourth nests consist of five and three eggs, respectively. All eggs are spheroidal with 8.5 cm in diameter with the lack of ornamentation. However, the eggshell of the third nest is thinner than that of the fourth nest (1.31 mm vs 1.83 mm). Their microstructures are different from each other, indicating they are different kinds of eggs. No embryonic skeleton inside the eggs and ratio of the concavity of eggshells imply that almost eggs may have been hatched before burial. It is unusual that nests of multiple types of ootaxa were laid in the vicinity, suggesting that this nesting ground may have been shared by multiple types of dinosaurs.
Grant Information:
This work was supported by Basic Research Program (16-3115) of Korea Institute of Geoscience and Mineral Resources (KIGAM).

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

PRIMITIVE FEATHER ARRANGEMENT ALONG THE HINDWING OF A NEW JURASSIC PARAVIAN FROM CHINA

LEFÈVRE, Ulysse, Royal Belgian Institute of Natural Sciences, Bruxelles, Belgium; CAU, Andrea, Bologna University, Bologna, Italy; HU, Dongyu, Shenyang Normal University, Shenyang, China; GODEFROIT, Pascal, Institut Royal des Sciences Naturelles de Belgique, Brussels, Belgium

The Middle-Late Jurassic Tiaojishan Formation (Liaoning Province, China) has yielded numerous feathered non-avian theropods (e.g. *Anchiornis huxleyi, Xiaotingia zhengi*, *Aurornis xui, Eosinopteryx brevipenna, …*). Here we describe a new small paravian from the Jianchang County, which belongs to a new taxon. A large phylogenetic analysis encompassing 992 characters and 107 Operational Taxonomic Units places it at the base of the Eumaniraptora clade.
Previous studies proposed that the flapping flight of modern birds was preceded by a four-winged (tetrapterygian) gliding stage in basal paravians. This hypothesis is supported by numerous paravians presenting well-preserved teguments and various stages of feather development. Although the main function of the tetrapterygian condition remains questionable (gliding and/or flying function and/or social display), recent studies pointed that most of basal paravians should have been ground-dwelling feathered theropods rather than true gliders. The forelimbs of the new specimen were covered with undifferentiated contour and flight feathers, a primitive feather arrangement also reported in *Anchiornis huxleyi*. Although there is no preserved traces of femoral and tibial feathers (due to a taphonomical bias), at least three layers of undifferentiated contour and flight feathers are preserved along the metatarsus, representing a pattern identical to the primitive forelimb feather arrangement.
Skeletal morphology, plumage characters and phylogenetic position of this new paravian supports a ground-dwelling stage at the base of the Eumaniraptora clade and suggests that flapping flight is potentially synapomorphic for Dromaeosauridae and Avialae.
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BL/36/62 SPP Politique scientifique to P.G.
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

RECONSTRUCTING LATE TRIASSIC VERTEBRATE FAUNAS FROM THE UPPER TRIASSIC DOCKUM GROUP OF TEXAS USING APOMORPHY-BASED IDENTIFICATIONS

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The Upper Triassic Dockum Group of Garza County, Texas (Tecovas, Trujillo, and Bull Canyon Formations) captures the radiation of Triassic tetrapods by preserving a variety of Late Triassic taxa from the southwestern United States. Our understanding of the vertebrate assemblage from this unit largely comes from the Post Quarry (Tecovas Formation), with previous research documenting a variety of temnospondyls, sphenodontians, non-archosauriform archosauromorphs, and archosauriforms including a phytosaur, three species of aetosaurs, a poposauroid, a rauisuchid, a crocodylomorph, and several dinosauromorphs. To reconstruct the fauna of the Dockum Group of Garza County we use an apomorphy-based approach to assign morphologically similar disarticulated and fragmentary elements from a variety of sites to phylogenetically distinct taxa. Many elements are incomplete yet diagnostic and are assigned to the least inclusive clade if discrete characters do not allow for an unambiguous species-level identification. We identify new voucher specimens for Drepanosauridae, Tanystropheidae, Allokotosauria, Azendohsauridae, Phytosauria, Paracrocodylomorpha, Dinosauriformes, Silesauridae, and Saurischia in addition to the species-level identifications of the archosauriform *Vancleavea campii*, the aetosaur *Scutarx deltatlyus*, and the dinosauromorph *Dromomeron gregorii*. Our study of this material demonstrates the utility of an apomorphy-based approach in identifying small, isolated fragmentary limb material to reconstruct an accurate faunal hypothesis for a portion of the Late Triassic of Texas. Additionally, the presence of a diversity of early diapsids, early

archosauromorphs, and non-dinosaurian dinosauromorphs supports the hypothesis suggesting that these groups were more common and widespread in low latitudes during this time.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ASSESSMENT OF DENTAL ONTOGENY IN LATE MIOCENE HIPPARIONINES FROM THE LAMAGOU FAUNA OF FUGU, SHAANXI PROVINCE, CHINA

LI, Yangfan, Xi'an, China; DENG, Tao, Beijing, China; HUA, Hong, Xi'an, China; LI, Yongxiang, Xi'an, China; ZHANG, Yunxiang, Xi'an, China

A collection of 28 hipparionine skull and mandible fossils with a dated age of approximately 7.4 Ma from Fugu, Shaanxi, northwestern China (belonging to *Hipparion chiai* and *Hipparion* cf. *coelophyes*) shows an age distribution in a successive development sequence. By observing the dentitions in these fossil materials, new dental ontogenetic laws had been gained, such as the opening time of the posterior wall of post-fossettes, the displacement of the plis hypostyle, the morphologic changes of the protocone and hypocone, etc. Additionally, 4 isolated maxillary cheek teeth and 2 mandibular cheek teeth were cut into slices in the traditional manner for authentication. These indicated that both hipparions in the Lamagou fauna are referable to *Hipparion* cf. *chiai* exactly, and offered the further morphologic changesMar that occur during dental wear in hipparionines. The current study was aimed at introducing an observation method for morphology of hipparionine cheek tooth, and we hope it can be replicated to the following specific works:(1)This will help to clarify the intraspecies variation and reduce the classification error caused by aging.(2)Enabling the truly species differences, particularly those that between the similar species. Those differences may significantly indicate the polarity and orientation of evolution, however, the variables of age make it much harder for researchers to notice these differences.(3)Quantitative analysis for morphology by computer graphics, which need the appropriate comparative models to reach the more reasonable results. The framework which was established by ontogenesis sequence would be an appropriate comparative model for calculating the evolutionary rate and/or intelligent identification.

Grant Information**:**
National Natural Science Foundation of China (41430102, 41272020, 41290253)

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW SPECIES OF *PARAMACHAERODUS* (MAMMALIA, CARNIVORA, FELIDAE) FROM THE LATE MIOCENE OF CHINA AND BULGARIA

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Here we describe in detail new Machairodontinae material from the late Miocene localities of Hezheng (China) and Hadjidimovo (Bulgaria), which represents a new species of *Paramachaerodus* Pilgrim. Both localities are similar in age and suggest that the new species had a very large geographic range extending from the northwestern China adjacent to the Tibetan Plateau to southeastern Europe or probably the whole southern Europe. The new species is characterized by a combination of features of *Promegantereon* and *Paramachaerodus*, two primitive saber-toothed felid genera with close features. This specific morphology, as well as the age of the Hezheng and Hadjidimovo (early Turolian, after the European Land Mammal Ages) put the new species in intermediary position between *Promegantereon* and *Paramachaerodus*. The new felid material give grounds to discuss and revise in a new light the systematic and evolution of the *Promegantereon* - *Paramachaerodus* lineage, which should represent successive stages of one and the same genus: *Paramachaerodus* Pilgrim.

Grant Information:
National Natural Science Foundation of China (Grant Number 41430102), the Strategic Priority Research Program of the Chinese Academy of Sciences (XDB03020104)

Technical Session XVII (Saturday, August 26, 2017, 11:15 AM)

NANPOPING FAUNA OF THE LANZHOU BASIN AND ITS ENVIRONMENTAL SIGNIFICANCE

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The Asian monsoon-arid environment system began to develop during the Oligocene, but the exact position of the arid zone boundary is uncertain in the Oligocene. Fossil mammal assemblages can be used to assess the environment of an area. There were two sizes of mammals in the Nanpoping fauna from the Oligocene strata of the Lanzhou Basin: the small ones were grassland rodents such as Ctenodactylidae; the large ones were forest dwellers such as Paraceratherium and Paraentelodon. Of the 23 species of mammals identified in the Nanpoping fauna, ~40% were forest dwellers and the rest (~60%) were grassland taxa. This palaeoecological information indicates that the Lanzhou Basin was a dry, semi-arid to semi-humid region. Three faunas from the study area and adjacent areas are found in the Oligocene fluviolacustrine strata with a similar sedimentary environment; however, there are also significant differences in the faunal assemblages. The Dingdanggou fauna of the Danghe area to the northwest consists mainly of steppe-adapted rodents, whereas the Jiaozigou fauna of Linxia to the south is mainly large herbivores of forest type. The Nanpoping fauna of Lanzhou appears to be transitional between the Dingdanggou and Jiaozigou faunas. So, it can be inferred that southern boundary of the arid zone in China during the late part of the early Oligocene (about 31 Ma) was probably located in the Lanzhou Basin. This area would have had a semi-arid to semi-humid environment during the deposition of the Hanjiajing Formation. Therefore, during that period, the Lanzhou Basin and the surrounding area would have been a transitional region between semi-arid and semi-humid settings in which animal types from the humid region to the south and the arid region to the north occurred together.

Technical Session XII (Friday, August 25, 2017, 11:45 AM)

TRIASSIC TURTLE TRACKS AND THE ORIGIN OF TURTLES

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Turtle tracks, *Chelonipus torquatus*, from the Lower Triassic of Wyoming and the Middle Triassic of Germany, are the oldest fossil evidence of turtles or their more basal stem. However, the ichnological evidence has been ignored in recent discussions of turtle origins, even though Spathian-Anisian aged turtle tracks predate the oldest unambiguous turtle body fossils from the Carnian by more than 10 million years. The turtle track record is extensive, spanning the Early Triassic through the Eocene, with the same basic morphology as in modern turtle tracks. Turtle trackways are quite distinctive: the manus and pes form tracks are nearly parallel to the midline and have an unusually wide gait, so that trackway width is nearly equal to stride length. The broad manus and digit III or IV longest are observed in turtle tracks, but digit proportions can show a large variation due to the dynamics and dragging of the foot. Also, the pes track often has a rounded plantar surface and relatively longer digits than the manus. The *Chelonipus* type trackway has a stride length of ~15 cm and an internal trackway width of ~12 cm. The manus tracks are not significantly angled toward the midline; their transverse axis is perpendicular to the midline (pace angulation = 63º). In turtles, no pectoral or pelvic rotation is possible, so the angle between the position of the forward manus and the opposite manus relative to a line perpendicular to the trackway midline reflects the advance of the shell or trunk of the animal with each step; in *Chelonipus* it is only about 17º, This is similar to extant *Testudo hermanni* and *T. marginata*. In *Chelonipus*, the ratio of stride to internal trackway width is approximately 1.25, between that of the terrestrial *T. marginata* (1.05) and semi-aquatic *Chrysemys picta* (1.39). The trackmaker of Triassic *Chelonipus* was likely at least semi-terrestrial, spending a portion of its time moving on land, but entering water. However, these tracks do not fit what would be expected of Triassic *Pappochelys* or *Odontochelys*, a supposed prototurtle and an early turtle, respectively. In contrast, *Chelonipus* tracks are consistent with what would be expected from the Triassic turtles *Proganochelys* and *Proterochersis*. *Chelonipus* also occurs in a trackway pattern similar to the dual gait of Permian *Pachypes,* inferred to be a pareiasaur trackway with sprawling forelimbs and with limited wrist motion tied to the decreased torsion of the humerus. These observations highlight the need to consider all available evidence regarding turtle origins, not just the body fossils.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

DENTAL MORPHOLOGY AND TAXONOMY OF MEGATOOTHED SHARKS: A MORPHOMETRIC APPROACH

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The fossil record of sharks is mostly represented by isolated teeth that are ubiquitous in marine deposits. These teeth have a long history of study, with qualitative assessments of dental shape forming the basis of taxonomic arguments. Unfortunately, the varied nature of fossil shark alpha-level taxonomy has limited the ability to confidently reconstruct patterns of shark palaeobiodiversity. Poorly understood patterns of intra-and interspecific variation add to the complexity and difficulty in grounding identifications of known or potentially new taxa. In an attempt to qualify and validate extinct shark species solely erected on the basis of isolated teeth we adopted a 2D-geometric morphometric approach based on a dataset (n=190) of teeth attributed to megatoothed taxa (n=7) spanning the Palaeogene and Neogene. The crown gross morphology (excluding serrations) was quantified using both homologous and semi-landmarks (p=100) and formed the basis of a principal component analysis. To test for major group separation, we used a non-parametric multivariate analysis of variance and computed pair-wise comparisons between species along the first 2 PC-axes (>80% of the total variance). The morphological extremes along PC1 (52%) describe tall, narrow, and symmetrical teeth to low, broad, and asymmetrically crowned teeth, whereas PC2 (29%) describes highly triangular and non-cusped dentitions to slightly recurved teeth with well-developed cusps. Notable group separations are restricted to PC2, between: Carcharocles (Otodus) megalodon vs. C. auriculatus, C. angustidens vs. C. megalodon, and C. paradoxodon vs. O. obliquus (Bonferroni-corrected p=0.036). Tooth morphologies of C. auriculatus, C. angustidens, and C. subserratus occupy comparable regions of morphospace and cannot be discriminated. We admit that although potential diagnostic traits (e.g., root and serrations) of aforementioned taxa are not captured by our morphometric scheme, the analysis of crown shape does not support taxonomic divisions between all Carcharocles species and demonstrates the importance of quantitative assessments of shape as complements to future descriptive and taxonomic work.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW PACHYPLEUROSAUR (REPTILIA: SAUROPTERYGIA) FROM THE MIDDLE TRIASSIC GUANLING FORMATION OF SOUTHWESTERN CHINA

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The pachypleurosaurs were mainly reported from the Middle Triassic of the western Tethys until the end of the 20th century when abundant and complete skeletons were found from southern China. Thus far, six Chinese pachypleurosaur taxa from the Middle Triassic have been erected, including *Wumengosaurus delicatomandibularis* Jiang et al., 2008, *Dianopachyosaurus dingi* Liu et al., 2011, *Diandongosaurus acutidentatus* Shang et al., 2011, *Dianmeisaurus gracilis* Shang et al., 2015, *Keichousaurus hui* Young, 1958, *Qianxisaurus chajiangensis* Cheng et al., 2012. Among them, *Keichousuaurs*, *Dianopachyosaurus*, *Diandongosaurus* and *Dianmeisaurus* are small-sized pachypleurosaurs. The latter three are from the Anisian (Middle Triassic) Luoping Biota,

while from the time-equivalent Panxian Fauna, however, only one specimen diagnosed as *Keichousuaurs* sp. has been reported.
Here we report a new small pachypleurosaur-like specimen, GMPKU-P-3241, excavated from the fossil Bed 87 in the Upper Member of Guanling Formation at Yangjuan in Xinmin of Panxian. It is almost complete, only lacks some elements of the pectoral girdle and of the forelimb. The preserved skeleton is of 27 cm in length. The vertebral centra constricted are absent in ventral view, cervical ribs bear two proximal heads, the sacral ribs are not distally expanded, and the dorsal iliac blade is reduced to simple dorsal process. These features indicate it is a pachypleurosaur eosauropterygian. The new specimen shares some interesting morphological similarities with *Diandongosaurus*, including: the unfused parietals anteriorly to the pineal foramen, the presence of an ectopterygoid, 19 cervical and 19 dorsal vertebrae, the ungual phalanges of pes expanded, and the phalangeal formula (2-3-4-5-3). Compared to *Dianopachyosaurus*, the distinct pachyostotic dorsal and sacral ribs are absent in the new specimen and *Diandongosaurus*. And this specimen also has some differences from *Diandongosaurus*, such as its paired frontals, the humerus slightly longer than the femur, the presence of the entepicondylar foramen, three tarsals. However, these differences are possibly due to the intraspecific variations. In summary, GMPKU-P-3241 approaches *Diandongosaurus* most closely amongst small-sized pachypleurosaur eosauropterygians in its morphology, and hereby assigned to *Diandongosaurus* sp.

Preparators' Session (Thursday, August 24, 2017, 11:00 AM)

PALEONTOLOGICAL RESEARCH IN CHINA IN THE CONTEXT OF THE NEW SVP ETHICS STATEMENT

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Fossil protection legislation exists to restrict the irresponsible collection of fossil material and preserve natural science heritage from the unregulated ravages of museums, commercial dealers, private collectors and tourists. This legislation has global problems in terms of wording, practicality and adequate resourcing support. Invariably, the enforcement of such legislation is under-resourced when it comes to policing sites, the lower resource requirement of customs monitoring (to prevent material leaving a given territory after collection) being preferred by authorities, rather than protect sites to actively control the initial excavation stage. Ongoing problems with fossil smuggling in China, Mongolia and many other territories around the world have recently focused attention on this issue, with a number of high profile media stories. Not simply restricted to the fossil trade, this smuggling also extends to material that ends up as the subject of scientific study and publication. New fossil legislation in China has extended pre-existing legal protection from solely fossil vertebrates in 1982 to now encompass invertebrate, paleobotanical and trace fossils. In parallel to lobbying for appropriate legislative protection covering the collection and/or export of paleontological material, it behooves the paleontological community to self-regulate. As the international body representing vertebrate paleontologists around the world, the Society of Vertebrate Paleontology has a responsibility to reflect respect for such legislative issues, and has recently revised its ethics statement for members. Although the SVP's previous ethics statement clearly stated the requirement to be familiar with the laws regarding fossil collecting wherever one worked, the 2015 iteration makes explicit the consequences of a failure to comply. Any member of SVP that does not acquaint themselves directly with the legislation relevant to where they are working risks failing to acquire the appropriate permits for excavating or exporting fossil material. In the latter scenario, they would be violating international law, and in both cases would be liable to expulsion from the Society. This welcome development recognises that when academic publications have financial significance, illegal fossil transport is not solely a problem of a part of the commercial fossil dealing world. It is important that these ethical parameters are actively promoted at the SVP's annual meeting, as not to do so could be seen as irresponsible negligence, and part of the problem.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW PERMIAN THEROCEPHALIANS FROM CHINA

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Therocephalians were important component of middle to late Permian terrestrial faunas in Russia and Africa. Even the Chinese Permian is well represented, this therapsid lineage has a very elusive record in China. The therocephalian *Urumchia lii* was original reported as late Permian in age, but further studies demonstrated that it really come from the Early Triassic Jiucaiyuan Formation. Recent prospective works resulted in the discovery of several therocephalians, remarkably increasing the diversity of this therapsid group in the late Permian of China.
Dalongkoua fuae, represented by an incomplete skeleton from Bed 40 of the Guodikeng Formation, is a new eutherocephalian on the basis of the following characters: maxillary ventral margin is strongly concave in lateral view; incisors spatulated and rounded; coronoid process of the dentary with a marked adductor fossa; triangular reflected lamina with two concavities. In addition to this, at least three new species of therocephalians are documented in the Naobaogou Formation, Nei (Inner) Mongolia. The first one is represented by a snout missing its dorsal edge, featuring a nicely preserved palate. The morphology resemble to akidnognathid therocephalians, most particularly *Annatherapsidus* from Russia. A phylogenetic analysis recover this Chinese in a polytomy with *Perplexisaurus*, (*Chthonosurus*, *Ichibengops*) and Akidnognathidae. The second one is represented by a nearly complete skull with lower jaws, and it is a typical akidnognathid. The third therocephalian is a partial skull with lower jaws and the left humerus. The braincase is well-preserved and prepared. Its phylogenetic position could not be determined, and more work needs to be done to resolve it. Current phylogenetic results do not support a close (sister) relationship of Chinese and Russian species.
Grant Information:
National Natural Science Foundation of China (41572019)
State Key Laboratory of Palaeobiology and Stratigraphy (20161101)

Preparators' Session (Thursday, August 24, 2017, 12:00 PM)

MOSASAURS AND MICROTINES: TAXONOMIC PRACTICE SHAPES COGNITIVE BIASES IN PALEONTOLOGY

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Interpretations of evolutionary pattern and process in the fossil record are strongly influenced by primary taxonomy. Historical practices in taxonomy can and do allow the persistence of taxonomic names that are unsupported on morphological grounds; the resulting inertial taxonomy can have a strong influence on both operational practices and cognitive biases. We discuss and illustrate this broad problem with examples from the Cretaceous and middle Pleistocene of North America.
Mosasaur systematists struggled for decades with the nominal genus *Clidastes*, which consistently is recovered as a paraphyletic assemblage of taxa in modern phylogenetic analyses. The three recognized species within the genus *Clidastes* are *C. propython*, *C. liodontus*, and *C. moorevillensis*. The latter two taxa are here considered nomen dubium and nomen nudum, respectively. The type specimen of *liodontus* is missing; the taxon *moorevillensis* was never formally published and described, but the name was extracted from an unpublished thesis and was allowed to persist in the literature. A new specimen-level phylogenetic analysis of referred specimens demonstrates that neither of the two nominal species is monophyletic and neither can be diagnosed.
The arvicoline rodent *Microtus paroperarius* was named based on isolated teeth from Pleistocene sediments in Kansas; the name reflects a strong morphological similarity with the extant *M. oeconomus* (formerly *operarius*). A detailed quantitative study in the late 1970s failed to find any quantitative difference between molars of the two species. The name *paroperarius* was not sunk, presumably because of its perceived geographic restriction to the Great Plains and its importance for correlating middle Pleistocene sites in that region. It now is known from a more expansive geographic distribution, extending across the Rocky Mountains and Great Basin into southeastern Oregon. Justification for continued use based on morphological grounds was eliminated nearly 40 years ago; it is now also no longer supported by biogeographic distribution.
These examples illustrate that continued use of demonstrably inappropriate nomenclature, for any reason, has deleterious effects for our discipline. This practice may mask potentially important problems and questions, impose methodological and interpretive constraints, inflate estimates of diversity through time, allow the persistence of a false sense of information content in our data, and obscure relevant data for biostratigraphy, biochronology, and paleobiogeography.
Grant Information:
Geological Society of America; Evolving Earth Foundation; Texas Academy of Science; Jackson School of Geosciences

Technical Session V (Wednesday, August 23, 2017, 4:00 PM)

WHAT THE VERTEBRATE FOSSIL RECORD CONTRIBUTES TO CONSERVATION BIOLOGY PRIORITIES

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Conservation biology routinely utilises phylogenetic metrics to ascribe conservation value to specific taxa or geographic regions. However, such approaches routinely ignore the fossil record beyond the inclusion of a limited number of occurrences used to calibrate a molecular clock. This can be problematic where molecular timescales are at odds with the fossil record (for example, where implausibly older divergence times are used), but can also ignore critical information on taxonomic turnover that can alter our expectations surrounding extinction.
Here I utilise two phylogenetic hypotheses for eusuchian (crown) crocodilians that are identical in the relationships of the 23 extant species, but differ in terms of timescale and the inclusion of extinct species. The first of these comes from a published molecular tree (extant species only) calibrated using a single fossil occurrence and the second is a novel "metatree" containing a total of 98 crown species, extinct and extant (all of which effectively serve as calibration points). Both trees were then used, alongside current red list statuses, to create "EDGE" (Evolutionary Distinctive, Globally Endangered) – a commonly utilised single taxon conservation priority metric – values for each extant tip.
The results show major differences between the two trees. The purely molecular hypothesis returns highest EDGE values (6.82-6.87; highest conservation priority) for the Chinese Alligator (*Alligator sinensis*), whereas the fossil tree instead has highest EDGE values (6.44-7.04) for the gharial (*Gavialis gangeticus*). These results capture two major differences between the two approaches. Firstly, and perhaps surprisingly, the fossil timescale is in many cases younger than the molecular one. In fact, some molecular dates were younger than the oldest member of that clade, showing the importance of using multiple fossil calibrations where available (and safely diagnosed). Secondly, the inclusion of fossil taxa can help distinguish between truly long isolated branches and clades with low diversity, but high turnover rate (alligators here). In conclusion, the vertebrate fossil record is critical in establishing an accurate picture in setting conservation priorities and can conflict strongly with approaches that ignore paleontological data.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

EVIDENCE OF LOCAL NICHE PARTITIONING AMONG EARLY JURASSIC DINOSAURS AT LARGE KAYENTA SANDSTONE TRACKSITES NEAR MOAB, UTAH

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A partially exposed dinosaur tracksite reported to the Bureau of Land Management (Canyon Country District) was first investigated in 2008, when a reconnaissance

photogrammetric survey documented a representative sample of approximately 50 footprints, in a new area rich in tracks, south of Moab, Utah. In 2016 the site (here named Flat Iron Mesa) was reinvestigated, cleaned, and mapped using traditional compass and tape methods. The result was the preliminary documentation of more than 200 footprints, in an area of ~ 400 m^2, all representing relatively large theropods (foot length ~30-35 cm), assigned to *Eubrontes* and *Kayentapus*. Mode and quality of preservation vary considerably, and include natural molds, natural casts, and compaction features weathered into visually striking pedestals.
The stratigraphic level of this large site is about 12 meters below a major facies change from purplish, water-lain fluvial sandstones with thin carbonate, 'playa' beds, to orange, cliff-forming, eolian, cross-bedded sandstones (i.e., transition from Kayenta Sandstone to Navajo Sandstone facies). This 12 -meter sequence contains at least six track-bearing horizons, including a "top Kayenta" site with more than 350 *Grallator*, *Otozoum* and miscellaneous theropod tracks preserved as natural molds in a localized lacustrine unit. Another nearby and stratigraphically higher site yields only *Grallator* tracks.
These multiple track-bearing horizons attest to the increasingly well-recognized fact that the Early Jurassic Glen Canyon Group (Wingate, Kayenta, Navajo formations) is track rich throughout much of its outcrop in Utah. It is notable that despite yielding a typical Lower Jurassic biochron ichnofauna of *Grallator, Eubrontes, Kayentapus, Otozoum, Anomoepus, and Batrachopus* (mostly from interdune deposits, with *Brasilichnium* a typical addition in dune facies), all these ichnogenera rarely if ever co-occur at a single site. Most tracksites are heavily dominated by only one or two ichnogenera, as the examples here indicate. This suggests that despite regional uniformity and predictability in the composition of a moderately diverse ichnofauna of 6-7 ichnogenera (typical of the biochron), individual sites generally yield only 2-3 ichnogenera locally; implying a tendency for niche partitioning of trackmakers in localized paleoenvironments. For example, the *Eubrontes-Kayentapus* assemblage indicates a carnivore-only ichnofauna, whereas the *Anomoepus-Otozoum* assemblage indicates a mixed herbivore-small theropod ichnofauna.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

MAMMALIAN BIOSTRATIGRAPHY OF HIGH ELEVATION TERTIARY STRATA IN THE GRAVELLY RANGE, SOUTHWESTERN MONTANA

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Tertiary strata that yield significant assemblages of Uintan to Whitneyan mammals are exposed at four high elevation sites (9,200-9,800 feet) in the south-central part of the Gravelly Range. These strata have yielded dozens of well-preserved fossils, including skulls from concretions, but only three specimens have been described. Thus, we are making additional collections as well as studying previously collected specimens housed at the American Museum of Natural History and the Museum of Comparative Zoology.
The thickest stratigraphic section (270m) is Lion Mountain, where lowermost strata are approximately Duchesnean-Chadronian, and uppermost strata are Whitneyan overlain by basalt dated at about 31 Ma. The basal half of the 140m thick Black Butte section is also approximately Duchesnean-Chadronian and has yielded specimens of *Mesohippus*, *Protoreodon*, *Palaeolagus*, *Leptomeryx*, *Hyracodon*, and ?*Subhyracodon*. Recent collections that include *Miohippus* indicate that uppermost exposures at Black Butte could be as young as Orellan. The 23m thick Teepee Mountain section, notable for its abundance of fragmentary brontothere elements, is probably also Duchesnean-Chadronian. The *Rapamys* site is a small, 10m thick exposure that contains concretions yielding late Uintan to early Duchesnean taxa, such as *Rapamys atramontis*, *Protoreodon pearcei*, and a new species of *Lycophocyon*. Gravelly Range Tertiary strata include fluvial and aeolian deposits that are probably associated with localized late Eocene-early Oligocene volcanism. The lower half of the Lion Mountain section is primarily aeolian, with fluvial units dominating much of its upper half. The Black Butte, *Rapamys*, and Teepee Mountain sections are mostly aeolian, but the basal 20m of strata at Black Butte are partly comprised of fluvial deposits. Based on mammalian assemblages, the lower half of the Black Butte section is approximately equivalent to the Teepee Mountain section and the lower 80m of the Lion Mountain section. Ongoing field work in the Gravelly Range will allow significant refinement in biostratigraphic correlation between these four main areas of high elevation outcrop and Eocene-Oligocene strata elsewhere in North America.

Technical Session XXI (Saturday, August 26, 2017, 2:45 PM)

THE TAXONOMIC UTILITY OF HINDFIN MORPHOLOGY IN *ICHTHYOSAURUS*

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Hindfins have often been neglected in morphological, taxonomic and phylogenetic studies of *Ichthyosaurus*, in part because they are infrequently preserved. Hindfins are less variable than forefins, although this might be due, in part, to fewer hindfins being preserved. As in the forefin, digit I has been lost in the hindfin. The tibia and fibula are distinct in only one species, *I. conybeari*, where the tibia is notched and the fibula is substantially larger than the tibia. The next (distal) row of elements are the tarsal 2 (tibiale), astragalus ('intermedium'), and calcaneum (fibulare). These elements do not vary much either, although *I. breviceps, I. conybeari,* and *I. somersetensis* often have a straight distal edge on the intermedium. The third row of elements, however, vary among species. Some species have a bifurcation in the third row, and this leads to three different morphologies: (1) three elements, with one digit in broad contact with the astragalus, (2) four elements, with two digits in contact with the astragalus, and (3) four elements, with three digits in contact with the astragalus. The first variation is found only in *I. breviceps, I. conybeari,* and *I. somersetensis*. The second variation occurs in *I. communis*, *I. anningae*, and less often in *I. breviceps*, *I. conybeari* and *I. somersetensis*. The third morphology occurs only in *I. larkini*. *I. communis, I. conybeari*, *I. anningae* and *I. somersetensis* have a second anterior digital bifurcation in one of the phalangeal rows, which results in five primary digits in the hindfin. However, the fin must be fairly complete to preserve the second bifurcation. Whether the second bifurcation occurs in all individuals or varies among individuals cannot be evaluated with the number of specimens available. *I. breviceps*, however, appears to have only four primary digits. The number cannot be assessed in *I. larkini* because preserved forefins are not sufficiently complete. Thus, although the morphologies overlap among species, the hindfin provides some taxonomic information that can be used with other features in species identifications.

Technical Session XIV (Friday, August 25, 2017, 2:15 PM)

DID SABER-TOOTH KITTENS GROW UP MUSCLEBOUND? A STUDY OF POSTNATAL LIMB BONE ALLOMETRY IN FELIDS FROM THE PLEISTOCENE OF RANCHO LA BREA

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Previous studies have demonstrated that the Pleistocene saber-toothed cat *Smilodon fatalis* had many forelimb adaptations for increased strength, presumably to grapple with and subdue prey. At Rancho La Brea tar pits, there are also large samples of juvenile limb bones forming a growth series that allow us to examine how *Smilodon* kittens grew up. Almost all available juvenile limb bones were measured, and reduced major axis fits were calculated to determine the allometric growth trends. Contrary to expectations, *Smilodon* kittens show the normal pattern of growth found in other large felids (such as the Ice Age lion, *Panthera atrox*, as well as living tigers, cougars, servals, and wildcats) where the limb grows longer and more slender faster than they grow thick. This adaptation is thought to give felids greater running speed. *Smilodon* kittens show no evidence of more robust forelimbs in their growth history. It is possible that these bones have features such as thickened cortical bone or other adaptations that indicate stronger forelimbs, but *Smilodon* kittens do not demonstrate the predicted pattern of more robust forelimbs compared to other felids.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

FIRST *PROGONOMYS* FROM THE LATE MIOCENE OF THE ARABIAN PLATE

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Recent extensive field prospecting conducted in the Late Miocene of Lebanon resulted in the discovery of several new fossiliferous sites. One of these localities, which is situated immediately North-West of the town of Zahleh (Bekaa Valley, central Lebanon), has yielded a diverse vertebrate fauna: fishes, frogs, chelonians, crocodiles, and a variety of micromammals. The latter are of the utmost importance because they represent not only the first Neogene micromammals from Lebanon but also the only Late Miocene ones from the whole Arabian plate, together with those of the Al Gharbia region in the United Arab Emirates. The micromammal assemblage is mostly constituted by rodents. Some teeth of insectivores are present, but no lagomorph remains have been found. Rodents are dominated by murines. Ctenodactylines and glirids are the second most abundant taxa. Sciurids, cricetodontines, myocricetodontines, and eomyids are scarce. Only the ctenodactylines have been studied so far. Ongoing examinations of the murines reveal that they belong to a tiny species of *Progonomys*. The teeth are clearly smaller than all the species belonging to this genus known so far except for *Progonomys debruijni* and *Progonomys hispanicus*. However, from a morphological point of view, the Lebanese taxon shows some differences that prevent it from being assigned to either species. *Progonomys* sp. from Lebanon is a primitive murine that is characterized by the absence of any remnant of longitudinal connections between cusps, the lack of cusp t7, and the presence of a well-developed posterior cingulum on the upper molars. The first upper molars show cusp t1 placed very much backwards as well as very weak connections between the lingual and central cusps. The first lower molar of this species lack the longitudinal crest and the medial anteroconid and have, at least, three distinct anterolabial cuspids (Cv5, Cv3, and Cv2). The second lower molars are also characterized by well-developed labial cuspids (A1, B1, B2, and A1' and C1 in some specimens). This is the first time that *Progonomys* is identified on the Arabian plate. This record not only sheds new light into the early dispersal of mice, but also helps determine the age of the Lebanese locality, which is in all likelihood MN9.
Grant Information:
This research received support from the SYNTHESYS Project http://www.synthesys.info/

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE SMALL-MAMMAL ASSEMBLAGE FROM CAVERNE MARIE JEANNE (HASTIÈRE-LAVAUX, BELGIUM): ENVIRONMENTAL AND CLIMATIC APPROACH OF THE MARINE ISOTOPE STAGE 3 IN NORTH-WESTERN EUROPE

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Small mammal faunas from the Pleistocene of Belgium are not well-known. Some have been studied from the second half of the Late Pleistocene and the Early Holocene. However, only a few sites from the first half of the Late Pleistocene (Marine Isotope Stage 3, MIS 3, ca. 60-30 ka) have yielded small mammal assemblages. Among them is

the Marie-Jeanne Cave that is situated in the southeast of Belgium, in the Ardennes region. It is formed in the Early Carboniferous limestone deposits above the Meuse River, near the town of Hastière-Lavaux. The excavated deposits evidenced ten different layers but only the layers 6 to 2 yieldeda large collection of faunal remains. Recent dating of the stratigraphic sequence of the Marie-Jeanne Cave shows that these layers have a chronological range pertaining to MIS 3 (about 50-40 ka BP). During the first field campaign in 1943, about 40 m^3 of sedimentswereextracted recovering a large collection of disarticulated bone fragments and several plant, mollusc and archaeological remains housed at the RBINS. A first study of this material underlined the presence of 29 taxa of insectivores, bats and rodents. The recent revision of the material revealed 9897 identified specimens, corresponding to a minimum of 4980 individuals. This permitted us to add to the previous list two vole species, the steppe lemming *Lagurus lagurus* and the European pine vole *Microtus* (*Terricola*) *subterraneus*.

We also undertook new paleoenvironmental and paleoclimatic reconstructions based on alternative methods from those previously used for the MIS 3 sequence of the Marie-Jeanne Cave. Our results indicate that MIS 3 is characterized by dynamic alternations of forest expansion with semiarid area expansion in accordance with the warming and cooling, respectively, of the sea-surface temperatures. It was in this context of rapid fluctuations that the terrestrial sequence of the Marie-Jeanne Cave in north-western Europe was formed. The fossiliferous layers underwent cold and dry environmental and climatic conditions. This is indicated by lower temperatures and slightly higher precipitation than today, together with an environment dominated by open woodland formations and open dry meadows. Our results are consistent with the available chronological, large-mammal, herpetofaunal, and mollusc datasets for this lower part of the sequence. They are also consistent with regional loess studies in Belgium and with previous work performed on small mammals from MIS 3 in Belgium and elsewhere in Europe.

Grant Information**:**
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Technical Session VIII (Thursday, August 24, 2017, 2:30 PM)

THE PHYLOGENETIC RELATIONSHIPS OF THE PAROMOMYIDAE (PRIMATES, MAMMALIA)

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Plesiadapiforms are the first adaptive radiation of Primates, appearing near the Cretaceous-Paleogene boundary. Eleven families of plesiadapiforms are recognized, including the Paromomyidae. Paromomyids are the longest-lived (27 million years) and most broadly geographically distributed extinct primate family known. A previous phylogenetic analysis resolved the European clade of paromomyids (genus *Arcius*) as monophyletic, suggesting that the European radiation was a product of a single dispersal event from North America around the Paleocene-Eocene transition, possibly through the Greenland land bridge. However, the phylogenetic relationships among North American paromomyids are largely unknown. An attempt at resolving these relationships at a generic level only used 4 taxa and 12 dental characters. This previous analysis supported an *Ignacius-Phenacolemur* clade, *Acidomomys* as its sister taxon, and *Paromomys* as the sister taxon of the clade including the three previous genera.

Our analysis uses 101 dental characters, and includes all species of paromomyids, multiple species of non-paromomyid primitive plesiadapiforms, and a primitive eutherian (*Ukhaatherium*). The resulting Adams consensus tree (based on 72 equally-parsimonious trees) agrees with previous phylogenies in terms of the monophyly of the genus *Arcius*. The genus *Phenacolemur* is paraphyletic, with several *Phenacolemur* species being more closely related to European paromomyids than to other species of *Phenacolemur*. *Acidomomys hebeticus* is resolved as the sister taxon of the clade that includes *Arcius*, *Phenacolmeur*, and *Elwynella*, but not *Ignacius*, in contrast to previous inferences. The results are consistent with the monophyly of *Ignacius*, although they are somewhat equivocal, probably due to the primitive nature of *Ignacius fremontensis*. The primitive paromomyid genus *Paromomys* falls out as successive stem lineages at the base of Paromomyidae, with *Edworthia* placed among these branches. This result with respect to *Edworthia* supports the inference that it is a paromomyid.

This better resolution of paromomyid phylogenetic relationships helps consolidate our understanding of early primate evolution. Paromomyids have been central to debates over euarchontan relationships, and knowing what is primitive for Paromomyidae is of utmost importance to correctly positioning them within the euarchontan tree of life. Therefore, a clear resolution of paromomyid relationships is critical to broader questions of the evolution of Euarchontoglires.

Grant Information**:**
Doris O. and Samuel P. Welles Research Fund, AMNH Collections Study Grant, and University of Toronto Research Travelling Grant to SLT; NSERC Discovery Grant to MTS.

Technical Session IX (Thursday, August 24, 2017, 3:45 PM)

TAPHONOMY OF MAMMAL FOSSILS IN THE BARSTOW FORMATION, SOUTHERN CALIFORNIA, IN RELATION TO FACIES AND ENVIRONMENTS

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The Barstow Formation of southeastern California preserves a rich middle Miocene mammalian fossil record that forms the basis of the Barstovian North American Mammal Age. Large- and small-mammal zonations have been established from the type section in the Mud Hills in the central Mojave Desert. Faunal zonation spans the three members of the Barstow Formation—the Owl Conglomerate, Middle, and Upper members—distinguished on the basis of broad lithological differences. Major facies associations within these members represent the dominant environments at the time of deposition. Using facies analysis, geochemistry, and phytoliths, I have reconstructed the sequence of paleoenvironmental changes in the extensional Barstow Basin: playa- and alluvial-fan-dominated environments (Owl Conglomerate Member) transitioned to forested floodplain environments (Middle Member) to wooded grassland and spring-fed wetlands (Upper Member) over time. Both the number of vertebrate fossil localities and mammal diversity increase upsection with changing paleoenvironments.

To determine how taphonomic histories changed in relation to changing environments, I examined skeletal material in museum collections from 70 vertebrate localities for taphonomic indicators (e.g., weathering stage, abrasion, tooth marks) and evaluated depositional settings of 64 representative vertebrate localities from major facies associations. Taphonomic histories are more diverse in facies of the Upper Member than in facies of the Owl Conglomerate or Middle members, and the increased occurrence of fossil localities relates to the number of different depositional settings preserved in later-forming environments. These settings are grouped in terms of position on the paleolandscape: of 64 fossil localities examined in detailed stratigraphic sections, 8 (12.5%) represent well drained floodplain settings, 17 (26.5%) represent poorly drained floodplain settings, 8 (12.5%) represent channel and bar deposits, 17 (26.5%) represent proximal-channel settings, and 14 (21.8%) represent distal-channel settings. Facies associations that preserve a greater range of depositional settings preserve more localities and vertebrate taxa. Changes in mammalian faunal composition occur within and between facies associations, coinciding with minor and major paleolandscape transitions. Thus, paleolandscape heterogeneity exerts an important influence on fossil preservation and the taphonomic pathways through which fossil concentrations form.

Grant Information:
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Technical Session VI (Thursday, August 24, 2017, 9:00 AM)

THE FIRST LATE TRIASSIC TEMNOSPONDYL MASS-MORTALITY LOCALITIES FROM THE POPO AGIE FORMATION, FREMONT COUNTY, WY

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The Late Triassic Popo Agie Formation of Wyoming preserves a fauna that appears to pre-date that of the oldest Chinle Formation. Comparisons of the vertebrate fauna from the Popo Agie and the lowest formations of the Dockum Group demonstrate an assemblage distinct from that observed within the Chinle, including the phytosaurs *Paleorhinus* and *Angistorhinus*, and three genera of small trematosaur temnospondyls (*Latiscopus* and *Rileymillerus* from the Dockum of Texas, and a new Popo Agie taxon reported here).

Two temnospondyl mass-mortality localities were discovered in western Fremont County, WY in 2015; Serendipity Site (SS) and Nobby Knob (NK). The SS locality is stratigraphically below (~5 m) NK, and represents a time-averaged assemblage represented by multiple generations of vertical burrows containing vertebrate remains. The 1 m thick pedogenically modified fine-grained fluvial sandstone extends at least 500 m laterally. Of the 47 in-situ burrows collected, at least 22 of them contain partially to fully articulated skeletons. The burrows are semicircular (2.5-10 cm diameter) in cross section and often terminate with a rounded base. Preliminary computed tomography of the excavated burrows were performed at UW-Madison to identify the specimen location within the burrow, completeness, and to act as a guide for preparation of bulk material to facilitate higher resolution micro-CT scans for more detailed anatomical studies. At least four size classes of trematosaur temnospondyl with consistent morphology have been observed, possibly representing multi-year residency of a seasonal wetland environment. The NK locality is preserved in a silty-mudstone deposit consistent with slow moving water, interpreted to be a small pond or shallow lacustrine environment. The quarry is limited in lateral extent and contains numerous semi-articulated to disarticulated metoposaurid (cf. *Koskinonodon* sp.) individuals that represent a size continuum spanning 10 to 40 cm long skulls (minimum number of individuals = 7). These two sites provide a rare opportunity to observe ontogenetic variability, life histories, and fossorial behaviors within two genera of trematosaur temnospondyls.

Technical Session XIII (Friday, August 25, 2017, 2:45 PM)

A CASSOWARY-LIKE CRESTED OVIRAPTORID DINOSAUR (DINOSAURIA: OVIRAPTOROSAURIA) FROM SOUTHERN CHINA

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Oviraptorosaurs, a special group of coelurosaurian dinosaurs, are characterized by short and deep skulls with toothless jaws (except for primitive forms such as *Incisivosaurus* and *Caudipteryx*), pneumatized caudal vertebrae, anteriorly concave pubic shafts, and posteriorly curved ischia. In recent years, numerous different oviraptorid eggs and clutches as well as skeletons have been unearthed from Upper Cretaceous deposits of Ganzhou, Jiangxi Province. This site has become the Chinese bonanza of oviraptorosaur fossils, and one of the richest in the world. Herein we report a new, cassowary-like crested oviraptorid dinosaur from the Late Cretaceous of the Ganzhou area.

Histological observations revealed the absence of external fundamental system, suggesting that the new oviraptorid specimen did not reach its maximum body size but rather died during still rapid, but not the fastest, growth rates. Furthermore, it appears that the animal perished at the beginning of a new growth cycle as the cortical deposition was partly resumed external to the latest break in bone development. Lines of arrested growth preserved in the fibula suggest that the individual was more than six year-old, whereas in

the radius-based estimates indicate the minimum age of seven years. The histology of the new oviraptorid may correspond to a younger adult individual, approaching a stationary stage of bone development. It took probably more than eight years for the new oviraptorid to reach somatic maturity.
The new oviraptorid dinosaur is mainly characterized by bearing a distinct cassowary-like crest on the skull, long axis of the external narial opening parallel to the dorsal margin of antorbital fenestra, no pleurocoels on the centra from the second through fourth cervical vertebrae, the neck being twice as long as the dorsal vertebral column, and slightly longer than the forelimb (including the manus), the ungual of digit III less curved than other unguals, and lesser trochanter (cranial trochanter) completely fused with the greater trochanter. Phylogenetic analysis recovers the new oviraptorid as closely related to *Huanansaurus* from Ganzhou, however, it differs from *Huanansaurus* in the skull morphology and postcranial skeletons. The discovery of the new oviraptorid dinosaur provides unprecedented evidence that oviraptorid dinosaurs were morphologically and taxonomically far more diverse in the Ganzhou area than in any other known region of the world.
Grant Information:
National Natural Science Foundation of China (grant no.: 41672019; 41688103), and the China Geological Survey (grant no.: DD 20160201)

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

STRATIGRAPHIC DISTRIBUTION AND AGE OF THE DINOSAURS OF THE UPPER CRETACEOUS HALL LAKE MEMBER OF THE MCRAE FORMATION, SIERRA COUNTY, NEW MEXICO

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The Upper Cretaceous McRae Formation consists of fluvial sediments exposed in south-central New Mexico in Sierra County, primarily across the Cutter sag, between the Fra Cristobal Mountains to the north and Caballo Mountains to the south. Total thickness of the McRae Formation is at least 1 km, and it is divided into a lower, Jose Creek Member up to 120 m thick overlain by an upper, Hall Lake Member at least 850 m thick. Dinosaur fossils have been known from the Hall Lake Member for more than a century, and have been long regarded as of late Maastrichtian (Lancian) age. Recent collecting has augmented the Hall Lake Member dinosaur fauna, and stratigraphic analysis puts many of the dinosaur fossils into a precise and detailed lithostratigraphic framework. These fossils are from a nonmarine facies composed of commonly crossbedded conglomerate and sandstone representing fluvial channel fills, and thick siltstone-mudstone intervals, representing floodplain or overbank deposits, locally containing pedogenic carbonate beds. Most of the dinosaur fossils come from a thin stratigraphic interval 23-43 m above the base of the Hall Lake Member. This includes *Tyrannosaurus "rex*," a new ceratopsian genus similar to *Torosaurus* and an abundance of indeterminate ceratopsid fossils. Stratigraphically higher fossils, about 140-150 m above the base of the Hall Lake Member, include the titanosaur *Alamosaurus*. Other dinosaurs, mostly indeterminate ceratopsids and hadrosaurids, are also known from Hall Lake Member localities that cannot be placed into the detailed stratigraphic framework because of faulting and/or Quaternary cover. *Tyrannosaurus* and *Alamosaurus* are not known from pre-Lancian strata, so their presence reaffirms a Lancian age for the lower part of the Hall Lake Member. Fossil turtles from the Hall Lake Member include *Compsemys* and an indeterminate bothremydid and only indicate a Campanian to Maastrichtian age. A recently reported $^{206}Pb/^{238}Pb$ age of a tuff bed 9 meters above the base of the Hall Lake Member is 74 Ma, about 7 million years older than the biostratigraphic age based on the dinosaur fossils. We thus question the accuracy of this radioisotopic age, and of other Campanian ages in the 74-76 Ma range on tuffs in the Jose Creek Member. It seems likely that the McRae Formation is mostly of late Maastrichtian age, though its maximum and minimum ages remain undetermined based on present data.

Podium Symposium (Wednesday, August 23, 2017, 11:00 AM)

INCREASED LIMB MORPHOLOGICAL DISPARITY COINCIDENT WITH THE EMERGENCE OF MAJOR SYNAPSID CLADES AND SHIFTS TO NEW MORPHOFUNCTIONAL TYPES

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The Permian was a critical time in which Synapsida underwent a taxonomic and morphological diversification. Synapsid evolution can be characterized by three successive radiations: the Pennsylvanian and early Permian pelycosaurs, the Permo-Triassic Therapsida, and finally Mammaliformes, which arise in the Late Triassic. While descriptive studies have suggested an overall increase in morphological disparity concurrent with the rise of Permian therapsids, no work has attempted to compare disparity across this entire evolutionary interval. Temporally pinpointing significant changes in disparity at different hierarchical levels will provide important insight into factors affecting the replacement of pelycosaurs by therapsids, as well as how synapsids responded to the end-Permian mass extinction (EPME).
Here I present the first detailed analysis of shape disparity in select forelimb elements of synapsids. The study included 281 specimens from all major pelycosaur families except Eothyrididae, all major Permian therapsid orders, and a selection of Triassic cynodont orders. Nine landmarks and 48 equally spaced semilandmarks were digitized on humeri and ulnae. Clades were analyzed for Procrustes variance, calculated both within and between groups. Data were time-binned at both 5 and 10 million year increments, starting 305 Mya in the Late Pennsylvanian and ranging to the end of the Middle Triassic (230 Mya).
Disparity starts low and remains relatively constant until around 275 Mya, followed by a substantial increase in total disparity approaching and across the EPME (252.3 Mya). Overall, pelycosaur families show lower disparity than therapsids, and increased total group disparity coincides with the emergence of Therapsida. The lowest variance values in pelycosaurs and Therapsida are observed in Sphenacodontidae (0.0105) and Dinocephalia (0.0108). The highest variance levels are observed in Ophiacodontidae (0.01833) and Cynodontia (0.01816). Cynodontia had dramatically increased variance immediately following the EPME (0.03316), early in the group's history. This research reveals two progressive increases in variance that appear associated with the emergence of the major clades Therapsida and Cynodontia, and thus with known shifts in limb morphology. This research provides evidence that along with the historically recognized major shifts in forelimb morphology, group-wide increases in disparity may have been critical to the evolutionary success of these groups.

Technical Session XIV (Friday, August 25, 2017, 4:00 PM)

SKELETAL LIMB MORPHOLOGY OF *MARTES AMERICANA*, A SMALL MUSTELID CARNIVORAN, VARIES PREDICTABLY BY BIOME BUT NOT IN CORRELATION WITH BODY SIZE

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Skeletal limb morphology of carnivorans often correlates with prey size and capture method, ecoprovinces, and vegetation density. *Martes americana* occupies four biomes and has a varied diet, which includes small mammals, eggs, insects, and fruit. This makes it an ideal taxon to test whether the morphological patterns seen interspecifically in Carnivora are also present intraspecifically. I tested whether the skeletal limb morphology of *M. americana* differed between biomes in its U.S. distribution.
I collected 3D geometric morphometric landmark data from the humerus, radius, ulna, femur, tibia, and fibula of 39 specimens collected 2000-2013. Each specimen was identified by collection site to one of three biomes: temperate broadleaf forest (TBM), boreal forest (BFT), and temperate grasslands (TGSS). I included three specimens from temperate coniferous forest (TCF) that were close to the boundary of grassland with TGSS. I aligned landmarks using a Generalized Procrustes Analysis and plotted them in a PCA. I then tested for morphological differences between specimens using the top significant (95%) PC scores of each bone in a PERMANOVA and Bonferroni post hoc analysis.
I found a significant difference in morphology between specimens from TBM and TGSS/TCF in all bones except the humerus. Differences were mostly in the robusticity of the proximal ends of each bone, with TBM specimens being more gracile. There was a significant difference between specimens from BFT and TGSS/TCF in the ulna and the three bones of the hindlimb. The femoral condyles in BFT specimens were angled superiorly toward the lateral side, and the tibia and fibula had an increased convex lateral curvature of the distal diaphysis. Researchers have found similar patterns of increased robusticity and diaphyseal curvature in other carnivorans and correlated this morphology with an increase in body size. I tested for an allometric correlation between Procrustes landmarks and skull length, a proxy for body size, using a Procrustes ANOVA and regression. None of the bones showed a correlation between shape and body size. This suggests that other factors besides body size correlate with these patterns of morphological variation.
It is unclear whether the observed morphological variation in *M. americana* is in correlation with environmental factors or whether these specimens are also phylogenetically distinct. I am, therefore, sequencing four mitochondrial genes from the same specimens to determine whether the observed phenotypic differences correlate with phylogenetic relationships.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

NICHE MODELING OF THE EXTANT AILURID TAXON TO IMPROVE SAMPLING PROBABILITY OF EXTINCT RELATIVES (CARNIVORA, MUSTELOIDEA)

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Ailuridae (Carnivora, Musteloidea) was once diverse in species, diet, and distribution (covering most of the northern hemisphere). However, relationships within the family are poorly understood because of a limited fossil record and the existence of only one extant taxon; the highly derived red panda (*Ailurus fulgens*). In particular, most fossil ailurids are represented by only cranial and dental fragments; with the exception of *Pristinailurus bristoli* (subfamily Ailurinae) from the Gray Fossil Site (Washington County, TN), which is represented by several nearly complete specimens (e.g. ETMNH 3596 = 98% complete).
Certainly more complete material from additional fossil taxa would improve our understanding of ailurid phylogeny; however, focusing sampling efforts is nearly impossible without some form of assistance (as with any fossil group). Fortunately, niche models were created for the living *A. fulgens*, as a separate project. These models then served as a platform to extrapolate probably distributions using past climate data. In particular, global data available from the Holocene Climatic Optimum and the Last Glacial Maximum, was used as part of the maximum entropy modeling approach (Maxent) to generate projections of potential fossil regions/localities across Eurasia, and was compared to known sites containing fossil ailurids. Examination of past abiotic factors such as climate, precipitation, and elevation yielded probability maps of areas most likely to produce ailurid fossils.
In addition to the results above, because *A. fulgens* is currently endangered due to increasing anthropogenic influences, it is restricted more than its ancestors in terms of diet, habitat, and distribution. Consequently, by better understanding the relationships within Ailuridae, we can focus our conservation efforts.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

FUNCTIONAL ANATOMY OF A GIANT DINOSAUR BEAK: *GIGANTORAPTOR* AND THE EVOLUTION OF THE OVIRAPTOROSAURIAN JAW

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The Oviraptorosauria are one of several theropod dinosaur groups that diverge from the typical carnivorous theropod diet. Studying the detailed skeletal anatomy of oviraptorosaurian jaws is therefore important to address uncertainties in their seemingly complex dietary evolution, which encompassed omnivory and herbivory. The two main lineages of oviraptorosaurs – Caenagnathidae and Oviraptoridae – display a number of differences in mandibular morphology, but little is known about how they relate to potential differences in function. *Gigantoraptor erlianensis* is a giant oviraptorosaur from the Late Cretaceous Iren Dabasu Formation of Nei Mongol, China. Its mandible is the only well-preserved mandible of a basal caenagnathid, so it is particularly promising towards understanding the evolution of potentially diet-related mandibular features in caenagnathids and oviraptorids.

The mandible of the *Gigantoraptor* holotype (LH V0011) was described in detail for the first time. It shows the greatest relative beak depth among caenagnathids. In modern finches, a deeper beak appears to be an adaptation for processing harder seeds. However, *Gigantoraptor* does not show obvious mandibular features (e.g. a tall coronoid process prominence) that favour the production of a large bite force. A lingual triturating shelf is present in more derived caenagnathids but not in *Gigantoraptor*. This suggests a possible increased specialisation towards shearing along the caenagnathid lineage. The possession of a dorsally convex articular glenoid in *Gigantoraptor* and more derived caenagnathids indicates that propalinal jaw movement was probably an important mechanism in food processing, as supported by similar morphologies in living *Sphenodon* and dicynodonts.

Based on a number of osteological features, we find that the mandible of oviraptorids is more suited for producing a powerful bite (e.g. crushing-related behavior) than that of caenagnathids. In general, oviraptorids possess a deeper, more downturned beak, a taller coronoid process prominence and a larger medial mandibular fossa. The disparity in mandible morphology between caenagnathids and oviraptorids potentially suggests specialisation towards two different feeding styles – shearing and crushing-related mechanisms respectively. This study provides new data and functional analogues that reinforces previous suggestions that the two main oviraptorosaur lineages had divergent feeding styles likely to be linked with divergent dietary preferences.

Grant Information:
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Technical Session VI (Thursday, August 24, 2017, 10:45 AM)

THE RICHARDS SPUR LOCALITY (289 MA), OKLAHOMA, A UNIQUE UPLAND EARLY PERMIAN LOCALITY WITH A DISTINCT PALEOECOLOGY

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The Richards Spur locality is distinctive in that it represents one of the few documented upland assemblages of the Early Permian, with the only other assemblage considered upland being the Bromacker locality in Germany. Historically, these upland sites have been poorly studied. In contrast terrestrial lowland localities of the Early Permian are well known, with the classic deltaic/fluvial red bed assemblages of Texas, New Mexico, and Oklahoma being extensively studied. However, the lack of information regarding upland Early Permian localities has resulted in a gap in our knowledge of this period in time. The research presented here attempts to rectify this problem by filling in some of these gaps using new data gained from the study of the upland Richards Spur locality. Using new geological, taxonomic, and relative abundance data we are able to better interpret the paleoenvironment and paleoecology of the locality. Recent analyses of speleothems from the locality have been instrumental in determining the potential climate and more precise age of Richards Spur, granting us a better context in which to interpret the fauna of the locality. With regards to taxa, numerous new tetrapods have been described from Richards Spur recently, which has greatly increased the taxonomic diversity of the faunal assemblage. Relative abundances of Richards Spur taxa were calculated using the large blocks of disarticulated material found at the locality. The results of this analysis reveal that the reptile *Captorhinus* and the small anamniote *Doleserpeton* dominated this particular sample; microsaur and parareptile remains were also relatively common, whereas other larger anamniotes and amniotes were rare. The low amount of large taxa and the higher number of small taxa resembles the pattern that we see in modern systems. Normally, Early Permian lowland assemblages tend to be dominated by the remains of larger taxa, with small taxa being rare, this is likely a result of the preservational environments associated with lowland deltaic/fluvial systems. However, Richards Spur's nature as a cave deposits results in a distinct preservational environment that seems to capture many smaller tetrapods, offering a unique opportunity to study what is typically a hidden aspect of Early Permian localities. Together, this new information from Richards Spur allows for the reconstruction of the paleoecology of the locality. Furthermore, comparisons with the more common Early Permian lowland localities allow for a more integrated view of Early Permian continental assemblages.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

AN EARLY MIOCENE MOBULID LOCALITY FROM THE FRANK R. BOWERMAN LANDFILL, IRVINE, CALIFORNIA: THE IMPORTANCE OF MITIGATION PALEONTOLOGY AND ITS IMPLICATIONS FOR MOBUILD PALEOBIOGEOGRAPHY

MACIAS, Melissa K., Psomas, Long Beach, CA, United States of America; ROEDER, Mark A., Costa Mesa, CA, United States of America

The extant Mobulidae (Chondrichthyes: Myliobatiformes) are known from localities worldwide, but they are relatively rare in the fossil record, and few occurrences are known from marine sediments along the eastern Pacific. Previous biogeographic range studies of fossils of this taxon did not include any of the California localities. Until the discovery of these specimens, the northernmost fossil locality known along the eastern Pacific was at the La Mision Local Fauna of the Rosarito Beach Formation in Baja California, Mexico. The recent discovery of mobulid (devil ray) teeth in the early Miocene Vaqueros Formation in Southern California extends the biogeographic range of the genus northward along the eastern Pacific coastline, and may be the oldest known mobulid locality in western North America.

The fossils reported herein were found during recent mitigation monitoring activities at the Bowerman Landfill in Orange County, California. Further investigation of mobulid specimens in museum collections yielded three additional localities in Southern California, including the late Miocene Sharktooth Hill Locality in Kern County. These occurrences suggest that mobulids inhabited the waters off the eastern Pacific coast throughout the Miocene.

The Bowerman Landfill specimens and two of the additional mobulid localities in Southern California were found as a result of mitigation monitoring. Mitigation paleontology is a unique opportunity as land development can expose rock formations not typically uncovered through natural processes. Mitigation paleontology is an important resource that provides museums and researchers with specimens that might otherwise be lost due to development or forever remain buried. Closer collaboration between academic and consulting paleontologists, including the sharing of specimens, data, and theoretical models can lead to better, valid, and reliable research results that will benefit all.

Technical Session XI (Friday, August 25, 2017, 9:45 AM)

CHALLENGING THE TAPIR *STATUS QUO* – FORELIMB VARIATION INDEPENDENT OF BODY MASS ACROSS TIME AND SPACE IN THE GENUS *TAPIRUS* (PERISSODACTYLA: TAPIRIDAE)

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For over 60 years, the postcrania of tapirs (Perissodactyla: *Tapirus*) have been considered to vary morphologically only as a result of changes in body size. Recent quantitative evidence from the forelimb of modern tapir species has cast doubt upon this viewpoint, with interspecific differences revealed which pertain to ecomorphological outcomes rather than being associated with changes in body mass (BM). However, it remains unknown whether these differences represent a very recent speciation, or if the tapir forelimb exhibits ecomorphological variation in both extant and fossil tapirs. Here, we investigated the forelimb osteology of a sample of nine tapir species, including five extinct taxa from south-eastern USA. Estimated BMs from humeral width measures ranged from 117kg (*T. polkensis*) to 326kg (*T. indicus*). A composite phylogeny was constructed based on published trees to test for strength of phylogenetic signal in forelimb bone morphology. Bone shape was quantified using three-dimensional landmark-based geometric morphometrics, based on laser surface scans of 14 forelimb bones. Procrustes coordinates were regressed against bone centroid size (intrinsic size measure) to account for allometry, and residuals were examined using principal components analysis (PCA). PerMANOVAs were performed on the Procrustes residuals with Bonferroni post-hoc tests to detect significant interspecific differences. The modern Malayan tapir *T. indicus* was separated from American taxa for most forelimb bones ($p < 0.05$). North American and Neotropical species exhibited variability in morphospace overlap, dependent upon the bone. In 57% of cases, North American taxa within subgenus *Helicotapiurus* occupied novel regions of morphospace compared to modern tapirs. Large species (BM > 270kg) demonstrated significant differences to one another in metacarpal morphospace occupation ($p < 0.05$). Phylogenetic signal based on the first two principal components suggested that the humerus, MC3, and lunar are not significantly constrained by phylogeny after size is accounted for (Pagel's $\lambda < 0.01$). We conclude that morphological variation in tapir forelimb osteology is not exclusive to changes in body size, although it is certainly a factor for some limb elements. Phylogenetic relatedness plays a major role in shaping the forelimb in tapirs, with several forelimb elements hinting at additional underlying causes of variation.

Grant Information:
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Technical Session VIII (Thursday, August 24, 2017, 3:45 PM)

MIXING AND MATCHING "ENDEMIC" PRIMATE TAXA: A DISTINCT COMBINATION OF CATARRHINE PRIMATES FROM AN EARLY MIOCENE SITE AT BUKWA, UGANDA

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Recent radiometric reappraisal of the age of the Early Miocene Bukwa sites on Mount Elgon, Uganda have shown them to be 19.5-19.1 Ma, intermediate between the older Tinderet (~20 Ma, Kenya) and Napak (20 Ma, Uganda) localities on the one hand, and the younger Kisingiri (~18 Ma, Kenya) sites on the other. Collectively, Napak, Tinderet and Kisingiri chronicle a high level of catarrhine diversity, but with high endemism.

However, the only primate recognized from Bukwa has been *Limnopithecus legetet,* based on one tooth. Here we report new records of catarrhines collected during 2015.
An upper molar (likely M2) shares features with both *Ekembo heseloni* from Kisingiri and *Proconsul africanus* from Tinderet. For example, like *P. africanus*, the crown has a rhomboid occlusal shape and a strongly curved distal margin; but like *E. heseloni*, and unlike *P. africanus*, it has only a rudimentary buccal cingulum and reduced buccolingual flare. These two taxa were previously considered to be congeneric, and are separated by up to 2 Ma. On balance, the Bukwa molar resembles *Ekembo* more. A second, partial, worn upper molar (lacking buccal flare and a buccal cingulum) and a worn lower molar (with a poorly developed cingulum) are also tentatively assigned to *Ekembo*. These teeth represent the oldest known records of *Ekembo*.
An upper canine may represent *Micropithecus* based on size, and because it is more buccolingually compressed than is typical for *Limnopithecus*. However, the canines for *Micropithecus* are not known in association with other dentition and so the assignment is tentative. An upper premolar has an extremely reduced mesiodistal length relative to buccolingual breadth, like those of *Lomorupithecus* and some *Dendropithecus* specimens. The premolar also has two crests extending distally from the protocone, as in *Lomorupithecus*, but unlike the condition in *Dendropithecus*.
These five new specimens signify the presence of at least three catarrhine taxa at Bukwa. Although this diversity is low relative to that found at Napak, Tinderet or Kisingiri, Bukwa's intermediate age and geographic location makes it important in examining faunal change in catarrhine and other mammalian lineages during the early Miocene. Records of *Ekembo* and *Lomorupithecus* were previously restricted to Kisingiri and Napak, respectively. Our preliminary analyses suggest that the perception of elevated catarrhine endemism in the East African early Miocene may be partly driven by limited stratigraphic and geographic sampling.
Grant Information:
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Technical Session XX (Saturday, August 26, 2017, 3:00 PM)

PALEOPROTEOMIC ANALYSIS OF THE RELATIONSHIPS OF QUATERNARY WEST INDIAN FOLIVORANS (PILOSA, XENARTHRA)

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A diverse assemblage of folivorans (sloths) occupied several islands in the West Indies from at least as early as the Early Miocene until the middle Holocene. Although often viewed as monophyletic and megalonychid by relationship, other family-level dispositions as well as a diphyletic origin have been asserted for this group in the past, mostly on the basis of morphology.
Attempts to test these arguments with paleogenomic information have had limited success: DNA does not survive well in hot, wet localities like caves—virtually the only contexts in which folivoran fossils occur in the West Indies. Collagen is also subject to degradation under such conditions, but degrades more slowly. We successfully recovered collagen I*a*1 and/or I*a*2 sequence information from Cuban and Hispaniolan specimens of species of *Parocnus*, *Acratocnus*, and *Neocnus*, as well as from mainland North and South American mylodontids (4 spp.), megatheriids (2 spp.), and megalonychids (1 sp.). Sequence results for extant *Choloepus hoffmanni*, *Bradypus tridactylus*, *Cyclopes didactylus*, and *Dasypus novemcinctus*, as well as extinct *Glyptodon* and *Doedicurus* spp., were also included to permit a robust Bayesian phylogenetic analysis that simultaneously sampled tree topologies and branching times. Divergence time calibrations were integrated using a model allowing fossil occurrences to be treated as distinct lineages rather than node age prior distributions.
Most traditional groupings were recovered on the maximum clade credibility tree, with the following important exceptions: (1) extant *Choloepus* strongly grouped with mylodontids, while (2) the *Acratocnus*-*Neocnus* clade paired with megatheriids, to the exclusion of megalonychids in both cases. It is noteworthy that grouping 1 is supported by recent aDNA studies, while grouping 2 is consistent with some morphological studies that couple Acrotocnini/Neocnini with schismotheriine megatheriids (e.g., *Hapalops*). Although not all relevant West Indian and mainland taxa are represented in this preliminary analysis, the diphyly argument for extinct Caribbean sloths now seems unlikely, all taxa having seemingly diverged within Megatheriidae. Our mean estimate for the divergence time of the MRCA of the West Indian taxa vs. other megatheriids is 24.0 Ma, during the Oligo-Miocene transition. The empirical age of the oldest named insular taxon*, Imagocnus zazae* (Lagunitas Fm, Domo de Zaza, Cuba), is mid-Burdigalian (18.5-17.5 Ma) and thus in good temporal agreement with the divergence estimate.
Grant Information**:**
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

STASIS IN RANCHO LA BREA LITTLE OWLS OVER THE LAST GLACIAL-INTERGLACIAL CYCLE

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Classic cases of modern bird evolution, such as the rapid response of Galápagos finches to climate fluctuations, make them the textbook example of evolution. However, all previous studies of common birds from Rancho La Brea (Teratorns, Condors, Black Vultures, Golden Eagles, Bald Eagles, Turkeys, and Caracaras) have demonstrated stasis through the climatic extremes of the last glacial-interglacial cycle. This is also true of the Great Horned Owl and Barn Owl. But would smaller species be more likely to respond to climatic fluctuations than larger species? To test this, we examined specimens of the two common small owls (the Long-Eared Owl *Asio otus*, and the Burrowing Owl *Athene cunicularia*) from the La Brea Tar Pits and Museum collections to determine changes in size or limb robustness over the last 35,000 years in response to climate changes. Living owls display a weak Bergmann's rule effect, with larger body sizes in colder regions. Despite this effect, all the large and small La Brea owls maintained stasis over this period with little significant change in size or robustness despite climate changes over the peak glacial maximum 18,000-20,000 years ago, during which the climate at La Brea consisted primarily of snowy winters and coniferous forests. Our results concur with previous research on all the La Brea birds, which all show stasis through the entire range of dated pits. It seems birds do not respond to climate change in a simple manner, they are adaptable to many environments and may live in various ecosystems and climates without much change in body size or limb robustness over time.

Technical Session VI (Thursday, August 24, 2017, 9:30 AM)

IMPLICATIONS OF THE EVOLUTION OF SOMITIC CONTRIBUTIONS TO THE HEAD ON THE EVOLUTION OF CRANIAL MUSCLES IN TETRAPODS

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Living amphibians (lissamphibians) show a reduced contribution of axial somites to the occiput (portions of two to three somites) in comparison to amniotes (portions of five somites). The presence of the amniote condition near the base of Tetrapoda, as revealed by the presence of hypoglossal nerve foramina (an osteological correlate of somite contribution to the occiput), supports the often-overlooked hypothesis that the lissamphibian condition is secondarily derived. It remains unclear, however, what factors led to the apparent fixation of the "amniote" condition early in tetrapod evolution, as are the consequences of reducing the number of occipital somites in lissamphibians. Experiments conducted on salamanders aimed at understanding the developmental mechanism underlying changes in occipital composition revealed that homeotic shifts in anterior axial patterning could explain the diversity of occipital conditions observed in the skulls of tetrapods. Interestingly, these experiments also revealed that homeotic shifts are not restricted to the skeletal components of the axis, and similar shifts are seen in the fate of muscles derived from the myotomes of these somites, i.e., the hypobranchial and glossal muscles. These data, and observations of extant lissamphibian and amniote hypobranchial and glossal musculature, reveal that an important consequence of incorporating more somites in the head may be the formation of a greater number and diversity of these myotome-derived muscles.
Thus, it is inferred that if early tetrapods possessed an amniote-like somite contribution to the skull, they likely also possessed an amniote-like complement of somite-derived cranial muscles. It is hypothesized that the recruitment of these myotomes into the hypobranchial and glossal musculature facilitated the development of a feeding apparatus that conferred an advantage during terrestrial feeding, thereby leading to fixation of this condition early in tetrapod evolution. Lissamphibians may then be poor models for understanding early feeding strategies in terrestrial tetrapods, as they possess a derived reduction in the number of muscles involved in feeding mechanics. Finally, if considered within the context of the evolution of axial regionalization, the presence of an amniote-like number of occipital somites in the vast majority of both extinct and extant tetrapods supplants previous examples of extreme evolutionary developmental constraint in the tetrapod axis.
Grant Information:
Funding: NSERC Discovery Grant to HCM.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW PHYLOGENY OF STEGOSAURIA (DINOSAURIA: ORNITHISCHIA)

MAIDMENT, Susannah C., University of Brighton, Brighton, United Kingdom; RAVEN, Thomas J., Imperial College London, London, United Kingdom
The stegosaurs are some of the most easily recognisable dinosaurs, but they are surprisingly rare as fossils. Consequently much remains unknown about their palaeobiology, and every new stegosaurian find contributes to understanding the evolution of the clade. Since the last attempt to examine the evolutionary relationships of Stegosauria, new specimens have come to light, including the most complete individual of *Stegosaurus* ever found, new taxa have been described and, perhaps most importantly, new methods for analysis of cladistic datasets have been produced. In the light of these new data and technological advances, the phylogenetic relationships of the stegosaurs and basal armoured dinosaurs are investigated. The inclusion of continuous data results in much better resolution than was previously obtained, and the resulting single most parsimonious tree supports re-erection of the genera *Miragaia* and *Hesperosaurus*, which had previously been synonymized with *Dacentrurus* and *Stegosaurus* respectively. The recently described genus *Alcovasaurus* is resolved as a basal thyreophoran, but this is likely to be due to a combination of a very high degree of missing data and the questionable ontogenetic stage of the specimen. Examination of the effects of continuous data on the analysis suggest that while it contains a phylogenetic signal congruent with that of discrete data and provides better resolution than discrete data alone, it can affect topologies in unpredictable ways, particularly in areas of the tree where there are large amounts of missing data.
Grant Information**:**
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

OCCURRENCE OF LAMNIFORM AND CARCHARHINIFORM SHARKS FROM THE PUNGO RIVER AND YORKTOWN FORMATIONS (MIOCENE-PLIOCENE) OF THE SUBMERGED CONTINENTAL SHELF, ONSLOW BAY, NORTH CAROLINA, U.S.A.

MAISCH IV, Harry M., CUNY Graduate Center, New York, NY, United States of America; BECKER, Martin A., William Paterson University, Wayne, NJ, United States of America; CHAMBERLAIN JR., John A., Brooklyn College, Brooklyn, NY, United States of America

The submerged continental shelf of Onslow Bay, North Carolina preserves hardbottom limestone scarps with underlying clays as small isolated exposures in progressively deeper water from the modern day shoreline. Fossiliferous residuum occurs adjacent to these scarps and contains an abundance of lamniform and carcharhiniform shark teeth, including those belonging to the megatoothed sharks, and specifically: *Otodus chubutensis, Otodus megalodon*, *Carchardon hastalis, Carcharodon carcharias, Parotodus benedinii, Alopias grandis*, *Isurus oxyrinchus, Carcharias* cf. *C. taurus*, *Hemipristis serra*, *Galeocerdo aduncus*, *Physogaleus contortus*, *Galeocerdo cuvier, Negaprion brevirostris*, *Carcharhinus priscus*, *Carcharhinus obscurus*, and *Rhizoprionodon* sp. Comparison of chronostratigraphically significant lamniform and carcharhiniform taxa from Onslow Bay with those from land-based assemblages along the Atlantic Coastal Plain indicates that the shallower shelf (≈ 28m deep) exposes the Miocene Pungo River Formation and intermediate and deeper shelf (≈35-40m deep) exposes the Pliocene Yorktown Formation. These submarine scarps formed as a result of glacioeustactic sea level cyclicity and the migration of the ancestral shoreline seaward throughout the Pleistocene and landward since the end of the last Ice Age and into modern times. Lamniform and carcharhiniform teeth adjacent to these scarps accumulated during multiple exhumation and reburial episodes as a result of this dynamic ancestral shoreline within the Onslow Embayment.

Technical Session XIII (Friday, August 25, 2017, 2:00 PM)

A NEW, ALMOST COMPLETE SPECIMEN OF *ALNASHETRI CERROPOLICIENSIS* IMPACTS OUR UNDERSTANDING OF ALVAREZSAUROID EVOLUTION

MAKOVICKY, Peter J., Field Museum of Natural History, Chicago, IL, United States of America; APESTEGUÍA, Sebastian, Fundación de Historia Natural 'Félix de Azara' Universidad Maimónides, Buenos Aires, Argentina; GIANECHINI, Federico, Universidad Nacional de San Luis, San Luis, Argentina

A new specimen of the diminutive alvarezsauroid *Alnashetri cerropoliciensis* (Museo Provincial Carlos Ameghino 377) was collected from the Candeleros Formation near Cerro Policía, Rio Negro Province, Argentina in 2014. The specimen is very complete missing only major sections of the tail, and represents the first Gondwanan alvarezsauroid with cranial remains. Referral to *Alnashetri* is based on anatomy of the hindlimb and in particular the metatarsus, which is identical to that of the holotype specimen.

Derived traits throughout the new skeleton confirm that *Alnashetri* is a basal alvarezsauroid: the cervical vertebrae are incipiently opisthocoelous; the last sacral vertebra has a convex caudal articulation and a small ventral ridge; the coracoid lacks a coracoid tubercle; the distal end of the humerus is expanded and bears an extensor fossa on its caudal face; Metacarpals II and III are extremely slender compared to metacarpal I; the ungual of digit I bears a reduced and pinched flexor tubercle and its medial claw groove terminates in an enclosed canal; the opisthopubic pubes lack an apron. The new specimen exhibits numerous plesiomorphic traits when compared to Alvarezsauridae. The sternal plates are unfused and plate-like. The forelimb is about half the length of the hindlimb, the olecranon process of the ulna is short, and the ilia have broad pubic peduncles but narrow brevis fossae and do not meet above the sacrum.

As the earliest and most complete alvarezsauroid in the South American fossil record, the new specimen has important implications for our understanding of phylogenetic relationships, biogeography and body size evolution in this clade. Phylogenetic analysis posits *Alnashetri* as sister to Alvarezsauridae, but South American alvarezsauroids remain paraphyletic with respect to Laurasian parvicursorine alvarezsaurids. As one of the smallest as well as earliest diverging alvarezsauroids, *Alnashetri* provides evidence for multiple instances of miniaturization within this clade of unusual theropods.

Grant Information**:**
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

ANALYSIS OF THE CRANIAL ANATOMY OF *ALLOSAURUS* FROM THE ANDRÉS FOSSIL SITE (PORTUGAL, UPPER JURASSIC)

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The description, in 1999, of a partial skeleton of a theropod dinosaur collected in the Andrés fossil site from the Upper Jurassic of the Lusitanian Basin and assigned to the North American species *Allosaurus fragilis* promoted an interesting paleobiogeographic discussion about the relationship of the Late Jurassic dinosaur faunas from Portugal and North America. The similarity of these faunas was explained by the existence of faunal exchanges across the proto-North Atlantic Ocean at the end of the Jurassic due the presence of intermittent land bridges between the landmasses of North America and Iberia. Later, the description of the new species *Allosaurus europaeus* as well as other vertebrate taxa exclusive from the Lusitanian Basin supports a different scenario in which the evolution of these faunas would be marked by vicariant processes. A set of cranial and postcranial remains collected in the Andrés fossil site in 2005 and 2010 allows a better knowledge of the cranial morphology and diversity of the Portuguese forms of *Allosaurus* and may add important data for the paleobiogeographic discussion. These specimens include approximately 85% of a complete skull representing the most complete set of theropod cranial remains known from the Upper Jurassic of Portugal. These elements are fairly well preserved allowing the description of several fragile elements and structures that are poorly known in the fossil record of theropods, allowing achieve a detailed knowledge of the cranial morphology of this theropod. These specimens show some differences relative to the *Allosaurus* specimens from the Morrison Formation, but have also some variations relative to the Portuguese species *A. europaeus*. However, based on the paleobiogeographic context of the specimens from Andrés it is more reliable to assign these specimens to *Allosaurus* cf. *europaeus* pending to establish a robust interpretation of the relationships between the Portuguese and North American members of *Allosaurus*.

Grant Information**:**
PhD grant SFRH / BD / 84746 / 2012

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW TERMINAL CRETACEOUS (LATE MAASTRICHTIAN) NON-AVIAN DINOSAUR DISCOVERIES FROM SOUTH DAKOTA: IMPLICATIONS FOR LARAMIDIAN PALEOECOLOGY AND PALEOBIOGEOGRAPHY

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Much of our current understanding of the latest Cretaceous continental vertebrate faunas of Laramidia (i.e., western North America) comes from the upper Maastrichtian Hell Creek and Lance formations of Montana (MT) and Wyoming (WY), respectively. The uppermost Fox Hills Formation (FHF) and the Hell Creek Formation (HCF) of South Dakota (SD) are contemporaneous with sediments found in these more frequently studied areas of MT and WY. Due to their paleogeographic position, proximal to the regressing Western Interior Seaway (WIS), the vertebrate assemblages of these units provide insight into the paleoecology of this region under continued marine regression, and may also enable comparisons to the more inland faunas of MT and WY.

The recent discoveries of the theropods *Anzu* and *Dakotaraptor* in the HCF of the East Short Pine Hills (ESPH) area of SD represent important additions to our understanding of Laramidian paleobiogeography during the late Maastrichtian. Although *Anzu* has also been recovered from MT, *Dakotaraptor* is, to date, known only from SD. Further, a recently-identified tooth of the ceratopsian *Leptoceratops* from the ESPH area may constitute the first record of this taxon from SD, and a partial ornithomimid skeleton from the uppermost FHF exhibits proportional differences with material of known latest Cretaceous ornithomimid taxa. Continued analysis of the latter specimen will determine its lower-level affinities and potential paleobiogeographic significance. The preservation and occurrence of these delicate specimens may suggest burial in low-energy paleoenvironments, as opposed to the higher-energy channel deposition that is more typically seen in HCF and Lance outcrops in MT and WY, and may also reflect paleoenvironmental variation associated with increasing proximity to the WIS.

Moreover, HCF deposits on the Standing Rock Reservation and elsewhere in SD have produced several monodominant *Edmontosaurus* bonebeds, each of which preserves hundreds of elements from multiple individuals. This represents a greater frequency of this type of bonebed than is observed elsewhere in the HCF. Collectively, these finds, in tandem with other work currently underway, indicate that the late Maastrichtian paleoecology of Laramidian regions proximal to the regressing WIS may have differed substantially from that of more inland environments. Consequently, SD fossils promise to contribute key data to our understanding of the continental vertebrate paleobiogeography and paleoecology of western North America at the end of the Mesozoic.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

DISSECTING THE EVOLUTIONARY HISTORY OF ELEPHANTS

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Two lineages of proboscideans are alive today: African elephants (Loxodonta sp.) and Asian elephants (Elephas maximus). Their closest relatives, woolly mammoths (Mammuthus primigenius) and mastodons (Mammut americanum) are extinct, and therefore previous phylogenetic analysis of all these taxa have typically used available fossil morphology to assess relationships.

To provide new evidence for alternative phylogenetic hypotheses in proboscideans, we used ancient DNA from fossil samples of these extinct taxa in combination with high coverage genomes of 2 forest elephants, 2 savannah elephants, and 2 asian elephants. We have assembled or newly generated high coverage genomes on several ancient samples including 1 straight-tusked elephant and 3 mammoths, as well as lower coverage genomes of 2 mastodons.

The higher coverage data allows us to refine proboscidean evolutionary history. We confirm that the Asian elephant and mammoth form a clade to the exclusion of savannah and forest elephants, and allow admixture between different lineages to be explored, using asymmetries in trees in 4-population test sets, using the Patterson D-statistic approach. Given a fixed phylogeny, a D-statistic would be expected to be zero in the absence of admixture but in fact we observe multiple admixture events across elephantid taxa, such as between woolly and Columbian mammoths, and between forest and straight-tusked elephants.

To further explore these admixtures, we study the spatial distribution of genome segments with evidence for introgression across species, providing insights about how these species evolved.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE RIDDLE OF THE UPSIDE-DOWN ANKYLOSAURS

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Although North American ankylosaurs are purported to typically occur upside-down, and despite a variety of hypotheses that seek to explain this phenomenon, no study to date has tested any of these postulates. To remedy this, we compiled a database of 37 ankylosaur occurrences from Alberta, using field notes, photographs, and erosion indicators to determine the orientation of the fossils (particularly the transportation-resistant skulls, pelves, and tail clubs) in situ. Of these, 26 occurrences (70.3%) were upside-down, which is significantly different from even (χ^2=6.081, df = 1, p = 0.021).

Upside-down ankylosaur occurrences are unlikely to be due to carnivore activity, whereby the carcass is overturned by carnivores prior to being consumed, because tooth marks occur on only one of the overturned specimens. Similarly, it is doubtful that the ankylosaurs were overturned by bloating of the carcass on dry land, as is purported to occur in armadillo roadkills, because Asian ankylosaurs preserved in aeolian deposits are

always recovered upright. This analogy is further falsified by our original field observations that roadkilled armadillos do not occur upside-down more often than not (n = 174, $X^2 = 4.79$, df = 2, $p = 0.091$), whereas ankylosaurs do.
We maintain that upside-down ankylosaur occurrences result from bloat-and-float, whereby the bloated carcass overturns in water prior to final deposition. This hypothesis is supported by computer models demonstrating that the centers of buoyancy (CB) and mass (CM) are nearly coincident in a freely floating model of the Early Cretaceous nodosaurid *Sauropelta* with its armour removed. The dorsal armour represents between 5% and 10% of total body mass. Returning this mass onto the model displaces the center of mass dorsally, resulting in an unstable situation of having the CB below the CM. Including a ventral body region distended by gases of decay results in an even greater separation between the CM and CB, increasing the probability of carcass inversion. This finding may have some bearing on the preservation of glyptodonts, which are also frequently said to occur upside-down.

Technical Session II (Wednesday, August 23, 2017, 9:45 AM)

PETTY TRIBALISM UNMASKED: OVEREMPHASIS ON DERMATOCRANIAL DATA IN PACHYCORMIDAE LEADS TO SKEWED INTRAFAMILIAL PATTERNS

MALTESE, Anthony, Rocky Mountain Dinosaur Resource Center, Woodland Park, CO, United States of America; LISTON, Jeff, Bayerische Staatssammlung für Paläontologie und Geologie, München, Germany

Pachycormids occupy a key position within Actinopterygii, as part of the Holostei-Teleostei Transition, although their precise position in this hierarchy has been disputed for some years. In general, the larger the adult size of a pachycormid taxon, the more reduced the amount of its skeleton that ossifies. An exception is that the skull and pectoral girdle maintain a higher degree of ossification relative to the rest of the body. Reduction in preservation potential for the axial skeleton means that, although known for well over a century, large pachycormids are primarily represented by incomplete, fragmentary, disarticulated and distorted remains. In addition, collecting bias resulted in an overrepresentation of cranial material in museums. In a group with such reduced skeletal ossification, it is hard not to base phylogenetic assumptions on the limited skull material present. Pachycormids show a remarkable conservatism in their dermatocranial anatomy, and while the few differences are useful for showing the separation of genera, they are of little utility in working out broader intrafamilial relationships. Although challenging to code compared with dermatocranial characteristics, the inclusion of several postcranial features in the pectoral and pelvic fins, supplemented by splanchnocranial characters from the gill basket, produces a much clearer picture questioning the traditional perception of a single carnivore lineage. *Protosphyraena* emerges as secondarily carnivorous from the suspension-feeding tribe of pachycormids (SFPs), reflecting 130 years of misidentification of North American *Bonnerichthys* specimens as *Protosphyraena*. The combination of a paucity of postcranial characters in the Late Cretaceous pursuit predator *Protosphyraena* and poor knowledge about the skulls of SFPs had led to the interpretation of the absence of Early Cretaceous pachycormid predators as indicating that a ghost lineage linked *Protosphyraena* with the European Upper Jurassic taxa *Orthocormus* and *Hypsocormus* over the near 50 million year gap. Unexpectedly, new data from the only virtually complete (including scales) specimen of *Protosphyraena* suggests that it possesses more characters in common with SFPs than with its Jurassic predator cousins, despite the superficially similar fanged or tusked appearance. Confirmation of this will rely on the further recovery of data concerning the skull morphology of SFPs. This new data on a well-established historical taxon reveals surprising complexities of this remarkable group of animals.

Technical Session VI (Thursday, August 24, 2017, 8:15 AM)

A NEW MICROSAUR (LEPOSPONDYLI: TETRAPODA) FROM THE CARBONIFEROUS FRANCIS CREEK SHALE, MAZON CREEK, ILLINOIS, AND IMPLICATIONS FOR AN ECOLOGICALLY DIVERSE MICROSAURIAN FAUNA

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The Carboniferous record of the Lepospondyli is scant, with specimens popping up sporadically at different localities and in lower abundance than at Early-Middle Permian-aged localities, such as the Dolese Brothers Quarry, Oklahoma, or the redbeds of Texas and Oklahoma. The Pennsylvanian-aged (309-307 Ma) Mazon Creek site produces some of the earliest tetrapod fossils of major Paleozoic lineages, including members of the paraphyletic 'Microsauria'. Previously, the Mazon Creek microsaurs were known from only a single uniquely preserved specimen, FMNH PR 981. However, the lack of key anatomical structures, such as the skull, precluded a confident taxonomic assignment, and thus an affinity to the microsaur *Hyloplesion* was only suggested. Recently, several new tetrapod specimens from Mazon Creek have come to light, of which some indicate microsaurian affinity. Here we describe a new short-bodied microsaur (FMNH PR 847), utilizing both Parsimony and Bayesian phylogenetic methods. The new taxon is diagnosed by the following autapomorphies: 16 presacral vertebrae; small monocuspid needle-like teeth; a large hour-glass shaped supraoccipital; and a markedly shortened tail. Phylogenetic analysis was performed in the programs PAUP and MrBayes, where the new specimen is recovered as the sister taxon to the clade including *Carrolla* and *Batropetes*. Six characters unite the new specimen with these taxa, including a triangular shaped skull that is wider than long. This new taxon helps shed light on early microsaurian diversity at the Mazon Creek site and, in a larger context, of the early evolution of the group during the Carboniferous. For example, in contrast to the likely semi-aquatic microsaur previously known, this new short bodied taxon is interpreted as fully terrestrial. We have also identified a third, small form with potential microsaurian affinities (FMNH PR 1039, FMNH PR 1031) that exhibits an elongated body suggestive of a fossorial habit. Taken together, these new data indicate the Mazon Creek microsaur fauna is taxonomically more diverse than previously thought, and it displays a wider range of bauplans indicating a Pennsylvanian-aged ecological diversity that rivals that thought to characterize later Permian-aged ecosystems. Compared with other tetrapod lineages microsaurian ecospace occupation through time shows an early increase in niche exploitation, including some of the earliest examples of fossoriality.
Grant Information:
NSERC Discovery Grant awarded to Hillary C. Maddin

Technical Session X (Friday, August 25, 2017, 10:15 AM)

THE QUALITY OF THE 230 MILLION YEAR FOSSIL RECORD OF TERRESTRIAL CROCODYLOMORPHS AND ITS IMPACT ON DIVERSITY

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The 24 species of living crocodylians (alligators, caimans, crocodiles and gavials) are the remnants of a once much more diverse clade. Crocodylomorpha has an approximately 230 million year (myr) history that was punctuated by a series of radiations and extinctions that appear to be closely tied to fluctuations in temperature and aridity, at least in the terrestrial realm. Whereas previous studies have examined the impacts of sampling biases on crocodylomorph taxonomic and morphological diversity, the completeness of the fossil specimens themselves provides additional information that is not captured in those approaches. Studies have examined fossil specimen completeness for Paleozoic and Mesozoic tetrapods, but this approach has not been applied in the Cenozoic, and thus never for an extant group's entire evolutionary history. We have compiled a dataset of all taxonomically diagnosable, non-marine species (403) of Crocodylomorpha, throughout their 230 myr history, including fossil occurrences of extant taxa. Based on the number of phylogenetic characters (484) that can be scored for all known fossils of each species (with 80% of these characters pertaining to the skull and mandibles), we have calculated a completeness value for each taxon. Just 6 valid species are known only from postcrania, whereas 48% of species are represented solely by cranial remains. Average species completeness is 55%, and this value is largely consistent (50–60%) within subgroups (e.g. Crocodylia, Notosuchia, non-neosuchians) and for different body size classes, suggesting no significant biases across the crocodylomorph tree. In general, average completeness values are higher in the Mesozoic (60%) than the Cenozoic (50%). Within the Mesozoic, average completeness is much higher in Jurassic taxa (73%) compared to those in the Cretaceous (55%), with a marked decline across the Jurassic/Cretaceous boundary. Completeness also decreases across the Cretaceous/Paleogene boundary, which might explain why an uncorrected census of taxonomic diversity shows a crash at this mass extinction, whereas a sampling standardisation approach reveals little change in overall standing diversity. There is no evidence for a Pull of the Recent effect, with low average completeness during the last ~10 myr (45%), and many extant taxa known from very incomplete fossil remains. A positive correlation between uncorrected taxonomic diversity and specimen completeness suggests that the latter negatively impacts our ability to identify crocodylomorph species in the fossil record.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

POSSIBLE DIPHYODONTY AS EVIDENCE OF MAMMALNESS FOR HARAMIYIDANS

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Haramiyidans are an extinct group of mammaliaforms and their phylogenetic positions with multituberculates and other mammals have remained contentious. In most recent phylogenetic analyses, haramiyidans were clustered with multituberculates and placed within Mammalia, but some considered them as non-mammalian cynodonts. Haramiyidans show a mosaic pattern of dental morphology. For instance, they lack prismatic enamel that was thought to be a synapomorphy of mammals. On the other hand, they have reduced tooth numbers, such as having only two upper and lower molars, and a molar morphology permitting palinal move in chewing, which are similar to those of multituberculates. In addition to their possessing definitive mammalian middle ear, dentary-squamosal jaw joint, precise molar occlusion, and numerous other mammalian features, here we report evidence of tooth replacement in haramiyidans, another critical mammalian feature. In the lower and upper jaws of at least two species of euharamiyidans, we observed tooth germs by direct observation and by CT-scan imaging. The tooth germ in the lower jaw shows only the crown and is interpreted as the permanent i2. This tooth germ is positioned dorsal to the root of the erupted large incisor and has reddish pigmentation in the enamel, in contrast to the light color of the erupted incisor; these two features are similar to positional and pigmentation relationships of the deciduous and permanent incisors of multituberculates. The tooth germ in the upper jaw also has only the crown that bears two cusps. This tooth germ is located in the maxilla between the erupted upper incisor and the mesial premolar (P3) and is best interpreted as the I2 germ. Based on the tooth eruption condition in these two species and comparison with multituberculates and other euharamiyidan species, we interpret that those tooth germs would not replace the erupted deciduous incisors but were absorbed during ontogeny. Their presence in the jawbone, however, suggests presence of diphyodonty at least in the incisor loci of euharamiyidans. Diphyodonty is one of the key features of mammals that is potentially related to determinate skull growth, maintenance of continuity in tooth function, precise tooth occlusion that is correlated with the dentary-squamosal jaw joint, and even associated with evolution of lactation and parental care.
Grant Information:

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Technical Session IV (Wednesday, August 23, 2017, 1:45 PM)

PRIMATE CHEWING BIOMECHANICS: THE PERSPECTIVE OF THE DAMAGE IN FOODS

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Primates have diverse diets. Besides of frugivory, basic dietary strategies range from omnivory to pure folivory. The relationship between diet and morphology has been studied in primates over the last years by applying a wide array of techniques including morphometry and biomechanical analyses based on high resolution 3D models. Here we study the biomechanics of chewing using Finite Element Analysis (FEA) models on primate post canine dentitions. Instead of describing tooth morphology, we analyse the effect of morphology to chewed items when a bolus is processed. Subsequently we analyse the damage imposed. Photogrammetry acquired 3D models of corresponding upper and lower postcanine tooth rows from the four extant great ape species, *Pan troglodytes, Gorilla gorilla*, *Pongo pygmaeus* and *Homo sapiens*. Non-linear Static FEA were performed and contacts were defined between upper and lower teeth and the bolus as non-linear contacts with rough properties.

Different biomechanical results from FEA have been examined regarding the stress distribution after biting in the food bolus to assess the damage that each tooth morphology performs. *P. troglodytes* damages and stresses the bolus most. In general, *H. sapiens* causes larger damage than by *P. pygmaeus* and *G. gorilla*, respectively. We interpret these results as reflecting the performance of relatively sharper cusps in more pronounced occlusal reliefs to cope with foods, which can be soft brittle and/or tough. However, this morphology is matched with a diet that is rather low in abrasiveness for the species feeding on these items. This is consistent with the fact that stressing hard and abrasive objects with sharp cusps might heavily damage the tip of the cusp.

Grant Information:
Deutsche Forschungsgemeinschaft (DFG, German Research Foundation, KA 1525/9-2)

Podium Symposium (Wednesday, August 23, 2017, 11:45 AM)

LIMB EVOLUTION OF NORTH AMERICAN UNGULATES IN RESPONSE TO CENOZOIC ENVIRONMENTAL CHANGE

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The skeletal anatomy and proportions of ungulate limbs are demonstrably linked to their locomotor function and behavior. The limb morphology of living ungulates from open environments (e.g., grasslands) differs predictably from that of ungulate in closed environments (e.g., forests) in two major ways. First, the limb skeleton of cursorial, open-habitat ungulates is reduced via element fusion and loss. Second, the relative lengths of the major limb segments of cursorial ungulates characteristically differ from those of closed-habitat ungulates. The close link between limb morphology and limb function in different habitats allows to understand the evolutionary response of ungulates to changing environments throughout the Cenozoic.

The Cenozoic generally is characterized by a trend of increasing geographical extent of open habitats (e.g., grasslands) at the expense of closed habitats (e.g., forests). This environmental transformation placed similar selective pressures on the locomotor ecology and corresponding limb morphology of many mammalian taxa. Contrasting the rates and patterns of limb evolution among ungulates provides insight into the degree to which extrinsic environmental stimuli drive evolutionary change.

This study contrasts limb evolution in focal groups of Artiodactyla and Perissodactyla. Reduction and loss of limb skeletal elements are characterized using discrete characters. Changes in limb proportions within Equidae and Camelidae are quantified using linear lengths of the six major elements of the fore- and hind limb skeleton. We use a dated estimate of North American ungulate phylogeny to estimate evolutionary rates and patterns of these two data sets between 55 and 5 Ma, spanning the interval prior to and following the expansion of grass-dominated open environments in North America.

Both limb element reduction and loss, and limb proportions indicate that considerable evolution toward cursorial morphologies began at latest by the late Eocene, and that cursorial ungulates were well established prior to any evidence for the expansion of grass-dominated open environments. Moreover, ungulate clades that span this transition show similar timing of evolutionary dynamics, underscoring the influence of environmental change.

Grant Information**:**
This research was supported by the National Science Foundation (EAR-1252123)

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

REGIONALISATION OF THE AVIAN CERVICAL COLUMN: A LINK BETWEEN MORPHOLOGY AND ECOLOGY

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Birds have evolved powerful forelimbs that are used primarily in flapping flight. This has rendered these appendages less useful for environmental manipulation than in many of their dinosaurian antecedents. Reliance on the head and neck for feeding and environmental interaction places high selective pressure on cervical form-function, potentially explaining the diversity in neck morphology seen in birds. However, to-date there has no been systematic study of morphological diversity in the avian neck and its correlation with feeding habits. This study uses a combination of three-dimensional geometric morphometrics (GMM) and qualitative character coding to assess regionalisation within the cervical column of a wide variety of extant birds. These species represent a large diversity of feeding (carnivores, seed eaters) and functional (swimmers, flyers and terrestrial) ecology, cervical count (12-17) and body size. Results provide strong support for 5 cervical subregions (axis, anterior, middle, midposterior, posterior) in all species. The atlas subregion appears to show the strongest signal, with the axis (cervical 2) being clearly separate in all studied birds, possibly owing to its function into head stabilisation. Other subregions with a reasonably stable cervical count (anterior and posterior) also display a clear functional role. The remaining 2 regions (middle, midposterior) show much variability in cervical count between species (middle 2-6 cervicals, midposterior 1-4 cervicals). These results suggest that whilst the underlying *Hox* genetics may restrict avians to 5 cervical subregions, expansive variability in the middle and midposterior regions allow the cervical columns of birds to adapt to many different functional ecologies, and may be responsible for the large variety of neck morphologies observed in extant Aves.

Grant Information:
NERC ACCE DTP PhD studentship to the Institute of Ageing and Chronic Disease, University of Liverpool. CASE award from the Manchester Museum.

Romer Prize Session (Thursday, August 24, 2017, 9:00 AM)

VARIATION IN PTEROSAUR WING BONE GEOMETRY AND IMPLICATIONS FOR PTEROSAUR ECOLOGY

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Pterosaurs are the first vertebrates and largest animals to achieve powered flight. With 10-11 m wingspans, the largest species were nearly twice the size of the largest known birds. Pterosaurs have traditionally been portrayed as having extremely thin-walled wing bones, much thinner than birds. Thin-walled bones are assumed to lower mass, assisting large bodied forms in take-off and flight, yet there is a trade-off as thinner-walls are more likely to buckle or bend under load. Smaller, basal taxa are classified as 'thick'-walled, while more derived pterodactyloids are typically described as thinner-walled, suggesting a size constraint. These ideas persist in the literature, but lack a quantitative, phylogenetically-grounded study. Here I present the first cross-clade study of pterosaur wing bone geometry. I hypothesize that large-bodied pterosaurs maintain thin-walled bones regardless of phylogenetic affinity, and that a size constraint exists in pterosaur wing bone geometry, impacting their ecology. I studied over 100 pterosaur wing bones spanning pterosaur evolution, measuring the cortical thickness (*t*) and diaphyseal radius (*R*) of wing bones in order to characterize variation using *R/t* and *K*-values (inner to outer bone radius). Cross-sectional geometry was studied using second moment of area (*I*), providing an estimate of bending stiffness. Phylogenetic generalized linear models and calculating lambda estimated phylogenetic signal. Contrary to previous studies, wing bone cortical thickness does not carry a phylogenetic signal, and does not vary consistently between or within groups. Also differing from classical pterosaur ideology, *R/t* values from 1 to 8, similar to those seen in modern birds are common, with relatively few large-bodied pterodactyloids reaching extreme values upwards of 15. Incorporating size, which is phylogenetically correlated, reveals a phylogenetic signal in *K* and *R/t* values. Bending stiffness varies substantially with *I* from 30 to 17000 m^4, increasing with bone size. These data show that many pterosaurs, especially smaller-bodied forms, were optimized for impact strength, and to resist compression and buckling, typical of animals flying in forested areas or frequently taking-off and landing. Conversely, larger pterosaurs were optimized for mass reduction and bending resistance, essential for wings under high loads. These findings are consistent with other studies suggesting pterosaur body size is phylogenetically correlated, and show that large pterosaurs were approaching their size limit.

Grant Information:
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Technical Session XVIII (Saturday, August 26, 2017, 12:00 PM)

SYNRIFT SEDIMENTARY DEPOSITION AND VERTEBRATE FOSSIL ABUNDANCE: THE TETRAPOD RECORD FROM GREENLAND

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East Greenland preserves well-exposed sedimentary basins that, ever since the 18th Century, have been target of paleontological explorations, producing some of the most iconic specimens known in vertebrate paleontology. To-date, at least 28 different taxa of fossil tetrapods are known from Greenland, aged from the Late Devonian to the Cenozoic.

The oldest tetrapods from Greenland are five stegocephals from Late Devonian (~365 Mya) fluvial deposits of the Aina Dal and Britta Dal Fms of the Celsius Bjerg Group, including the genera *Acanthostega*, *Ichthyostega*, and *Ymeria*. Late Carboniferous (~315 Mya) floodplain sandstones of the Mesters Vig Fm preserve tetrapod tracks of the morphotype *Limnopus*.

Aquiloniferus, *Selenocara*, *Stoschiosaurus*, and *Tupilakosaurus* are the four temnospondyl amphibians from the Early Triassic (~250 Mya) shallow marine deposits of the Wordie Creek Fm. The Late Triassic (~210 Mya) lacustrine deposits of the Fleming Fjord Fm of the Jameson Land Basin record the largest diversity of fossil tetrapods from Greenland: amphibians are represented by the capitosaurid *Cyclotosaurus* and the plagiosaurid *Gerrothorax*; reptiles comprise at least three specimens of testudines, the stagonolepids *Aetosaurus* and *Paratypothorax*, at least four specimens of phytosaurs, the eudimorphodontid *Arcticodactylus*, and sauropodomorph and theropod dinosaurs; therapsids are present with the cynodontid *Mitredon*, and mammals with *Haramiyavia* and *Kuehneotherium*. Tracks are also reported, as the crocodilomorph *Brachychirotherium* and the theropodian *Grallator*. Marine reptiles are the main findings from offshore shelf deposits of the Late Jurassic (~200 Mya) Kap Leslie Fm, namely indeterminate remains of Cryptoclididae plesiosaurs and Eoichthyosauria ichthyosaurs. The only Cenozoic fossil tetrapod known from Greenland is the Great auk *Pinguinus impennis*, extinct at mid-19th Century.

All Paleozoic and Mesozoic fossil tetrapods from Greenland have been found in outcrops on the East Coast, which is snow free during the summer months and available for expeditions. The two most fossiliferous periods are the Late Devonian and the Late Triassic, both in terms of richness and diversity of the tetrapodian fauna. During these two epochs, East Greenland was characterized by extensional crustal movements, followed by rapid synrift sedimentary fillings of the deposition of terrestrial deposits at low paleolatitudes: the Middle to Late Devonian Caledonian crustal welt and the Triassic phases of rifting due to the initial breakup of the Pangaea.
Grant Information:
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Technical Session X (Friday, August 25, 2017, 11:30 AM)

THE OLDEST CROCODYLIA? A NEW EUSUCHIAN FROM THE LATE CRETACEOUS (CENOMANIAN) OF PORTUGAL

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Eusuchia is well-known since the Early Cretaceous (Barremian), being *Hylaeochampsa* from England the oldest representative of this clade. Nevertheless, the eusuchian record from the Barremian to the Santonian is very scarce and fragmentary worldwide. The diversity of Eusuchia increases notably during the Campanian - Maastrichtian with the radiation of Hylaeochampsidae and the first appearance of Allodaposuchidae and Gavialoidea in Europe, or the oldest record of Crocodylia with representatives of Alligatoroidea, Crocodyloidea, Borealosuchidae and Gavialoidea in North America.

Here we described a new eusuchian crocodylomorph based in a partial skull and jaw (ML1818) from the early upper Cenomanian of Baixo Mondego, west central Portugal (Tentúgal Fm.). The specimen presents a series of exclusive characters not seen in other taxa. The most important characters are the presence of a small-sized external mandibular fenestra between the dentary-angular suture, without surangular participation; massive postorbital bar with a very marked mediolateral compression being twice as wide anteroposteriorly as mediolaterally; and dorsal margin of the infratemporal fenestra very elongated with trapezoidal contour rather than triangular.

The resulting cladistic analysis place this specimen nested at the base of Crocodylia in a more derived position than Gavialoidea and as the sister taxon of the rest of Crocodylia. Another change in the Eusuchia phylogeny after the incorporation of this new taxon is the position of Allodaposuchidae within Crocodylia, a clade generally considered as basal eusuchians.

Therefore, this Portuguese specimen would represents the only well documented and valid eusuchian species in the Cenomanian of Europe and probably the oldest representative of Crocodylia worldwide, helping to fill a gap of Eusuchia and Crocodylia record from the Barremian to the Campanian. In addition, the discovery of this new taxon would shed light on the radiation of Eusuchia and the origin of Crocodylia, which probably would have taken place in Europe. Nevertheless, due to the fragmentary nature of these remains, although the position within Eusuchia is undoubtedly (choanae clearly enclosed by the pterygoids), the phylogenetic position of this specimen within Crocodylia is not very well supported. Hence, the recovery of new remains would help to confirm or discard this hypothesis.

Romer Prize Session (Thursday, August 24, 2017, 10:30 AM)

QUANTITATIVE ANALYSIS OF AQUATIC ADAPTATION IN DESMOSTYLIA (MAMMALIA: ?AFROTHERIA) BASED ON CRANIAL CHARACTERISTICS

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Desmostylia is a clade of extinct aquatic mammals with no close living relative. Numerous desmostylian fossils are known from the uppermost Eocene to Miocene marine strata in the North Pacific Rim. However, their paleoecology is still debated, mainly due to unique, highly-specialized postcranial skeletal morphology. In particular, inferences on the habitat and aquatic adaptation of desmostylians greatly vary, depicting them as mostly terrestrial forms, semiaquatic animals restricted to shallow water, or even active swimmers invading the pelagic area, dependent on sources of data (e.g., postcranial osteology or bone histology).

One key for clarifying aquatic adaptation of desmostylians is the cranial and brain morphology, especially characters related to the olfaction and vision, because these characters have been considered as modified in aquatic mammals. However, there have been few studies that analyzed the correlations between such characters and the degrees of aquatic adaptation quantitatively in extant mammals, a prerequisite for inferring aquatic adaptation in fossil taxa.

To rectify the problem, I analyzed cranial and brain endocast characters quantitatively in 97 species of extant mammals covering all major clades based on digital 3D reconstructions using CT scan data, with a particular focus on the sizes of the olfactory bulb, orbit and optic canal, all of which past qualitative observations indicated as having been modified through aquatic adaptation. The result showed that the sizes of the olfactory bulb and optic canal are significantly different among animals of different degrees of aquatic adaptation and become smaller in more extensively aquatic taxa, thus establishing these characters as quantitative indices for making an inference on paleoecology of fossil taxa. The orbital size, however, did not show a clear difference corresponding to different degrees of aquatic adaptation.

Based on the above analysis, an inference was made on the paleoecology of *Paleoparadoxia* using a CT data set of the skull. The relative size of the olfactory bulb of *Paleoparadoxia* was intermediate between the median values of extant aquatic and semiaquatic mammals whereas its optic canal size was close to the median of aquatic and full-aquatic species. These data suggest that *Paleoparadoxia* was likely a semiaquatic species, with its habitat limited to shallow marine realms. Such a habitat preference may explain extinction of Desmostylia at around 10 Ma when the sea-level dropped rapidly, leading to great reduction in the shallow marine area.

Grant Information:
JSPS 16J00546

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW PARAPITHECINE (PRIMATES: ANTHROPOIDEA) FROM THE EARLY OLIGOCENE OF CENTRAL LIBYA

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Parapithecines are an extinct subfamily of stem anthropoid primates known only from the Jebel Qatrani Formation in Egypt. Currently, parapithecines are represented by two monotypic genera: *Parapithecus fraasi* and *Simonsius grangeri*. The generic distinction between these taxa has been questioned in the past, but recent analyses have maintained the validity of both genera on the basis of differences in their lower dental formula and cheek tooth morphology. Here, we report the discovery of a new, relatively small-bodied parapithecine taxon from Zallah Oasis in the Sirt Basin of central Libya. This new taxon documents the first occurrence of parapithecines outside of Egypt. It is currently represented by a right M_3 and a left P_4, both of which show affinities with *Simonsius* and *Parapithecus*. P_4 in the new taxon possesses a buccally and mesially inflated trigonid that is much larger than the reduced talonid, which bears no distinct cusps. This is in contrast to *Parapithecus*, which retains inflated, cuspidate hypoconids on P_{3-4} and shows less buccolingual inflation of the lower premolar trigonids. In these respects, the morphology of P_4 in the new Libyan parapithecine more closely resembles that of *Simonsius*, although P_4 of *Simonsius* bears an extremely reduced talonid. Relative size comparisons between P_4 and M_3 show that the new Libyan parapithecine resembles *Parapithecus* in having P_4 much smaller than M_3. In contrast, the distal premolars of *Simonsius* are hypertrophied so that P_4 is roughly equivalent in size to M_3. M_3 in the new Libyan parapithecine is low-crowned and bunodont, to the extent that the metaconid is the only obviously discernible cusp. As in all parapithecines, the paraconid is completely absent. The overall shape of M_3 seems to ally the new Libyan parapithecine with *Simonsius*, because both taxa possess buccolingually broad trigonids and narrow talonids that taper evenly into the hypoconulid lobe. A phylogenetic analysis based on dental characters reconstructs the new Libyan parapithecine as the sister group of *Simonsius*, with *Parapithecus* as sister to this clade. The new Libyan parapithecine augments previously reported evidence supporting a modest degree of faunal provincialism across northern Africa during the early Oligocene. The relatively small body size of the new Libyan parapithecine likewise supports the convergent acquisition of body mass larger than ~700 g among multiple clades of early Oligocene African anthropoids.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 10:15 AM)

RE-EVALUATION OF THE ONTOGENY AND REPRODUCTIVE BIOLOGY OF *SAURICHTHYS* (ACTINOPTERYGII)

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Viviparity has evolved independently at least 12 times in ray-finned fishes. However, it has been reported only in two non-teleost actinopterygians, *Saurichthys curionii* and *S. macrocephalus*, both from the Middle Triassic Meride Limestone (Monte San Giorgio, Switzerland). Recent work on gastrointestinal anatomy has raised the possibility that these reported 'embryos' are predated juveniles. We apply a combination of criteria to distinguish between embryos and gastric contents to draw new conclusions regarding life history and ontogeny in these fishes.

Our criteria are both preservational and positional. Small individuals preserved in the abdominal cavity of males (as indicated by the presence of an ossified gonopodium), incorporated into the gastric mass, positioned in the pharyngeal region, or chaotically oriented in the abdominal cavity were considered to be predated juveniles. Embryos show unusual preservation, never observed in unambiguous gastric contents, in that the notochord is preserved in three dimensions and phosphatized. This was used as one of the primary criteria in separating embryos from cannibalized juveniles in our study. As a rule, embryos were positioned with the skulls usually directed anteriorly, dorsal to the gastrointestinal tract, parallel to the axial skeleton and to each other, in the posterior 2/3 of the abdominal region.

After applying these criteria, of 6/18 adults with small individuals preserved in the abdominal region are unambiguously gravid. A minimum of 16 embryos are preserved in the most fecund females, and based on the largest preserved embryos and smallest preserved neonates, birth must have occurred at 7-12% of maternal fork length. Embryonic crania and teeth are relatively well-ossified. In the postcranium, the median scale rows and lepidotrichia are ossified, but not the lateral scale rows. Ossified squamation suggests that neonates of *S. curionii* did not undergo metamorphosis, and were relatively precocial.

Viviparity is associated with exploitation of pelagic habitats in fishes, and often with higher rates of speciation. A better understanding of early ontogeny in the oldest documented case of actinopterygian viviparity provides additional data to help in uncovering the underlying selective pressures driving the repeated evolution of this life-history strategy. Detailed information on embryonic size, position, and morphology will be of use in identifying fossilized embryos in other non-teleostean actinopterygians.

Technical Session XVII (Saturday, August 26, 2017, 9:15 AM)

HISPANIOLA-LA! UNDEREXPLORED INTRASPECIFIC VARIATION AND TAXONOMIC IMPLICATIONS FOR ISLAND SLOTHS (MAMMALIA: PILOSA: MEGALONYCHIDAE)

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The diversity of fossil sloths of the Greater Antilles (Cuba, Hispaniola, Puerto Rico) is restricted to the Family Megalonychidae, but includes five Pleistocene genera, of which four are found on multiple islands as different species. Intraspecific variation previously has been discussed for some taxa (*e.g.* Cuban *Megalocnus*) in terms of specimen size disparity believed to represent species- or subspecies-level diversity. The novel species and subspecies erected were later synonymized but with limited explanations such as possible sexual dimorphism or unassessed geographic differences. Hispaniolan fossil sloths (Dominican Republic, Haiti) are the most numerous of the Antillean forms found in museum collections, making them suited for studying the intraspecific variation of Caribbean sloths. Principal Components Analysis of limb elements reveals a pattern of separation in the sloth genera (*Acratocnus*, *Neocnus*, *Parocnus*) into long and short morphs, which extends into the paleogeographical divisions of Southern, Central, and Northern Hispaniola. In Haitian (Southern and west Central Hispaniola) specimens, these morphs are found together within the same locality and at multiple sites. *Acratocnus* and *Neocnus* from other islands also exhibit this pattern, and we interpret this to reflect sexual dimorphism given the shared temporal data in Haiti and the widespread geographic occurrences. Species of *Neocnus* exhibit the long-short dichotomy for *N. comes* but no differential sizes exist within *N. dousman* or *N. toupiti*. Variation of each species is very low but within ranges shown for other sloths when combined, and thus they may represent one species. *Neocnus* is commonly found across the Southern Hispaniola range and the western (Haiti) part of the Central, but is only found in one site on the eastern (Dominican) portion of Central Hispaniola. Occurrences of *Parocnus* are the reverse of those seen for *Neocnus*, but with some interesting size differences across the Hispaniola divisions that may be indicative of an increased taxonomic diversity beyond the single species of *P. serus*. Sloths belonging to *Acratocnus* are commonly found throughout the entire island, and often in conjunction with the other sloth genera, and exhibits a trend toward slightly larger Dominican specimens than Haitian. Radiometric dates have not yet been obtainable for Dominican specimens, and until then it is not possible to rule out temporal variation as accounting for some of the patterns as it applies to eastern Central Hispaniola.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW OCCURRENCE OF THE PHYTOSAUR (ARCHOSAURIFORMES, PHYTOSAURIA) *PRAVUSUCHUS HORTUS* FROM THE MONITOR BUTTE MEMBER (UPPER TRIASSIC; CHINLE FORMATION) OF UTAH

MCCORMACK, Larkin, Petrified Forest National Park, Holbrook, AZ, United States of America; PARKER, William, Petrified Forest National Park, Holbrook, AZ, United States of America

Phytosaur remains are some of the most common fossils present in the Late Triassic of the North American Southwest. Accordingly, they are often used as index taxa for Late Triassic biostratigraphy. However, most existing material is fragmentary, and there are few recent descriptions of associated cranial and postcranial remains. This makes assigning isolated elements to specific taxa or clades problematic, and further studies describing known well-preserved phytosaur material are needed. The Late Triassic Chinle Formation provides a unique opportunity to study these animals through 20 million years spanning the Carnian-Rhaetian ages. This evolutionary sequence expresses the transition in phytosaur taxa from non-pseudopalatine leptosuchomorphs to pseudopalatine leptosuchomorphs. A skull and associated postcrania from the Chinle of Utah is assigned to the taxon *Pravusuchus hortus*. Belonging to the non-pseudopalatine leptosuchomorph clade, it is sister taxon to the pseudopalatine phytosaurs. This assignment is supported by a unique combination of characters including possession of a subsidiary opisthotic process of the squamosal, a posterior process of the squamosal that is expanded medially and dorsoventrally, absence of an antorbital fossa, and supratemporal fenestra that are mostly visible in dorsal view, among other characters. The autapomorphy of the 'septomaxilla' forming the lateral portion of the nares cannot be seen in this material due to an iron oxide coating. To date, *Pravusuchus hortus* is known from only three specimens in the upper part of the Sonsela Member (Chinle Formation) of Petrified Forest National Park, Arizona. The new specimen is from the Monitor Butte Member at Fry Canyon, Utah, expanding the stratigraphic range of this taxon between about 223 Ma and 217 Ma. The material includes a mostly complete skull, missing only the anterior portion of the rostrum, and part of the palate, and includes a partial dentary. The postcrania are the first described for this taxon, and include partially articulated cervical and anterior dorsal vertebrae, femora, an ilium, cervical ribs, phalanges, and osteoderms. This individual bears immature ontogenetic indicators, as exhibited by open neurocentral sutures of the cervical and trunk vertebrae, and a significantly smaller overall size compared to other known specimens. This material extends the temporal and biogeographic range of this taxon, and provides key information on phytosaur osteology and ontogeny.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

OCCURRENCES OF SAUROPODA FROM CANADA

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The only record of Sauropoda in Canada is from their tracks. with the first find being made in 2000. A few isolated natural cast pes prints and one manus/pes set were discovered from the talus piles of an open pit coal mine in the Mist Mountain Formation (Tithonian-Berriasian) of southeastern British Columbia (present day latitude 49º 59'). Photographic evidence of a sauropod trackway from a nearby coal mine predated the initial report by several years and it exhibited a narrow-gauge trackway (c.f. *Brontopodus* isp). The same mine reported an incidence of three lengthy *Brontopodus* isp. trackways in 2008. A 10 m x 3 m latex mould (PRPRC 2008.08.001M) was made of six consecutive manus/pes prints, though manual impressions were often partially or wholly overprinted by the pes prints.

In 2013 a single natural cast of a relatively small sauropod pes (left) was recovered from the Minnes Group (Valanginian) within a stream bed on the slopes of Mount Reesor in northeastern British Columbia (present day latitude 55º). Additional *in situ* track surfaces have suspected sauropod tracks, but while these are large traces, they lack diagnostic features to enable a confident identification.

In 2016 two lengthy trackways were excavated from the Six Peaks Dinosaur Track Site within the Gaylard Member of the Gething Formation (Aptian) in the Carbon Creek Basin of northeaster British Columbia (present day latitude 55º 58'). Both trackways are wide-gauge (cf. *Parabrontopodus* isp.).

All of the above sauropod tracks occurrences in Canada were found in strata that have records of high diversity of vertebrate ichnotaxa.

These occurrences are the northernmost known for Sauropoda in North America and may be among the highest palaeolatitude occurrences in the world. None of these tracks were found in carbonate platform sediments typically associated with sauropod track occurrences that define the Brontopodus ichnofacies. Rather, these tracks are found in clastic sedimentary, coastal plains deposits occurring along the western shore of the Western Interior Seaway. Sauropoda had previously been thought to have been absent from Canada, but their track occurrences show that they had at least a 30 million year history in western Canada from the latest Jurassic until the late Early Cretaceous. Far from being absent in the geological record of Canada, Sauropoda were a significant part of the Early Cretaceous terrestrial fauna and were so for many millions of years.

Grant Information:
Jurassic Foundation, Dalglish Family Foundation, Conoco-Phillips Canada, BC Hydro.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ESCAPE BEHAVIOR IN LITOPTERNS (MERIDIUNGULATA; MAMMALIA) ACROSS THE GREAT AMERICAN BIOTIC INTERCHANGE

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Assessing the behavior of extinct organisms is challenging because direct evidence is so rarely preserved. Phylogenetic bracketing is of limited utility for attributes as evolutionarily plastic as behavior. Fortunately, some behaviors, such as those related to escaping predators, leave osteological traces. Large herbivores, such as litopterns, escape slower predators by outrunning them in a straight line and faster predators with evasive turns (swerving). The long bones of "swervers" encounter large transverse forces during turning, whereas in straight-line runners, the greatest forces lie within the anteroposterior plane.

Two different predator guilds preyed on litopterns over the course of their history. Prior to the Great American Biotic Interchange (GABI) (~7-3 Ma), the dominant South American predators were sparassodont marsupials and phorusrhacid birds. Large-bodied placental carnivorans reached South America late in GABI, quickly becoming the dominant predators.

Due to the scarcity of their fossils, the hunting behavior of pre-GABI predators is poorly understood, but it was likely very different than that of carnivoran predators. Such differences in hunting behavior would presumably be reflected in different prey escape strategies. Therefore, significant transitions in litoptern escape behavior across the GABI may suggest different hunting styles in these two predator guilds.

The escape behaviors of several macraucheniid and proterotheriid litopterns were assessed using the Indicator of Athletic Capability (IAC), a widely used metric to calculate long bone strength in a specific plane relative to body mass. The transverse/anteroposterior ratio of IAC is a proxy for swerving ability. The IAC values of litopterns were compared to a dataset of modern ungulates with known escape behaviors, potentially shedding light on litoptern escape behavior.

The IAC ratio in litoptern limbs follows no clear trend through time, with contemporaneous taxa exhibiting widely varying values. Low IAC ratios in some proterotheriids suggest straight-line running, as in modern horses to which they are often compared. Whereas the Pleistocene *Macrauchenia* appears specialized for swerving, other post-GABI macraucheniids more resemble modern straight-line running ungulates. Many pre-GABI macraucheniids appear specialized for straight-line running, but others appear to have utilized both behaviors. These data do not argue for significant differences in the hunting styles of the pre- and post-GABI predator guilds of South America.

Technical Session IX (Thursday, August 24, 2017, 4:00 PM)

MICROFAUNA OF NATURAL TRAP CAVE: TAPHONOMIC ANALYSES INDICATE A MIXED PREDATOR ASSEMBLAGE LIKELY RESULTING FROM *NEOTOMA* (WOODRAT) GATHERING

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Natural Trap Cave (Big Horn County, Wyoming) contains an abundant and diverse vertebrate microfossil assemblage (i.e., microfauna). Over 13,000 microfauna specimens have been collected, sorted, and identified since excavations commenced in 2014, and many more are still being processed. Radiocarbon dates coupled with fine-scaled stratigraphy indicate that we will have the resolution to distinguish major late Pleistocene and early Holocene events, including the transition from the Last Glacial Maximum to the current interglacial, end-Pleistocene extinctions, and the Holocene Climatic Optimum.

The goal of this study is to ensure that the taphonomic processes that led to the dense Natural Trap Cave microfauna concentrations were consistent through time, so a reliable comparison of microfauna communities can be made. We calculated breakage rates for 975 small mammal limb bones from the Holocene (6,000-2,000) of Natural Trap Cave. We found that 78% of femora, 80% of humeri, 76% of tibiae, and 86% of ulnae in the assemblage are broken. Using previously established discriminant analyses of breakage rates by different types of predators, we found that these breakage rates are intermediate between small mammal carnivores (41% posterior probability) and diurnal raptors (59%

posterior probability). This indicates that the primary source of specimens is likely a mixed predator assemblage. These findings are consistent with the hypothesis that microfauna concentration secondarily resulted from *Neotoma* (woodrat) gathering, which is not selective with regards to primary predator concentrations and strongly reflects overall microfauna community structure. Early analyses of late Pleistocene layers show similar breakage rates, indicating similar taphonomic modes of accumulation and compatibility for community-level comparisons through time.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

DIVERSITY DYNAMICS AND DIGIT REDUCTION IN FOSSIL HORSES

MCHORSE, Brianna, Harvard University, Cambridge, MA, United States of America; PIERCE, Stephanie E., Harvard University, Cambridge, MA, United States of America

Digit reduction, hypsodonty, and increasing body mass are classic evolutionary features of the horse lineage (family Equidae). These morphological changes are frequently explained as adaptations to the spread of grasslands over the course of the Miocene. At its peak in the mid-Miocene, the equid family contained approximately 20 genera, largely the result of a radiation of grazing species 15-18 million years ago. Yet by the late Pliocene, equid diversity had dropped to only three genera, and only *Equus* survived the Pleistocene. Often, this precipitous decline has been explained by the increased aridity and cooling throughout the North American Oligocene, which also ties to the spread of C4 grasses and potential competition with ruminant grazers.

Recent work has suggested that evolutionary changes in hypsodonty and body mass do not correlate with changes in lineage diversification rates, but the relationship of digit reduction to evolutionary rates remains untested. Using a birth-death model in the program PyRate, we estimated speciation and extinction rates across the equid lineage, including rate shifts. Our results support multiple rate shifts in the evolutionary history of horses, including a drop in speciation rate in the early Miocene after a steady climb and a sharp increase in extinction in the Pleistocene. The estimated times of speciation and extinction from this analysis are used to test whether diversification dynamics were influenced by changes in digit reduction, as measured by the Toe Reduction Index (TRI). Additionally, we expand previous analyses of hypsodonty and body mass by testing their relationship with diversity dynamics across the whole equid tree rather than only Neogene and Quaternary species. Our results provide insight into whether the sole survivorship of monodactyl horses was influenced by a relationship between digit state and lineage speciation and extinction dynamics.

Grant Information**:**
Supported by NSF DDIG #144564

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW DIPLODCID SKULL AND ASSOCIATED ANTERIOR CERVICAL VERTEBRAE FROM THE UPPER JURASSIC MYGATT-MOORE QUARRY (MORRISON FORMATION) IN RABBIT VALLEY, COLORADO

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In 2016, an intact diplodocid sauropod skull and an associated, articulated anterior cervical series were recovered from the grey mudstones of the Upper Jurassic Mygatt-Moore Quarry in Rabbit Valley, Colorado, and are described here. The cervical series is not in articulation with the skull, but the series and skull are in direct contact with each other. The right orbital and posterior maxillary regions of the skull are badly crushed by the cervical series. It is possible these associated remains represent a single individual, whose skull became dislodged from the neck and was crushed as the neck fell on the right orbital region or was pushed down onto that region after burial. Unfortunately, the mandibles were not found with the skull during excavations in 2016.

Located in the middle of the Brushy Basin Member of the Morrison Formation, the Mygatt-Moore Quarry has produced thousands of vertebrate fossils from over thirty years of excavation. The Mygatt-Moore Quarry represents an attritional assemblage with little to no transport of specimens. Sauropod remains in the Mygatt-Moore Quarry include the diplodocid *Apatosaurus*, which dominates the assemblage, the macronarian *Camarasaurus*, as well as ambiguous vertebral material identified as "Diplodocinae indet.". Vertebrae from the sauropod *Diplodocus* are found outside of the quarry within the Rabbit Valley area, but not within the quarry itself. Taxonomic identification of the collected specimens is based on morphology of the cervical series, as well as the presence of abundant cylindrical, peg-like teeth within the premaxillae and maxillae. Tooth morphology indicates the skull belongs to Diplodocoidea, and the anterior vertebral series associated with the skull, based on morphology of the neural spines and anterior morphology of the cervical ribs, is inconsistent with that known from *Diplodocus*, but is consistent with that of *Apatosaurus*. Though the mussel is narrower than previously reported skulls for the genus, this could indicate a degree of individual variation or the presence of a new genus at the quarry, the former being a more parsimonious argument. Additionally, the abundance of *Apatosaurus* postcranial material within the quarry layer, suggests this skull likely represents the fourth known intact *Apatosaurus* skull and is of substantial paleobiologic value.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

GEOMETRIC MORPHOMETRIC ANALYSIS OF THE PEDAL CLAW OF *CONFUCIUSORNIS SANCTUS* AND ITS IMPLICATIONS FOR CORRELATION TO ECOLOGICAL BEHAVIOR

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Confuciusornis sanctus is an Early Cretaceous bird from the Liaoning Province of northeastern China. Much work has been published on this species, but some details of its habitat and behavior remain unclear. Geometric morphometric analyses allow for the separation of specimens based on morphological variables, however each analysis must be assessed to determine which variables and sample groups are most informative. A geometric morphometric analysis of the ungual of the second pedal digit of *Confuciusornis sanctus* was performed to determine how its morphology compares to that of extant birds, which variables best distinguish between sample groups, and what type of group is most correlated with morphological differences. A total of 128 specimens was examined, comprising 104 extant bird species and *Confuciusornis sanctus*. Three fixed landmarks and 50 sliding semilandmarks were used to define shape. A principal component analysis gave two axes explaining over 73% of the variation in shape, with principal component one explaining 56%. Principal component one, which varies in the angle of claw curvature and the sharpness of the claw tip, represents a significant amount of variation among specimens. Principal component two, which varies in claw thickness, shows much less variation. This indicates that claw curvature and sharpness are correlated with differences in morphology between specimens, whereas claw thickness is not informative. Specimens grouped by taxonomic order show a large amount of overlap but when grouped by behavior much of the overlap disappears, indicating that the morphology of the second pedal claw in extant birds is closely correlated with ecological behavior and not evolutionary history. Additionally, variation in centroid size provides further separation of major behavioral groups. *Confuciusornis sanctus* is morphologically nearly identical to *Passer griseus* (northern grey-headed sparrow). Based on this, as well as reconstructions of the Jehol ecosystem as a heavily forested lacustrine environment, it is likely that *C. sanctus* spent most of its time foraging for seeds and invertebrates in densely wooded areas. The claw morphology of *Confuciusornis sanctus* is dissimilar to predatory birds, indicating that *C. sanctus* was unlikely to have been an active predator. However, whereas the robust, toothless beak of *C. sanctus* is suited to a granivorous diet, it is also a possible adaptation for an omnivorous diet. Therefore, *C. sanctus* may have been more of an opportunistic feeder, similar to modern crows.

Technical Session XVII (Saturday, August 26, 2017, 11:30 AM)

EVOLUTION OF NEOGENE KYRGYZ MAMMALIAN FAUNAS IN THE LIGHT OF TECTONIC AND CLIMATIC CHANGE

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The Kyrgyz Tien Shan are some of the most rapidly uplifting mountains, resulting in high seismic hazard and unique alpine ecosystems. These topographically complex mountains provided both a barrier to westward dispersal and an evolutionary nursery to the faunas trapped there. I aim to constrain the geochronology of new Neogene localities in Kyrgyzstan and reconstruct the paleoecology driving the deposition of mass death assemblages. Generic level biostratigraphy through comparison with the Chinese *Hipparion* faunas produces a more precise and accurate geochronology for the region when combined with the previously unconstrained magnetostratigraphy. The five bone bed strata fall between 10Ma and 6Ma, in the latest Miocene epoch. The death assemblages are also coeval with local to regional climate change in Central Asia. As the Himalayan, Pamir, and Tien Shan mountains rose, they achieved a height necessary to fundamentally change the formation and geographic extent of the Indian monsoon. Vodka Locality, a mass death assemblage in the Kyrgyz Shamsi Formation dated to 9-10Ma, is the oldest Kyrgyz Neogene site, and displays fauna and geologic indicators of semi-closed to closed habitat. The younger mass death assemblages, Bone Hill, Dam Site, and Rhino Party (7Ma), and Ortok (6Ma) in the Chu Formation, represent an opening of the habitat and continued uplift. This biotic and geologic shift observed in Kyrgyzstan is consistent with an 8Ma change in uplift and resulting climate in the Himalayas. Unlike previous workers, I interpret the boundary between the Shamsi and Chu formations as climatic rather than tectonic. This boundary reflects the rapid increase in elevation occurring in the latest Miocene as seen in the corresponding increase in body size in the Cervidae, Equidae, and Rhinocerotidae. The Kyrgyz faunas also have a high percentage of juveniles, over representation of ungulates, a mix of specimen and skeletal completeness, and dental wear consistent with drought-caused mortality events, all characteristic of modern African drought-killed mass death assemblages. Topographically driven climatic change drove faunal turnover and the emergence of new Central Asian faunas. These faunas became characteristic of the Tibetan Plateau high elevation faunas that dispersed to become broader Asian ice age ecosystems.

Grant Information**:**
2014-2015 Fulbright Student Research Grant, Kyrgyzstan
2014 SEPM Student Grant
2015 Paleontological Society Student Research Grant

Technical Session IX (Thursday, August 24, 2017, 2:00 PM)

ULTRASTRUCTURE AND CHEMISTRY OF INTEGUMENTARY STRUCTURES IN AN ORNITHISCHIAN DINOSAUR

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Research into the evolutionary origins of feathers has been stimulated over the last twenty years by discoveries of feather-like structures in non-avian theropod dinosaurs from the Middle Jurassic to Early Cretaceous. Despite such intensive research, many aspects of feather evolution remain poorly understood, including the nature and significance of filamentous integumentary structures and aberrant feather types. Previous studies of these tissues have lacked insights from tissue ultrastructure and chemistry. Here we report the preservation of diagnostic tissue structures and evidence of original biochemistry in diverse integumentary structures in the neornithischian dinosaur *Kulindadromeus zabaikalicu*, a basal neornithischian dinosaur from the Jurassic of Siberia. We analysed diverse integumentary structures, including scales, monofilaments, and compound feather-like structures, using scanning- and transmission electron microscopy, time-of-flight secondary ion mass spectrometry, and synchrotron X-ray absorption spectroscopy. The results reveal the widespread preservation of tissue ultrastructure, including keratinous tissue layers and melanosomes, in feathers and scales.

Different tissue types can be discriminated on the basis of the geometry and trace element and sulfur speciation chemistry of melanosomes. Our data provide a new mechanism to determine the nature of evolutionarily important tissue types in feathered dinosaurs and will help constrain scenarios for the evolution of feathers.
Grant Information:
European Research Council Starting Grant ERC-2014-StG-637691-ANICOLEVO awarded to MEM, Belgian Science Policy grant BL/36/62 to PG

Podium Symposium (Wednesday, August 23, 2017, 11:15 AM)

WHAT CAN THE SCAPHOLUNAR BONE TELL US ABOUT THE LOCOMOTION AND HABITAT OF EXTINCT CARNIVORES?
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The limb bones are the best way to examine both locomotor mode and habitat reconstruction in extinct animals and ecosystems, as they represent the interaction between an animal and its environment through locomotion. The goal of this study was to assess the locomotor modes of extinct Pleistocene carnivores using a carpal bone, the scapholunar. We chose the scapholunar because it is responsible for fore and aft motion of the manus at the wrist, and because carpals have been previously poorly studied. If ecometric utility can be established for carpal bones, they can be employed more frequently in locomotor and habitat reconstructions as they are small, compact, and fossilize well. In this study, we chose to examine carnivores from a single fossil locality, Natural Trap Cave (NTC), Wyoming. We chose a single fossil locality to not only assess locomotor mode of the extinct species, but also to reconstruct the habitat at NTC. Specific questions that we posed in this study were: Were species at NTC more cursorial than their modern counterparts and what can the wrist morphology of these extinct species tell us about the habitat at Natural Trap Cave during the late Pleistocene?
Extinct species examined included: the American lion (*Panthera atrox*), the American cheetah (*Miracinonyx trumani*), and the Beringian wolf (*Canis lupus spp*.); and modern proxies used were: gray wolves (*Canis lupus*), lions (*Panthera leo*), cheetahs (*Acinonyx jubatus*), pumas (*Puma concolor*), and the spotted hyena (*Crocuta crocuta*). Since the scapholunar bone has a complex morphology not easily captured by linear measurements, we used 3D models of this bone generated by a NextEngine laser scanner to obtain surface area, and completed angular measurements in GeoMagic, and Rhino, and analyses in R.
We found that overall, the species from NTC grouped toward the cursorial end of the morphospace relative to their modern counterparts. This suggests that the Pleistocene habitat at NTC was open and arid. We also found that the scapholunar bone is a useful predictor of locomotor mode and habitat.
Grant Information:
This project was funded by NSF EAR SGP grant #1425059

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A NEW PLEURASPIDOTHERIID MAMMAL FROM THE LATEST PALEOCENE OF FRANCE AND ITS PHYLOGENETIC IMPLICATIONS
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Pleuraspidotheriids are an extinct group of archaic ungulate mammals whose evolutionary history and systematics remain poorly resolved. They are common element of late Paleocene Cernaysian faunas from Western Europe but they are absent in the earliest Eocene faunas. However, they survived in Anatolia where they underwent a relative taxonomic diversification during the middle Eocene, probably in an endemic context.
Here we examine a new pleuraspidotheriid from the latest Paleocene locality of Rivecourt Petit-Pâtis in the Paris Basin which documents a so far unknown time interval in Europe and obviously equivalent to the Clarkforkian Land Mammal Age in North America. Therefore, this new taxon plugs the latest Paleocene gap in the fossil record of the family which probably went extinct in Western Europe during the Paleocene-Eocene transition. This new genus and species displays an unexpectedly derived dental morphology including the loss of paraconule and the expanded metacobule on the upper molars, as well as the enlarged hypoconulid of the lower m3, which set it apart from the other pleuraspidotherids, including those known from the middle Eocene of Turkey.
The origin and phylogenetic relationships of pleuraspidotheriids remains obscure, mostly because of the lack of appropriate fossil data regarding the family prior to the late Paleocene. A phylogenetic analysis of pleuraspidotheriids based on dental and postcranial characters that incorporates the new genus species from Rivecourt reveals a complex, two phased diversification of the family during the Paleogene. Finally, we ran a larger phylogenetic analysis to test the position of pleuraspidotherids among condylarths.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

PRELIMINARY APPROACH TOWARD DETERMINING TROPHIC RELATIONSHIPS AMONG ACTINOPTERYGIAN CLADES FROM THE WESTERN INTERIOR SEAWAY
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Actinopterygians underwent a great diversification during the Late Mesozoic, and were abundant throughout the Western Interior Seaway (WIS). However, little work has been done to determine the differences in niche occupation among actinopterygians from the WIS. This project focuses on determining a method that uses trophic relationships among genera to begin creating a basis for determining niche occupations among actinopterygian clades found in the WIS Niobrara Formation.
The ability to procure food relates strongly with both the amount of force that the jaws can open and close, and the velocity at which they do so. Twelve specimens representing nine genera were analyzed to determine opening and closing lever ratios in the lower jaws: *Protosphraena, Pachyrhizodus, Pycnodont, Saurodon, Apsopelix, Xiphactinus, Icthyodectes, Enchodus,* and *Bananogmius*. Lever ratios were then used to evaluate the relationship between the force the jaws could exert on their prey to the velocity at which they could close their jaws. An inverse relationship between the force and velocity ratio in the jaws was expressed for all specimens, with *Protosphraena* having an unusually high force value compared to the velocity outcome. This may have been due to an error while measuring, or to the possibility that the measurements were skewed due to taphonomic deformations.
A functional morphospace was also created by plotting the relative jaw length ratios against jaw closing lever ratios to determine the ecologic niches occupied by six genera: *Icthyodectes, Xiphactinus, Enchodus, Pachyrhizodus, Apsopelix,* and *Pycnodont*. The jaw calculations made it possible to determine prey items each specimen could capture, and specific feeding niches for each genus.
Comparing jaw closing lever ratios with the relative jaw lengths of the six specimens, two genera, *Pycnodont* and *Icthyodectes,* had jaw length ratios less than 0.08. Previous studies have shown fish with this size jaw length ratio belonged to a herbivorous niche. However, because of the elongated bodies of *Icthyodectes* and *Xiphactinus*, they both plotted in a lower region of morphospace than expected. This indicates that jaw lever ratios alone are not sufficient to determine the trophic relationships for actinopterygians from the WIS.
Currently, additional taxa are being added to the analysis. Also, more morphological traits such as orbit diameter, tooth size and shape, and fin structures are being explored to further explore the best method to determine the trophic relationships among actinopterygian clades from the WIS.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

DESCRIPTION OF A NEW LOWER ACTINOPTERYGIAN TAXON FROM THE LATE MISSISSIPPIAN BLUEFIELD FORMATION OF WEST VIRGINIA, U. S. A.
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The Late Mississippian (Chesterian) Bluefield Formation of the Mauch Chunk Group in West Virginia is known for the preservation of a variety of invertebrate taxa and early tetrapod trackways, but no lower actinopterygian remains have been described from these Carboniferous rocks. Here, the first lower actinopterygian fish is described from the Bluefield Formation of southeastern West Virginia. This fish is represented by a nearly complete articulated specimen with a three-dimensional snout and a clear view of the gular and branchiostegal region. This new taxon is defined by a unique set of characters, which include features of the snout, circumorbital series, cheek, and operculo-gular region, as well as the ganoine ornamentation on dermal bones and scales. These features make this fish different and distinct from previously described Carboniferous fishes. Some of the morphological features of note include the presence of a distinct antorbital bone, a narrow infraorbital ventral to the orbit, and a large crescent shaped infraorbital that contacts a single dermosphenotic. There is a hatchet shaped preoperculum that is anteriorly inclined with a preopercular angle of 31°. Six small suborbital bones are present anterior to the expanded region of the preoperculum, effectively filling the space between the preoperculum, dermosphenotic, and infraorbital. Posterior to the preoperculum, there is a single wedge shaped dermohyal and a series of three rectangular accessory opercular bones. The accessory opercular bones extend halfway down the anterior border of the rectangular operculum. The operculum is taller than the suboperculum, but the suboperculum is the wider of the two bones. The maxilla has a high posterior plate, a rounded posteroventral angle, and a long narrow anterior arm that extends to the anteroventral margin of the orbit. A median gular, lateral gulars and eight branchiostegal rays are present. The heterocercal caudal fin is deeply cleft and inequilobate. The scales have pectinated posterior margins and bear diagonal ridges of ganoine. The description of this new taxon represents the first actinopterygian and the first vertebrate body fossil described from the Bluefield Formation of West Virginia.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TOWARDS RESOLVING THE MORPHOLOGY AND TAXONOMY OF *PARAPITHECUS FRAASI* (PARAPITHECIDAE, ANTHROPOIDEA) FROM THE FAYUM DEPRESSION, EGYPT
MILLER, Ellen R., Wake Forest University, Winston Salem, NC, United States of America; GUNNELL, Gregg F., Duke University, Durham, NC, United States of America; SALLAM, Hesham, Mansoura University, Mansoura, Egypt; HABERSETZER, Jörg, Senckenberg Forschungsinsitut, Frankfurt, Germany; SEIFFERT, Erik, University of Southern California, Los Angeles, CA, United States of America
Parapithecidae is an archaic family of anthropoid primates, comprised of seven species in four genera: *Abuqatrania*, *Qatrania*, *Apidium*, and *Parapithecus*. The two known species of *Parapithecus* (*P. fraasi*, *P. grangeri*) both exhibit unexpected specializations of the anterior dentition, such that the nature of the taxonomic relationship between these two species, and between these species and other parapithecids, has been controversial. One confounding issue is that *P. fraasi* is known only from the holotype mandible (SNM 12639a), and the specimen lacks provenience, having been collected from an uncertain locality in the Fayum. The type mandible is also unusual in having only one pair of lower incisors (?.1.3.3/1.1.3.3), and it has never been clear whether these are adult teeth, or whether they are retained deciduous elements. *Parapithecus grangeri* (Quarries I and M) is known from many more specimens, and this species clearly lacks adult lower incisors (2.1.3.3/0.1.3.3). It is possible that incisor reduction in *P. fraasi* foreshadows the complete loss of lower incisors in *P. grangeri*, and that reduced or absent incisors is a synapomorphy of the genus. However, it has also been suggested that the known morphology of *P. fraasi* falls within the range for *Apidium phiomense*, such that the two should be synonomized, and a separate genus, *Simonsius*, used for specimens of *P. grangeri*. It is also possible that the presence of only a single pair of incisors in *P. fraasi*, compared with the complete loss of incisors in *P. grangeri*, in itself warrants recognition of *Simonsius*.
To help resolve these morphological and taxonomic issues, we compared micro-CT scans of *P. fraasi*, *P. grangeri*, and *A. phiomense* and conducted a phylogenetic analysis Results document: 1) the presence of an incisal root in *P. fraasi* that extends deep into the

jaw, suggesting that, deciduous or not, it is part of the permanent dentition; 2) morphological differences beyond incisor loss clearly distinguish *P. fraasi* from *A. phiomense*; and 3) a Bayesian tip-dating analysis of living and extinct anthropoids yielded overwhelming support for monophyly of both *Parapithecus* and *Apidium*.
Grant Information:
NSF DBI 1458192 & DBI 1640311 to GFG

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

DEVELOPING GUIDELINES TO INCREASE DATA ACCESSIBILITY AND INTEROPERABILITY FOR VERTEBRATE FOSSILS

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From collection in the field, to preparation in a lab, to storage in a drawer or on a shelf, fossils are thoroughly documented and described throughout their post-discovery lives. As a result of this, we record a broad range of paleontological data including taxonomic, stratigraphic, preparation, historical, and collections based information. Ensuring the data are integrated, standardized, and preserved according to best practices is vitally important to promote data quality and long term use for scientific research. Additionally, as data mobilization efforts grow through portals such as the Global Biodiversity Information Facility (GBIF) or Integrated Digitized Biocollections (iDigBio), the accountability for fostering the data increases.

An essential element of this effort is establishing guidelines for collecting and documenting specimen information in an interoperable format. At the Smithsonian National Museum of Natural History Department of Paleobiology, we have developed a focused approach for evaluating data management practices while considering the growth of the greater global collections community. As part of this, we've looked at how data are structured, identified what data are required, determined what standards exist or are lacking and how Darwin Core does or does not reflect vertebrate data needs. For example, research often involves studying a particular anatomical element, but there can be a high degree of variability in how morphology is recorded and it is not currently a field reported to data portals. In this poster, we will give an overview of our new vertebrate fossil data standards and share our approach to reviewing data practices within and outside of our department. With more discussion, the paleontological community can implement best practices and standardization across organizations and collections information systems to promote data mobility and interoperability, improve data discovery, and increase data accessibility for researchers.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

NEW SOUTHWESTERN UTAH PALEONTOLOGICAL LOCALITY FROM THE LOWER JURASSIC KAYENTA FORMATION REVEALS A DIVERSE VERTEBRATE FAUNA BASED ON TEETH AND TRACKS

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With the exception of dinosaur tracks, vertebrate fossils are very rare in the Lower Jurassic Kayenta Formation of Utah, in contrast to the rich assemblages from the silty facies in northern Arizona. During construction of a new highway (Utah Route 7) near St. George, Washington County, Utah, an important paleontological locality (Ws538) was discovered in the middle portion of the silty facies of the Kayenta Formation during monitoring for such resources. Initial examination revealed a semionotid fish and abundant plant fossils, leading to a systematic excavation of the site that resulted in the collection of over 3000 specimens including ~100 vertebrate teeth. These teeth are assignable to semionotids and other unidentified actinopterygian fishes, and tetrapods such as crocodylomorphs, ornithischian dinosaurs, small and medium-sized theropod dinosaurs, and a possible pterosaur. The ornithischian teeth differ from all other known Kayenta Formation ornithischian taxa, however they do resemble those of *Laquintasaura venezuelae* from the Early Jurassic La Quinta Formation of Venezuela. A minimum of eight different tetrapod tooth morphotypes have been recognized so far, several of which are new for the Early Jurassic. Additional vertebrate remains include rare articulated actinopterygians and a variety of vertebrate traces such as *Undichna, Grallator, Anomoepus, Eubrontes, Characichnos,* a single *Moyenisauropus*-like track, and two distinct four-toed track morphotypes that likely represent new ichnotaxa. Other fossils include a variety of invertebrate burrows, ostracods, conchostracans, gastropods, bivalves, oncolites, stromatolites, and vascular plants (*Zamites, Otozamites, Clathropteris,* unidentified cycads, and conifers). The beds containing vertebrate body fossils comprise a playa lake environment that is overlain by fluvial deposits preserving all of the plant fossils and the majority of the vertebrate tracks. This diverse fossil assemblage allows for the first time a reconstruction of the Kayenta biota in southern Utah, and suggests a productive ecosystem that differs taxonomically from the better-known fossils from further south in Arizona.

Technical Session XV (Friday, August 25, 2017, 1:45 PM)

COMPARATIVE MORPHOLOGY OF THE TRIGEMINAL CANAL AND A SCENARIO FOR THE EVOLUTION OF FACIAL MUSCULATURE IN MAMMALS

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The morphology of the nerve canal hosting the maxillary and mandibular branches of the trigeminus (cranial nerve V) changes throughout the evolutionary history of the mammalian lineage. Based on microCT scan reconstructions of the trigeminal canal and its branching patterns, we propose that a concentration of tactile sensory ability at the rostral end of the snout preceded the appearance of specialized whiskers, or vibrissae, that are actively moved by facial muscles. This concentration of tactile sensory ability in the snout occurred as early in the mammalian lineage as *Varanosaurus* (Early Permian) and was further elaborated in more crown-ward taxa such as *Thrinaxodon* (Early Triassic), which show maxillary and mandibular trigeminal nerve canals with both substantial ramifications throughout and a "starburst" of foramina at the tip of the snout. This configuration transformed into the appearance of the infraorbital foramen for the exit of the maxillary branch of the trigeminus in crown mammals. In comparison, a modern reptilian outgroup (*Anolis* spp.) shows a trigeminal canal with small, regularly-spaced foramina along the length of the jaws. As a result of our comparative morphological study, and drawing upon insights from developmental research on model vertebrates, biomechanical properties of nerves, and various lines of evidence for the evolution of nocturnality, we submit a hypothesized scenario for the evolution of mammalian facial musculature and motility.

Technical Session II (Wednesday, August 23, 2017, 8:15 AM)

EVOLUTIONARY ORIGINS OF THE ENDOSKELETAL JOINT IN VERTEBRATES

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A diarthrosis is a functional prerequisite to the mineralized endoskeletons of vertebrates, but its evolutionary origin remains a puzzle. The elastic cartilaginous skeletons of cyclostomes have no proper diarthrosis. Neither do stem cyclostomes show any correlates of a joint in the areas of the chondrocranium that are highly elastic in living cyclostomes. The distribution of characters in stem gnathostomes suggests jaw and pectoral joints as the earliest diarthrosis consisting of a fibrous capsule and articular cartilages. While the morphology of pectoral joints varies markedly and non-parsimoniously from one lineage to another, the jaw joint is conservative and tractable through comparison of distantly related living vertebrate models.

We tested three structures in cyclostomes as potential homologues of the jaw joint: (1) muscular articulation in the lingual apparatus; (2) mucocartilage (fibrous cartilage-like structures in larval lampreys); and (3) an intercartilaginous blood sinus. Expression profiles of jaw- or general-joint marker genes (*Bapx*, *Barx*, *Gdf5/6/7*, *Prg4*, etc.) in the lamprey *Petromyzon marinus* reject (1) muscular articulations but cannot discriminate (2) mucocartilage and (3) blood sinus. The expression domains overlap significantly in the anlagen for (2) and (3), but are not specific or exclusive to either anlage. CRISPR/Cas9-mediated partial knockouts of *Bapx* and *Barx* in lampreys resulted in equivocal phenotypes (CRISPR: Clustered Regularly Interspaced Short Palindromic Repeats).

Thus, we considered two scenarios at the origin of the jaw: (a) mucocartilage or blood sinus acquired expression of the transcription factors (*Bapx*, *Barx*) to specify the presumptive jaw joint; or (b) the transcription factors acquired functions to target effector genes such as *Col2a* to modify mucocartilage or blood sinus into a jaw joint. To test these hypotheses, we used CRISPR/Cas9 to generate homozygous *bapx* mutant zebrafish in which the jaw joint is predicted to fuse. These mutants could provide partial phenocopies of the states before and after the origin of the jaw, through comparison with the oropharyngeal morphology in osteostracans and placoderms. Comparison of gene expression patterns between the knockout lampreys and the mutant zebrafish is beginning to provide us a useful framework to contrast transcription factors versus effectors as a key attribute of the endoskeletal joint evolution in vertebrates.

Grant Information:
National Science and Engineering Research Council (Canada); National Institute of Health, National Science Foundation (USA)

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

TAXONOMIC EVALUATION OF A CORYPHODONTID PANTODONTAN (MAMMALIA, PANTODONTA) FROM THE MIDDLE EOCENE OYAKE FORMATION, FUKUOKA PREFECTURE, JAPAN

MIYATA, Kazunori, Fukui Prefectural University, Eiheiji-Town, Fukui, Japan; OKAZAKI, Yoshihiko, c/o Kitakyushu Museum of Natural History and Human History, Kitakyushu, Japan; SAKAI, Harutaka, Kyoto University, Kyoto, Japan; TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan

A coryphodontid pantodont specimen recovered in 1992 from the basal part of the Middle Eocene Oyake (Ooyake) Formation near Yoshidome, Munakata City, Fukuoka Prefecture, represents the first record of the order Pantodonta from Japan. The Oyake Formation at this locality is at least 44.2 (+/- 3.4) million years old based on a fission-track age obtained from the conformably overlying Uwaishi Formation. The coryphodontid was collected from the same coarse-grained sandstone bed as a specimen of the stem rhinocerotoid, *Hyrachyus* sp. Together these Munakata fossils serve to expand understanding of the paleobiogeographic distribution of Eocene mammals in East Asia. Up to now, the poor preservation of the coryphodontid has limited taxonomic analysis of this important specimen. However, ongoing fossil preparation reveals that the specimen consists of various cranial and postcranial elements including at least a few dental remains (left C1, posterior part of right p4, and incomplete right lower molars), several cervical vertebrae, a left tibia, and a left astragalus of a single individual. These are the first coryphodontid postcranial elements known from Asia. Although the C1 is relatively small (crown length: 74 mm, width: 36 mm), the bilophodont molars are larger (ca. 40 mm in m1) than those of *Coryphodon* and *Asiocoryphodon* and are hypsodont with a faint cristid obliqua like in *Eudinoceras* and *Heterocoryphodon*. The p4 talonid is longer than that of *Eudinoceras*, suggesting greater similarity with *Heterocoryphodon*. In mainland Asia, derived coryphodontid pantodontans such as *Eudinoceras* and *Heterocoryphodon*, as well as *Hyrachyus,* are known from the Arshantan (late Early to early Middle Eocene) and the Irdimanhan (Middle Eocene) Asian land mammal ages. However, definitive radiometric dating of these land mammal ages has yet to be completed.

Grant Information:

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Technical Session V (Wednesday, August 23, 2017, 2:15 PM)

ISOLATED "BIRD" TEETH FROM THE CRETACEOUS OF ALBERTA ARE FROM JUVENILE CROCODILIANS

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The Cretaceous birds of western North America are poorly understood as skeletal elements are rare, and most material attributed to birds from this time and region consists of isolated teeth. Differentiating bird teeth from those of other archosaurs is difficult, as numerous characters may be shared with some non-avian theropods and crocodilians, such as a laterally compressed crown and a basal construction between the crown and root. However, qualitative and quantitative comparisons of crocodilian dentition with those of non-avian theropods and birds have not previously been performed. We tested whether these "bird teeth" are morphologically distinct from those of non-avian theropods, extant crocodilians, and the toothed birds *Hesperornis* and *Ichthyornis*.

We examined putative bird teeth from the Milk River, Oldman, Dinosaur Park, Horseshoe Canyon, and Scollard formations of Alberta, as well as teeth from various Cretaceous theropods, *Hesperornis*, *Ichthyornis*, and extant *Alligator* jaws. Qualitative assessment of the teeth revealed considerable morphological variation, suggesting the presence of eleven morphotypes, as well as a strong resemblance to the teeth of juvenile crocodilians. A principal components analysis (PCA) of tooth crown measurements and bivariate plots of a variety of shape ratios both supported the recognition of morphotypes, but with considerable morphological overlap of putative avian teeth, *Hesperornis* and *Ichthyornis,* and juvenile crocodilian teeth. Teeth of *Richardoestesia* and *Saurornitholestes* also overlap slightly with the latter, but those of *Troodon* form a distinct cluster. We found no diagnosable differences between juvenile crocodilian and cf. Aves teeth from the Cretaceous of Alberta. Juvenile crocodilian skeletal material in Alberta is unknown, but these teeth may derive from the fossil alligatoroids *Leidyosuchus* and *Albertachampsa* rather than birds. Both fossil and extant crocodilian teeth show a high degree of shape variation within the jaw, suggesting that many fossil 'bird' morphotypes likely best represent variation in tooth position and ontogeny within Albertan alligatoroids, rather than avian species diversity. The reassignment of most known cf. Aves teeth from Alberta to those of the Crocodilia has important ramifications for interpreting the diversity of Cretaceous birds over time, particularly regarding species diversity near the K-Pg extinction event.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE ROLE OF LARGE REPTILIAN, ESPECIALLY ZIPHODONT CROCODILIAN, PREDATORS IN AUSTRALIAN PLEISTOCENE TERRESTRIAL TETRAPOD TROPHIC SYSTEMS

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Extensive knowledge of Eurasian and North American Neogene terrestrial tetrapod faunas has made them, often implicitly, a model for terrestrial tetrapod faunas in general. In this model both large herbivores and large predators are members of the same major clade, and both are eutherian mammals. Reptilian (including avian) predators are considered to have a marginal role either as being amphibious or smaller, and hence having less impact on prey populations. It has been recognised that Cenozoic terrestrial tetrapod faunas from South America do not fit this model in either of its aspects. The large herbivores and predators did not belong to the same major clade, and they were marsupials and archosaurs (phorusrhacids and sebecosuchians) not eutherians. In Australia there has been disagreement over the role of large reptilian (generally varanid) predators in comparison to that of marsupial predators. The discovery of the skull and mandibles of a new large Pleistocene ziphodont mekosuchian again raises this issue. This skull, approximately 50 cm long, is the largest known complete skull of a ziphodont crocodylomorph. This new material, estimated to represent an animal approximately three metres in length, demonstrates that there were also crocodilian predators approximately the size (mass) of the Megalania (*Varanus priscus*) and *Thylacoleo*. Thus the Australian Pleistocene tetrapod predator fauna comprised representatives of three major clades - lepidosaurs, marsupials and archosaurs. The new specimen also implies that isolated and incomplete mekosuchian material previously attributed to *Quinkana* needs to be reassessed.

Technical Session XII (Friday, August 25, 2017, 10:30 AM)

MOLECULAR PHYLOGENETIC SIGNAL IS INSUFFICIENT TO CONFIDENTLY RESOLVE THE SQUAMATE BACKBONE TOPOLOGY

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The Deep Scaly Project, an initiative intended to resolve basal lizard interrelationships, came to an end when the results of the morphological and molecular datasets were shown to be irreconcilable. Morphological data unambiguously support a basal divergence between Iguania and the remaining squamates (Scleroglossa), while molecular data place iguanians high in the squamate tree with snakes and anguimorphs, in a clade referred to as Toxicofera. This profound topological difference has since become a paradigmatic case of incongruence among phylogenetic datasets. However, recent publications claim to have resolved the conflict in favor of the Toxicofera hypothesis. Nonetheless, these studies were performed under the implicit assumption that molecular data are superior sources of evidence to reconstruct phylogenetic relationships, and that the misleading signal must therefore reside in the morphological characters. We investigate these conclusions by performing new analyses of the molecular dataset. Maximum likelihood gene trees show an impressive diversity of topologies, with most of the incongruence restricted to the deepest branches of the squamate tree. We use approximately unbiased tests to compare alternative resolutions of the squamate backbone topology. 72% of the genes are unable to statistically reject Scleroglossa. Only 11% consider a topology in which Toxicofera is monophyletic to be significantly better than a sample of alternative topologies lacking this clade. A phylogenetic informativeness approach reveals that molecular characters evolve at a rate that is faster than that optimal to confidently resolve the sequence of divergences in the squamate backbone. Moreover, there is a high probability that a Toxicofera topology is determined entirely by noise. Restricting analyses to just the slowest-evolving sites, which should be most useful for resolving deep events, lead to a complete collapse of the backbone tree. Our results show that the sampled genes preserve insufficient signal to resolve the initial squamate radiation, which molecular evidence date to the Early Jurassic. With such limited phylogenetic signal, even a small amount of systematic error, such as that resulting from the higher rates of sequence evolution in iguanians and snakes, can determine the outcome. Indeed, the higher signal/noise ratio of morphological characters, as well as their ability to accelerate during adaptive radiations, might provide a better estimate of phylogeny.

Technical Session XXI (Saturday, August 26, 2017, 3:00 PM)

MORPHOFUNCTIONAL DIVERSITY IN TOARCIAN (EARLY JURASSIC) ICHTHYOSAURS

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The Early Jurassic had the highest raw diversity of ichthyosaur taxa in the Mesozoic, yet not the highest disparity or ecological variation. Two great lagerstätten – the Lias Group and Posidonia Shale – have preserved abundant specimens representing this diversity, but three-dimensional specimens are rare. Morphological differences in the ichthyosaur taxa present at this time have been noted, but testing of ecological adaptation and niche occupation has heretofore been infrequent. We use micro-CT scans of two highly complete, three-dimensionally preserved ichthyosaur skulls from the Upper Lias (Toarcian) Strawberry Bank lagerstätte of Somerset, U.K. – referred to *Hauffiopteryx typicus* and *Stenopterygius triscissus* respectively – to reconstruct the internal cranial hard and soft anatomy. *Hauffiopteryx typicus* possesses a narrow, elongate snout and jaw, and anteroposteriorly short postorbital region and supratemporal fenestra – comparable to coeval Leptonectidae. The adductor cavity is large, providing broad areas for muscle attachment. In *Stenopterygius triscissus* the snout is broader and more robust, and the postorbital region is longer and supratemporal fenestra larger than in *H. typicus* – as in other Thunnosauria. A feature of Neoichthyosauria is the posterior position of the paracoronoid process on the surangular, close to the jaw articulation. We find this – coupled with extensive muscle attachment in this region – gives a high moment arm on the lower jaw, allowing the jaw to be closed rapidly even in the viscous medium of water. The teeth of *S. triscissus* are longer and greater in diameter than in *H. typicus*, and retained in both taxa through ontogeny. We suggest that these morphologies evidence niche partitioning between the taxa. No direct evidence of diet was found in the specimens, but the lagerstätte preserves numerous fishes and insects of small to large size. The deposit has been interpreted as a 'nursery' for ichthyosaurs. The similarity of the snout and tooth morphological in *H. typicus* and the crocodyliform *Pelagosaurus typus* may indicate similar feeding strategies.

Grant Information**:**
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Technical Session XVI (Saturday, August 26, 2017, 8:45 AM)

ANATOMY AND SYSTEMATICS OF *KLAMELISAURUS GOBIENSIS,* A MAMENCHISAURID SAUROPOD FROM THE MIDDLE-LATE JURASSIC SHISHUGOU FORMATION OF CHINA

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At least fifteen sauropod genera are recognized from the Middle and Late Jurassic of China, but most of these taxa have not been adequately described and many have not been included in modern phylogenetic analyses. Among these poorly known Chinese sauropods is *Klamelisaurus gobiensis* from the lower beds of the Middle-Late Jurassic Shishugou Formation. We present a revised description of *Klamelisaurus* and for the first time include *Klamelisaurus* in a phylogenetic analysis.

The holotype of *Klamelisaurus* preserves a largely intact vertebral column, portions of the pectoral and pelvic girdles, and well-preserved representatives of the stylopod and zeugopod of the fore- and hindlimbs. The dearth of detailed anatomical descriptions of Chinese sauropods and profusion of material assigned to *Mamenchisaurus* and *Omeisaurus* hinder robust diagnosis of *Klamelisaurus*. Nevertheless, we identify several features that may be diagnostic for *Klamelisaurus* or slightly more inclusive taxa, including middle-posterior cervical prezygodiapophyseal laminae with markedly convex ventral margins and weakly developed, parallel posterior centroparapophyseal laminae in posterior dorsal vertebrae. Differentiation of *Klamelisaurus* from the Shishugou sauropods *M. sinocanadorum* and *Tienshanosaurus* is complicated by limited morphological overlap and character-based diagnosis; however, *Klamelisaurus* is readily distinguished from *Bellusaurus sui* from the lower part of the upper Shishugou Formation. Although some characters distinguishing these taxa could reflect ontogenetic variation (e.g., neural spine bifurcation), *Bellusaurus* generally exhibits more derived pneumatic features in the axial series, including vertically divided pneumatic excavations in dorsal centra and numerous accessory laminae in the lateral pneumatic foramen of the cervical centra. Synonymizing these taxa as developmental variants of the same animal requires a decrease in pneumatic development through ontogeny, a trajectory not favored in sauropods for which an ontogenetic series is known.

Preliminary parsimony and Bayesian phylogenetic analyses recover a monophyletic Mamenchisauridae, with *Klamelisaurus* nested within a *Mamenchisaurus*-*Qijianglong*-*Chuanjiesaurus* clade that is sister to a *O. tianfuensis*-*Cetiosauriscus* lineage. Our analysis indicates that *Bellusaurus* is not a juvenile mamenchisaurid but an early-branching macronarian, though rigorous testing of this hypothesis awaits detailed study of material referred to *Bellusaurus* and *Omeisaurus*.

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Technical Session XVII (Saturday, August 26, 2017, 10:45 AM)

TAPHONOMIC AND ECOLOGICAL SHIFTS ACROSS THE EOCENE-OLIGOCENE BOUNDARY IN SOUTH DAKOTA AND NEBRASKA

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The Eocene-Oligocene boundary is marked by pronounced cooling of the high-latitude marine record, associated with the formation of permanent ice caps on Antarctica. The effect of this climate transition in the mid-latitude terrestrial record is less clearly defined. To better understand the contribution of this climate change to the terrestrial paleofaunal and paleoenvironmental record, we compare the patterns of taphonomic modification and taxonomic composition of vertebrate fossil assemblages before and after the Eocene-Oligocene Climate Transition (EOCT) in South Dakota and Nebraska. A suite of taphonomic and paleoecological data was collected from >5000 specimens at 10 localities spanning the EOCT. Multiple regression analyses of the taphonomic data against observed patterns of elemental abundance bias were used to quantitatively characterize the pattern of taphonomic modification at each locality, and changes in these patterns with time were examined. Although minor statistically significant differences between pre- and post-EOCT assemblages are present, these appear not to be of sufficient magnitude to obscure paleoecological patterns in the datasets. No abundant taxa are lost across the EOCT, and the changes in abundance associated with the EOCT are of similar magnitude to changes observed before and after the climate change. This suggests that the influence of EOCT cooling was minimal in the US mid-continent, and that a different cause must be inferred for the secular abundance changes observed through the study interval. We hypothesize that this relates to the progradation of the White River Distributive Fluvial System.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MAIA MOBILE SCIENCE LAB: USING MATHEMATICAL AND BIOLOGIC CONCEPTS OF GROWTH CURVES TO CONNECT STUDENTS WITH MONTANA'S AGRICULTURAL ECONOMY AND RICH FOSSIL HISTORY

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Dinosaur fossils were first displayed in Montana at the Carter County Museum (CCM) in 1936, but their collection goes back far earlier than that. Today, dinosaurs from Montana can be found in museums all over the world, including the Smithsonian National Museum of Natural History, the American Museum of Natural History, and the Los Angeles County Museum of Natural History. It has been a mission of local museums in Montana including the CCM and the Museum of the Rockies (MOR) to show our fossils in the state in which they were discovered. One aspect of that mission is outreach and education.

In 2013, MOR and CCM entered into an official sister museum relationship. MAIA:Mobile Science Lab is the first joint educational project for these institutions as a result of that partnership. The traveling trunk program combines the osteology collections of CCM, one of the best-studied dinosaur growth series from MOR, and a partnership with math and science teachers at Carter County High School (CCHS) in Ekalaka, Montana. The result is a hands-on learning experience that connects Montana's rural students to mathematical concepts, agriculture and natural science.

The lab was piloted at CCHS in 2016 and engaged students in measuring femurs from cattle, chicken, deer and Montana's state dinosaur, Maiasaura. MAIA: Mobile Science lab stands for Math and Agriculture in Action - a nod to the connections between the lab, Montana's rural community and its focus on National and Montana Science Standards as well as Mathematical Practices and Standards.

Rural students make up a significant portion of the Montana student population base. Almost half of Montana's school systems have less than 100 total students. Rural schools have limited access to informal science, technology, engineering and math educational experiences, like museum programming, because of the expense of traveling long distances between informal sites and school locations. MAIA:Mobile Science Lab links schools and museums by providing the resources for a classroom activity that is connected to the curriculum and easily adaptable to middle and high school grade levels.

The project is currently available to teachers in Montana and has been used in classrooms throughout the state including Ekalaka, Baker, Stevensville and Winnet Montana. Evaluation forms indicate that the trunk is well received by students and teachers and demand to host the trunk continues to grow. MAIA: Mobile Science Lab will provide a model for future joint projects, outreach and educational programming between CCM and MOR.

Grant Information:
This project is supported by an Outreach and Engagement Seed grant from Montana State University.

Technical Session XXI (Saturday, August 26, 2017, 3:45 PM)

NEW INSIGHTS INTO THE PHYLOGENY OF THE POLYCOTYLIDAE

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The polycotylids were a clade of plesiosaurs that flourished during the Late Cretaceous. The position of the Polycotylidae within Plesiosauria has been extensively studied; however, the evolutionary relationships within the clade remain speculative. Traditionally, new polycotylid species were placed in either the genus *Trinacromerum* or *Dolichorhynchops* based upon which taxon the cranium of the new species most closely resembled. In this study we report a new phylogenetic analysis for the Polycotylidae, including 275 characters with 19 ingroup taxa. The tree topology recovered shows the polycotylids are split into clades which generally correlate with their geologic age. The basal most clade consists of taxa from the Albian and Cenomanian, whereas Campanian and Maastrichtian taxa comprise the most derived clade. However, the Cenomanian taxon *Pahasapasaurus haasi*, was not recovered as a member of the basal polycotylid clade, but as a member of the more derived polycotylids, diverging close to the position of the Campanian polycotylids. The two named Moroccan polycotylids, *Manemergus anguirostris* and *Thililua longicollis*, were recovered as sister taxa in this analysis. *Trinacromerum bentonianum* was not found to be closely related to *Dolichorhynchops osborni*, as hypothesized, but was found to be more closely related to other Turonian taxa. The newly described juvenile polycotylid, *Mauriciosaurus fernandezi* formed a clade with *T. bentonianum*, as they may represent the same species. The genera *Dolichorhynchops* and *Polycotylus* were recovered as sister taxa, and as the most derived members of the Polycotylidae. The correct assignment of LACM 12639, PR 187, and SDSM 23020 to the species *Polycotylus latipinnis* was also confirmed, as all three specimens formed a polytomy. *Dolichorhynchops bonneri* was not recovered within the genus *Dolichorhynchops*, rather as a basal member of the *Polycotylus* clade, as was UNSM 50133. All members of the *Polycotylus* clade feature extensions of the frontal onto the rostrum, and propodials with expanded distal ends for articulation with at least four epipodials. *Polycotylus latipinnis* and UNSM 50133 also share an enlarged cultriform process that projects far into the anterior interpterygoid vacuity. The genus *Dolichorhynchops* was found to be restricted to *D. osborni* and *D. herschelensis*, as *D. tropicensis* was recovered as a more basal member within the Polycotylidae. This study affirms the monophyly of the Polycotylidae, and the tree topology illustrates that the subclades generally correlate with geologic age.

Technical Session XX (Saturday, August 26, 2017, 3:45 PM)

INSIGHTS FROM MORPHOMETRIC ANALYSIS OF ONTOGENETIC AND PHYLOGENETIC CHANGES IN THE SHAPE OF THE CROCODYLIAN SKULL

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The crocodylian skull has been the focus of intensive research for over a century, and has revealed which functional, evolutionary, and ecological factors were important. Recent analyses have shown interspecific differences in post-hatching development of the skull are not strongly correlated with phylogenetic relationships. To understand the development and evolution of crocodilian skulls more comprehensively, we extended these studies by adding skull shape data from two additional sources: 1) prenatal and perinatal crocodylians and 2) extinct crown and stem-crocodylians. We used 14 discrete 2D landmarks and geometric morphometrics to capture the meaningful patterns of shape diversity while being able to include the incompletely developed skulls of embryos. We included post-hatching ontogenies of 22 species of extant crocodylian (n=169) but additionally sampled the embryonic shape space for 12 species (n=42) and 13 extinct crocodylomorphs (n=15, total n=225).

Principal Coordinates Analysis (PCA) from our earlier studies suggested that embryos occupied a unique region of skull shape morphospace, with relatively shorter faces, larger orbits, and larger braincases. Permutation tests of both Mahalanobis and Euclidean distances from Canonical Variate Analysis verified that embryos are significantly different from post-hatching ontogenetic stages (p=0.006). PCA including extinct species did not significantly alter axes of shape variation. Although some extinct species occupy unique regions of shape space (e.g., extremely blunt skulls of *Acynodon*), most overlap with modern adult crocodylians. This suggests that the full ontogeny of skull shape change observed in extant crocodylians includes the shape variation found in fossils, at least for dorsal projections. Reconstruction of the evolution of ontogenetic trajectories on molecular and morphological phylogenies revealed that convergent evolution of blunt and slender skull shapes were achieved via changes in the trajectory (slope) of ontogeny and not intercept. Only modern *Gavialis* and *Tomistoma* were reconstructed as changing the onset of their trajectories (in addition to the slope). Overall our analyses suggest that crocodylians share a common embryonic skull shape and that convergent evolution of slender and blunt forms occurred repeatedly via heterochronic shifts (neoteny or acceleration) over much of ontogeny but rarely at the onset of development.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE LABIAL (HORIZONTAL) SHELF IS A SYNAPOMORPHY OF NEOCERATOPSIA (DINOSAURIA: ORNITHISCHIA)

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The labial shelf of non-ceratopsid neoceratopsians is a ledge of unworn dentine that projects labially at the base of dentary teeth. As dentary teeth slid past their maxillary counterparts during mastication the apices were attritionally worn, whereas the unworn base grew outward as a shelf. Often referred to as horizontal the labial shelf exhibits a variety of configurations. When viewed labially it can be inclined rostrally, inclined caudally, or appear deltoid exhibiting both inclinations, as well as the recognized horizontal orientation. Previous analyses limited the distribution of this shelf to members of Leptoceratopsidae; however, this structure and the variety of configurations it exhibits can be recognized in other ceratopsians including the most basal neoceratopsian *Liaoceratops,* as well as protoceratopsians. The shelf in these taxa likely forming through the same processes as that in *Leptoceratops*, and given their common genesis we propose that these structures should be considered homologous.

In previous phylogenetic analyses the labial shelf is an important synapomorphy of Leptoceratopsidae. To test the effects of our revised understanding of labial shelf formation and distribution on tree topology, the labial shelf was redefined to include the delta configuration and the relevant taxa were recoded and submitted to parsimony analysis. Using matrices from several recent papers, including a new matrix of 240

characters and 35 taxa incorporating all non-coronosaurian neoceratopsian taxa named in 2015, we found that in general, the labial shelf character states most often shifted from being synapomorphies for Leptoceratopsidae to being synapomorphies for Neoceratopsia. Overall tree topologies remained stable. Leptoceratopsidae remains supported by characters of the caudal vertebrae. *Liaoceratops* is recovered as the most basal neoceratopsian, with *Auroraceratops*, *Aquilops*, and *Archaeoceratops oshimai* diverging in a pectinate arrangement between *Liaoceratops* and *Mosaiceratops*. *Mosaiceratops* is recovered in a small clade as the sister taxon to *Yamaceratops*. This two-taxon clade is sister to a clade composed of Coronosauria and Leptoceratopsidae. This new distribution of the "labial shelf" emphasizes the need to more carefully examine changes in jaw mechanics between taxa near the base of Neoceratopsia.

Technical Session XXI (Saturday, August 26, 2017, 1:45 PM)

TESTING IF MESOZOIC MARINE REPTILES EMERGED BEFORE OR AFTER THE END-PERMIAN MASS EXTINCTION

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Ichthyosauromorpha is a clade that holds the oldest stratigraphic record of all Mesozoic marine reptiles, reaching the Procolumbites Zone of the Spathian, Lower Triassic. Even the most basal member of the clade had flippers suggestive of a high degree of aquatic adaptation, which led some to suspect that the group had a deep root in the Permian. However, it is also possible that the clade was quickly formed during the aftermaths of the end-Permian mass extinction, when there were new niches being built.

We tested these two competing hypotheses by two methods, stratigraphic confidence interval and Bayesian morphological clock. Our stratigraphic data has a high resolution down to the bed level, where each bed represented approximately 6,000 years on average, and resulted in largely consistent confidence intervals regardless of the assumptions involved. The results from the morphological clock varied depending on the assumptions made, largely because there was a wide range in the estimated rates of morphological evolution. For example, the rate was six times faster during the first few million years of the ichthyosauromorph fossil record compared to the average over 160 million years of their entire history. The use of faster rates resulted in divergence times as young as the Early Triassic while the slower rates suggested divergences as old as in the Early Permian. Only one of the results from the clock-based analysis, based on the fast evolutionary rate from the initial radiation time period of the clade, agreed with the independent outcome from the stratigraphic confidence interval. This congruence is reasonable because the time it took for the early divergence should reflect the earliest rate of morphological evolution in the clade rather than the slower average over 160 million years. The congruent result suggests that Ichthyosauromorpha emerged after the end-Permian mass extinction, most likely in the Olenekian or the latest Induan.

The Early Triassic records of other marine reptile groups, such as the clade comprising Sauropterygia and Saurosphargidae, are unfortunately not as robust as that of Ichthyosauromorpha, making it difficult to perform similar analyses. However, even the oldest fossils of these clades are at least half a million years younger than the oldest ichthyosauromorph fossil, while they still retained highly flexible limbs unlike in basal Ichthyosauromorpha. Then, it is likely that Mesozoic marine reptiles emerged in the aftermaths of the end-Permian mass extinction.

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

SKELETAL CHARACTERISTICS OF A PLEISTOCENE ELEPHANT FROM THE NAFUD DESERT, NORTHWESTERN SAUDI ARABIA

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Pleistocene vertebrate fossils from the Ti's al Ghada locality near the southwestern edge of the Nafud Desert in northwestern Saudi Arabia represent a land mammal assemblage preserved in fine sands of a paleolake system. This assemblage includes diverse Eurasian, African, and Levantine mammals (Perissodactyla, Proboscidea, Bovidae, Camelidae, Felidae, Canidae, and Hyaenidae), dated to about 500 ka. Most material is disarticulated and dispersed, but in 2014, we found numerous elements that appeared to come from a single elephant, all in an area <350 m^2. These bones comprise ca. 60% of a complete skeleton, with elements consistent in size, left-right identity, and states of epiphysis fusion with having derived from a large, adult male. Elements recovered to date include more than two-thirds of the pre-sacral vertebral column, about two-thirds of the ribs, limb girdle, and long-bone elements, and almost one-quarter of manus and pes elements (although all four feet are represented). Based on lengths of the main forelimb elements (scapula, 100.1 cm; humerus, 118.4 cm; radius, 99.5 cm; lunar, 8.1 cm; metacarpal III, 25.4 cm), we estimate the shoulder height of this individual at nearly 4 m. Initially, the only dental remains were an incomplete right tusk and most of the mandible, retaining both m3s in a moderate state of wear. Morphologically, these molars support identification as *Elephas recki*, and thin sections of tusk dentin show that appositional increments are well enough preserved to recover significant life history data. Additional excavation in 2017 revealed an abraded, but complete, left tusk 225 cm long, but we have not yet recovered the skull or pelvis. We observe little breakage on this skeleton and no post-mortem damage that we interpret as evidence of human association. Nevertheless, other discoveries in this region show that by this time, humans coexisted with proboscideans on the Arabian Peninsula. This specimen is complete enough to serve as an osteological reference that will help interpret less complete and possibly fragmentary remains that may be recovered in the future in a context that could be more suggestive of human association. We have therefore produced 3D surface models of major long bones and manus and pes elements of this individual using a laser scanning digitizer. This skeleton presents an opportunity to document the osteology of this species more thoroughly than has been possible previously, and we therefore expect it to play a key role in future taphonomic analyses.

Grant Information**:**
Saudi Geological Survey

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW SPECIES OF THE PALAEOCENE *JOFFRICHTHYS* (OSTEOGLOSSOMORPHA) FROM CALGARY, ALBERTA AND A REASSESSMENT OF THE RELATIONSHIPS OF THE GENUS

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The genus *Joffrichthys* was named based on articulated specimens recovered from Palaeocene sediments of the Paskapoo Formation from a road cut near Joffre Bridge Alberta. When the type species, *J. symmetropterus*, was described, it was placed in the subfamily Heterotinae of the Osteoglossidae. The extant members of Heterotinae are the South American *Arapaima* with perhaps six species, and *Heterotis niloticus* in Africa. Including *Joffrichthys* in this group leads intriguing biogeographic scenarios. One of the characters causing the union of *Joffrichthys* with the heterotines was a caudal fin with 15 branched principal rays (formula i,7,8,i). The presence of 15 branched principal rays in osteoglossomorphs is found in the order Osteoglossiformes, with the primitive character state of 16 branched principal rays present in Hiodontiformes and basal fossil groups. A second species of *Joffricthys*, *J. triangulpterus*, was later named from Palaeocene deposits of North Dakota. The specimens of this species did not completely preserve the caudal fin, which was reported to have a caudal fin ray formula of i,?,8,i. Newly prepared osteoglossomorph material from the Paskapoo Formation from a community in Calgary, Alberta, includes two specimens of a new species of *Joffrichthys*, one of which has a very clearly preserved caudal fin with 16 branched caudal fin rays (i,8,8,i). Based on this specimen, we reexamined the type material and other specimens of *Joffrichthys symmetropterus* in the collections of the University of Alberta Laboratory for Vertebrate Palaeontology (UALVP). Although a count of the caudal fin rays is difficult, we count eight branched rays in both the dorsal and ventral lobes of the fin, giving a formula of i,8,8,i (16 branched rays in total), matching the count in the new species. We reran the phylogenetic analysis of Osteoglossomorpha with the correction of the number of principal fin rays for *Joffrichthys*. In our analysis, *Joffrichthys* is removed from the Heterotinae and Osteoglossidae, and instead recovered in a more basal polytomy with several Cretaceous genera from Alberta and China, between the Osteoglossiformes and Hiodontiformes.

Technical Session III (Wednesday, August 23, 2017, 4:00 PM)

RESOLVING THE RADIATION AND PHENOTYPIC EVOLUTION OF BASAL NEOAVES: BEGINNING CONSTRUCTION OF A NEW MORPHOLOGICAL DATASET AND A NOVEL SISTER TAXON FOR *APTORNIS*

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Extensive phylogenomic and morphological studies have begun to reveal the large-scale architecture of avian phylogeny but exhibit conflicting phylogenetic relationships at the base of Neoaves, which comprises approximately 95% of all extant birds. Results indicate that stem-lineages of modern birds, especially Neoaves, diversified over 5-8 million years around the K-Pg boundary; however, these findings are largely shaped by molecular data and provide little insight into early neoavian evolutionary transformations in structure and function. A few studies have examined bird relationships using morphology, but each has suffered from limited taxon sampling or preconceptions about avian phylogeny; thus elucidation of early phenotypic transitions is critical for resolving conflicting basal clade relationships and providing a framework for reconstructing early neoavian phenotypic transitions. Knowledge of early phenotypic transitions will also allow better placement of problematic neoavian fossil taxa, enabling resolution of relationships and phenotypic evolution in all of Neoaves. The early Miocene *Aptornis*, an extinct terrestrial bird endemic to New Zealand, remains one of the most controversial of such problematic taxa. Past morphological studies placed *Aptornis* as a sister taxon to *Rhynochetos jubatus*, but recent genomic studies reveal *R. jubatus* and *Eurypyga helias* to be sister taxa, and posit that *Aptornis* falls within Gruoidea.

To better resolve these issues I have begun to construct a new morphological dataset for basal Neoaves. I defined 292 discrete morphological characters for 25 extant and 2 fossil taxa, the latter including *Aptornis defossor*. Direct study of skeletal specimens from the comparative and paleontological collections at the American Museum of Natural History and Yale University and surveys of published analyses served as the basis for character construction. The dataset also includes a thorough evaluation of characters from the largest avian morphological dataset to date. Heuristic, unweighted parsimony and maximum likelihood analyses were performed in PAUP*. Bootstrap and Bremer support values were then calculated for all analyses. All trees resulted in strong support for *R. jubatus* and *E. helias* as sister taxa, and placed *A. defossor* as sister to *Psophia obscura* with relatively high support. While the *R. jubatus* and *E. helias* sister group is consistent with recent genomic hypotheses, the *A. defossor* and *P. obscura* sister group is novel. If false, this relationship may be due to morphological convergence.

Grant Information:
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Romer Prize Session (Thursday, August 24, 2017, 8:00 AM)

FOSSILS, FECES, & THE FUTURE: A 20,000 YEAR EXPERIMENT OF MAMMALIAN EXTINCTIONS ON ISLANDS

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Views from the fossil record provide a roadmap of how past extinction events shaped our modern biodiversity. Such patterns are useful for identifying traits that predispose species to broad categories of threats. However, to truly apply extinction lessons of the past towards concrete conservation planning in the future, we must dissect the ecological mechanisms underlying these patterns. Perhaps nowhere is such a conservation paleobiology perspective more appropriate than on island systems. Through my research, I apply this perspective on multiple scales. First, I use the Quaternary fossil record to describe patterns of mammalian extinction on island systems globally. I find that islands have distinctive extinction patterns as compared with continents, suggesting that the unique evolutionary history of island communities may shape how they respond to perturbations. To explore the nuance of this broad extinction view, I zoomed into one system: the Caribbean. I reconstructed patterns of species loss, as well as paleoclimatic and archaeological selective pressures. There, I find that larger bodied species (eg sloths) went extinct in the Late Holocene, and smaller bodied species (eg rodents) went extinct in historic periods, enigmatically after coexisting with humans for thousands of years. I deployed an interdisciplinary toolkit to investigate the ecological mechanisms that could produce these patterns in the Caribbean fossil record. I excavated caves in the Dominican Republic in collaboration with the Museo Nacional de Historia Natural, where abundance and isotopic data reveal abrupt ecological changes at the time of Columbus' arrival, as compared with changes in response to climate. To complete the link from conservation paleobiology theory to practice, I use one of the few surviving species, the Hispaniolan Solenodon, to evaluate ecological mechanisms of persistence. Genomic analysis of feces confirms that dietary flexibility could provide the mechanism underpinning survival of this medium-sized species across the fossil record. Genetic sampling of historic bones shows that this survivor was once widespread throughout the island and only recently has succumbed to the modern extinction pressure of fragmentation. My research highlights the critical need for paleontological baselines in conservation planning on island systems.

Grant Information:
Stanford Interdisciplinary Graduate Fellowship, NSF DEB-1600728, American Society of Mammalogists, Paleontological Society, American Philosophical Society

Technical Session XVI (Saturday, August 26, 2017, 10:15 AM)

REAPPRAISAL OF ORNITHISCHIAN DINOSAUR JAW MUSCULATURE: IMPLICATIONS FOR FEEDING MECHANISMS AND PREVIOUSLY PROPOSED "CHEEK" ANATOMY

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For over a century, studies in ornithischian jaw mechanisms have examined their diverse herbivorous feeding strategies. Current jaw muscle reconstructions, although parsimonious, pose concerns of small adductor muscle bodies and caudally-displaced insertions relative to mandibular proportions. In this study, craniomandibular elements of 50 ornithischian genera spanning all subclades are examined for signs of osteological correlates of soft tissues. The multi-layered jaw adductor muscle complex, m. adductor mandibulae externus (mAME), has traditionally been reconstructed as solely inserting along the caudal margin of the coronoid process for closing the jaw. Here, a new mAME reconstruction is proposed in some derived ornithischians, with the superficial mAME layer reconstructed as a rostrolateral expansion of muscle, inserting along the lateral surface of the coronoid process and its rostrally extending, shelf-like lateral dentary ridge (LDR). This LDR creates the characteristic buccal emargination (i.e., medially-inset tooth row) in many ornithischians. As neoceratopsians, hadrosaurs, and ankylosaurs are known from dental microwear studies to have implemented a major palinal (i.e., caudally-oriented) feeding component in their jaw motions, this rostrally extending fan of muscle would create a greater support system and mechanical advantage along the lateral margin of the jaw, lifting the entire mandible up into occlusion and retracting it. This rostral expansion of muscle is also seen in other palinal feeding vertebrates with rostrolateral muscle attachments, such as dicynodonts and multituberculates, suggesting it is an important adaptation for palinal feeding. Laterally-flaring jugals in ornithischians, especially ceratopsids, create a rostroventral opening allowing direct communication for mAME to fit within the margins of the maxilla as it inserts fibers as a large muscle fan along the LDR. This rostrolaterally expanding muscle also acts in medial rotation of the dentaries about their long-axes in hadrosaurs and ankylosaurs. Conversely, buccal emarginations in primarily orthal feeding ornithischians (e.g., basal ornithischians, stegosaurs, and pachycephalosaurs) possess a more lepidosaur-like, thin lateral lamina, suggesting these taxa did not possess a rostrally expanding mAME. These observations reject the presence of an unparsimonious "cheek" muscle and instead incorporates a greatly advantageous adaptation accommodating diverse feeding mechanisms throughout Ornithischia.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NECK MOBILITY OF THE PLESIOSAUR *NICHOLLSSAURA BOREALIS* (PLESIOSAURIA; LEPTOCLEIDIDAE)

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Plesiosaurs are marine reptiles that inhabited the Mesozoic seas for 135 million years. This group exhibits one of the most unusual body plans in the fossil record, characterized by an elongate neck and paddle-like flippers. The evolutionary ecology of their elongate neck is poorly understood, and this trait has not evolved in any other marine vertebrate since. To understand the ecological role of the plesiosaurian neck, we estimate the range of inter-cervical vertebral mobility along the length of a fossil plesiosaur.

We produced a 3D model of the leptocleidid plesiosaur *Nichollssaura borealis* (TMP 1994.122.0001) using segmented CT scans to assess the mobility along its cervical series. Three range-of-motion profiles were generated: lateral flexion, elevation, and depression. The intervertebral spacing preserved in the fossil was used as an estimate of the natural intervertebral spacing because of the negligible deformation in the specimen. The cervical vertebrae were manipulated relative one another, keeping spacing constant, until bone-on-bone contact occurred to model movement in each of the three planes of motion. The inter-cervical mobility was measured as the offset between each cervical vertebra relative to another as an angle. Bone-on-bone contact would not occur in life because of soft tissue, so this represents osteological maxima for neck mobility. To assess osteological minima for neck mobility the intervertebral spacing were reduced, simulating a lack of intervertebral soft tissue. Cervical vertebrae were manipulated and measured as before.

The inter-cervical osteological maximum and minimum mobility was in the lateral plane, 13.51° and 5.20°, respectively. This indicates that *N. borealis* neck was most mobile in the medio-lateral plane. A neck capable of higher mediolateral mobility may have facilitated feeding along seafloor dwelling animals, such as gastropods, molluscs, and small fish that are often found in plesiosaur gut contents. Studying the neck musculature could test this model to see of the organization of muscle masses is consistent with the predicted flexibility. Finally, this type of 3D mobility modelling should be applied to more plesiosaur taxa to assess if this range of motion is widely observable across the group. In doing so, we will be able to enhance our understanding of the ecological role, and niches that plesiosaurs would have occupied in their ecosystems.

Grant Information:
NSERC Discovery Grant 307756-2011 to J. Anderson

Technical Session III (Wednesday, August 23, 2017, 3:45 PM)

CRANIAL INTEGRATION PATTERNS IN LANDBIRDS AND IMPLICATIONS FOR THE DIVERSIFICATION OF PASSERINES

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The evolutionary plasticity of the avian beak is often lauded as one of the key innovations that led to the diverse radiation of birds from within non-avian theropods. The particular architecture of the avian skull and the extraordinary variability of beak morphologies suggests that bird beaks evolved as separate evolutionary units. Yet recent research has challenged these views showing that cranial integration is prevalent in several avian lineages, or even in the whole crown group of birds. While cranial integration is a widespread phenomenon in vertebrate evolution, how alterations to this integration affect macroevolutionary patterns is still poorly understood. Here we used shape analysis (geometric morphometrics) to test the evolutionary covariation between the beak and the posterior skull across the whole landbird clade (Inopinaves). We tested the strength of cranial integration at several macroevolutionary levels between all clades of landbirds, and pinpointed where shifts in the degree of integration have likely occurred. We found strong cranial integration within and between the major radiations of landbirds and a conserved pattern of integration across many of them. Interestingly, we found that cranial integration significantly intensifies in parrots and oscine passerines (songbirds), but with much weaker levels of integration in the suboscines and basal songbirds, that sit phylogenetically between the other two clades. This suggests that a strengthening of cranial integration in landbirds has happened at least twice, in the parrots and within the songbirds, rather than once at the base of Psittacopasserea. Within Passeriformes, the integration shifts are coincident with the greatest diversification events in the clade, suggesting intensified cranial integration may represent a previously unrecognized 'key novelty' for these passerine radiations, allowing them to evolve and diversify more rapidly along certain axes of morphological change and access novel ecologies. Both songbirds and parrots, but not suboscines, share an unparalleled expansion of the forebrain alongside complex behaviours like vocal learning. The strong morphogenetic connection between the forebrain and the rostrum suggests these neuroanatomical changes in both lineages triggered the intensification of a constrained conserved craniofacial development pathway.

Grant Information:
GN is supported by a PG Scholarship/Studentship from The Alumni Foundation, University of Bristol, UK.

Technical Session X (Friday, August 25, 2017, 8:00 AM)

THE 'STRANGE REPTILES' OF THE TRIASSIC: THE MORPHOLOGY, ECOLOGY, AND TAXONOMIC DIVERSITY OF THE CLADE ALLOKOTOSAURIA ILLUMINATED BY THE DISCOVERY OF AN EARLY DIVERGING MEMBER

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Following the end-Permian mass extinction, archosauromorph reptiles underwent rapid lineage diversification, increases in disparity and body sizes, and expansion into new ecological opportunities. However, tracing the early portion of this diversification has been challenging because of taphonomic and biologic factors, including: 1) most skeletons are incompletely preserved, frequently disarticulated, and preserved with other taxa; 2) many early archosauromorphs are small (~1 meter in length or less) making character states determinations difficult; and 3) much of the fossil record is Late Triassic, tens of millions of years after the initial divergences and achieving high disparity. Mediation of some of these challenges is now possible with the recently recognized early archosauromorph clade Allokotosauria. This clade contains disparate, ecologically diverse (faunivores and herbivores), and typically larger bodied (1-3 meters in length) archosauromorphs (*Azendohsaurus*, *Trilophosaurus*), but to this point, plesiomorphic, early-diverging allokotosaurians have not been identified. Here, we recognize specimens

assigned to the enigmatic taxon *Malerisaurus* from both present-day India and western Texas as members of Allokotosauria, and more specifically, the Azendohsauridae. The morphology of the skull of *Malerisaurus* indicates that it had a long and low snout with recurved teeth, character states that represent plesiomorphic traits of the clade. Remains of *Malerisaurus* have been mistakenly identified as fragments pertaining to a diversity of Triassic reptiles (e.g., dinosaurs, phytosaurs, *Trilophosaurus*) and larger, likely ontogenetically older, representatives of the taxon were described as rhynchosaurs (e.g., *Otischalkia*). These fossils show that *Malerisaurus* was a common faunal member of the late Carnian to mid-Norian faunal assemblages from Upper Triassic strata of the southwestern United States. The recognition of *Malerisaurus* as both an allokotosaur and an azendohsaurid has also helped identify other fragmentary remains of close relatives from Triassic deposits across Pangea including India, elsewhere in North America, and Africa. As such, Allokotosauria had a near Pangean distribution for much of the Middle to Late Triassic. Allokotosauria represents one of the oldest successful clades of archosauromorphs that achieved a wide geographic distribution and both taxonomic and ecomorphological diversity.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HORSE-SIZED DUCKS AND DUCK-SIZED HORSES: THREE YEARS OF LARGE-SCALE OUTREACH ON THE INTERNET FORUM ASKSCIENCE

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Since 2014, the Society of Vertebrate Paleontology has participated in annual, live question-and-answer events called "Ask Me Anything" (AMA) sessions, via the AskScience forum on the social networking site Reddit. Participants, representing specialists across disciplines and vertebrate clades, have answered hundreds of questions from the public. Each of the AMAs lasted two to three hours and covered a wide range of topics.

Members of the public have the opportunity to interact with scientists, but an AMA can reach a more casual audience on a much larger scale than in-person outreach events. The time investment is less for experts and the public alike, and barriers to participation, such as travel and cost, are removed. The SVP AMAs have engaged thousands of people each year, making them a highly visible, wide-reaching outreach event that is low in cost and requires only an internet connection.

Current events and social media seem to create new trends in questions. Threads on unexpected topics are often traced to specific comments made by celebrities or politicians. These usually ask how claims, such as climate change denial or that dinosaur fossils are hoaxes, can be countered. Participants are generally science-positive, though more hostile questions, often regarding research funding and religion, are not rare.

Several questions are asked consistently each year, including pop-culture references. More scientific questions include recent discoveries; relationships between dinosaurs and birds; the concept of "living fossils"; whether dinosaurs were warm blooded; and evidence for "missing links". We frequently receive questions about reconstructing extinct organisms, including inferring behavior, color, or locomotion.

While other social media outlets sometimes require significant time and effort before building large audiences for outreach, established Reddit forums provide ready-made audiences. In the case of AskScience, this includes science enthusiasts from all fields. AMAs hosted by these forums represent a high return on investment for outreach, allowing experts to reach far more people with less time and effort than many traditional outreach platforms. In addition to honing our science communication skills, we have been able to stay informed, address longstanding areas of interest, and stay abreast of new topics. Therefore, participation in AMAs, andsimilar online platforms, provide more heightened access to larger outreach audiences for purposes of outreach and science communication than traditional methods.

Technical Session IV (Wednesday, August 23, 2017, 3:30 PM)

RECONSTRUCTING THE PALEOENVIRONMENT OF MIDDLE MIOCENE NEBRASKA, USA FROM STABLE ISOTOPES IN THE TEETH OF LARGE HERBIVORES

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Middle Miocene (18-12 Ma) mammalian faunas of the North American Great Plains contained a much higher diversity of apparent browsers than in any modern biome. This phenomenon has been attributed to greater primary productivity in vegetation. Greater productivity to support a greater diversity of browsers may be expected to correspond with densely vegetated habitats, but several lines of proxy evidence suggest that open woodlands or savannas with C3 grasses dominated the middle Miocene; neither of which support many browsers today. To reconstruct vegetation structure for middle Miocene habitats in Nebraska, we use stable carbon isotopes in mammalian herbivores.

Stable carbon isotopes in C3 dominated environments reflect vegetation density and herbivores in those environments record dietary values in their tissues with predictable offsets. We sample the tooth enamel of a diversity of presumed browsers, mixed-feeders, and grazers, based on hypsodonty and microwear studies, from four fossil-rich localities in Nebraska. These localities are from the late Barstovian (14.8-12.5 Ma), a time interval with a high diversity of browsers. To make paleoenvironmental interpretations, we use a predictive model based on δ13C values in C3 vegetation in modern biomes after adjusting for differences in atmospheric δ13C between the Barstovian and present, for diet-to-enamel enrichment, and for latitudinal and altitudinal differences in δ13C plant values.

Results show that mean δ13C faunal values plot in the upper range of values expected for C3 vegetation, suggesting open habitats such as savannas, bushlands, or grasslands. Means for several taxa plot in the range for water-stressed C3 environments; a range that partially overlaps with the range for C4 vegetation. Despite this overlap, no single individual has high enough values to unequivocally indicate C4 consumption. The narrow range in carbon values suggests that browsers, mixed feeders, and grazers all consumed vegetation in mostly open areas. Our results are consistent with previous interpretations of savanna or woodland biomes at this time, in spite of high browser diversity. Additional research is needed to understand the underlying causes for this non-analog ecosystem.

Grant Information:
Friends of the Nebraska State Museum Graduate Student Research Award
Nebraska Geological Society Yatkola-Edwards Research Grant

Technical Session XIX (Saturday, August 26, 2017, 2:00 PM)

A NORIAN COELOPHYSOID THEROPOD FROM FLEMING FJORD FORMATION, EAST GREENLAND

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Body fossils of Late Triassic theropod dinosaurs are scarce worldwide. Here we report several isolated remains of medium-sized theropod from the middle-upper Norian part (Malmros Klint Member) of the Fleming Fjord Formation exposed in the East Greenland. The material was collected at MacKnigth Bjerg (Jameson Land, Carlsberg Fjord area) by the Polish−Danish expedition that took place in 2014. These fragments of bones seem to preserve synapomorphies which allow us to confidently place them within Theropoda. The material includes a part of maxilla, two isolated teeth, two cervical vertebrae, a few fragments of tibia and fibula, several fragments of pubis and ischium, dorsal and caudal vertebrae and other remains. The most informative is distal tibia, which is transversely expanded and is almost identical morphologically and proportionally to that of the coelophysoids *Liliensternus* from the late Norian-early Rhaetian of Germany and *Zupaysaurus* from the Los Colorados Formation (?late Norian-Rhaetian) in Argentina. Fossils were collected on a heavily eroded surface and perhaps they represent the same individual. These remains represent the first unambiguous neotheropod specimen reported from the Upper Triassic of East Greenland, enlarging the meagre record of the group. This new coelophysoid is, with the other recorded from North and South America, Europe, part of an apparently Pangean radiation of neotheropods during late Norian/early Rhaetian time.

Grant Information:
The NCN (Poland) provided field exploration funding in 2014. This study was financially supported by a Wallenberg Scholarship (Uppsala University).

Technical Session XVIII (Saturday, August 26, 2017, 8:30 AM)

RELEASE OF OSTEOCYTES AND LAMELLAE THROUGH CHEMICAL DISSOLUTION REVEALS THE INTRICATE, ANASTOMOSING CIRCUMFERENTIAL PATTERN OF BLOOD VESSELS IN *DIMETRODON* NEURAL SPINES

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The circumferential arrangement of blood vessels and bone matrix layers has long been recognized as a prominent feature of the neural spines of the synapsid *Dimetrodon*. In this study, standard histologic procedures utilized in human pathology laboratories were found to provide useful information regarding the arrangement of the tissue components in Permian era *Dimetrodon* neural spine fossil specimens obtained in the Craddock Ranch Main Bone Bed in Seymour, Texas. Treatment of these specimens with a decalcification solution (containing hydrochloric acid) resulted in the rapid dissolution of the bone matrix. This reaction released casts of the osteocytes (complete with elaborate filopodia), often associated in parallel arrays with flexible sheets of bone matrix (lamellae). The treatment exposed complex, interconnecting patterns of parallel blood vessels in the remaining neural spine specimens, as revealed by both light and scanning electron microscopy. These results are similar to those in prior reports showing release of osteocytes and blood vessels from Cretaceous and Triassic era fossil specimens, except that prolonged treatment of the *Dimetrodon* neural spines with EDTA solution has thus far not led to significant demineralization or release of osteocyte casts. We also found that application of the commonly used histologic stains hematoxylin and eosin to neural spine thin sections revealed additional details not visible in unstained specimens. The circumferential lamellae of bone layers stained differentially with eosin, suggesting changes in composition during different phases of growth. Osteocytes were arranged longitudinally as expected, but not in concentric arrays around the blood vessels as commonly seen in plexiform bone. The results of this analysis confirm and extend previous studies indicating that the circumferentially arranged layers of blood vessels in *Dimetrodon* neural spines had frequent interconnections. The release of flexible lamellae also suggests the possible preservation of organic components in fossilized *Dimetrodon* bone.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HOW TO CONSTRUCT A REALISTIC SIMULATED DIG SITE AND ITS BENEFITS FOR PALAEONTOLOGY OUTREACH AND EDUCATION

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The Royal Tyrrell Museum of Palaeontology has been offering a simulated digging program for a number of years in the badlands adjacent to the museum. Palaeontological field work has always fascinated the public, but the majority of people are not prepared for the reality of the experience. Real dig sites can be remote, inaccessible, and are usually closed to the public. Sites that offer digging programs for visitors may have tight restrictions on participants' ages and can usually only offer the experience to a limited amount of people. In some regions, public excavation programs might be further restricted due to local fossil collecting regulations, or the amount of fossil resources in the area. A realistic simulated quarry can provide a digging experience that is accessible to the general public, and allow people of a variety of ages and backgrounds to experience the thrill of excavation with no danger to any original fossil material. The Royal Tyrrell Museum's outdoor simulated dig site was rebuilt in 2016 to provide more concentrated and realistic materials for participants to work on, and the planning and installation process was documented photographically. The current site consists of robust cast material, which is anchored in concrete and then embedded directly in the sediments and rock of the badlands. The finished site is covered with a mixture of dental plaster, paint, and sediments to create the simulated matrix that participants will remove using real tools such as awls, brushes, and dental picks. The permanent nature of this dig site means the program can be offered indefinitely in the same location, as long as appropriate site maintenance is completed each year. Similar techniques can be used to create indoor simulated dig sites that can be available in the case of inclement weather, allowing participants to have a meaningful, realistic dig experience rain or shine.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MORE CROCS, MORE PROBLEMS: ENIGMATIC SMALL CROCODYLIFORM MATERIAL FROM THE WOODBINE FORMATION OF TEXAS

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The Woodbine Formation of north-central Texas contains a plethora of vertebrate material from a poorly known interval in the Cenomanian of North America. These discoveries are shedding light on a critical transitional period in terrestrial vertebrate communities, with recent work suggesting a faunal composition similar to contemporaneous Laramidian assemblages. Currently at least three taxa of large neosuchian crocodyliform are known from the Woodbine Formation: longirostrine forms *Woodbinesuchus* and *Terminonaris*, and a new species of broad-snouted, ecological generalist. Excavations at the Arlington Archosaur Site (AAS) have added a diversity of fragmentary remains attributed to small crocodyliforms. Specimens include a mandible, vertebrae, osteoderms, and teeth. The partial mandible is distinguished by its low tooth count (10-11 alveoli), elongate symphysis with splenial participation, no external mandibular fenestra, a dorsally-expanded surangular forming a coronoid-like process, and an angular possessing a dorsoventral ridge. The complete mandible would have been V-shaped in ventral view with a convex ventral margin in lateral view. The shortened toothrow and small number of enlarged posterior teeth suggests a more durophagus, or possibly omnivorous, diet. The phylogenetic position of the mandible is enigmatic, as it shares characteristics with multiple mesoeucrocodylian clades. Additional specimens include procoelous cervical and caudal vertebrae, similar to *Pachycheilosuchus* and *Wannchampsus*. Numerous elongate, keeled osteoderms are known: one type is rectangular with an imbricating anterior edge, while the other type is a convex, elongate oval. Both are similar to some notosuchian and non-eusuchian neosuchian taxa. Isolated teeth are small (2-4 mm) and lanceolate in shape, with distinct carina and weak longitudinal enamel ridges. These teeth resemble those of small heterodont notosuchian and neosuchian taxa. The AAS represents a freshwater or brackish wetland surrounded by densely forested vegetation in a distal floodplain. A high diversity of fossil crocodyliforms is not uncommon in these settings and is achieved through niche partitioning. The AAS material shows small-bodied and durophagus taxa lived alongside larger, more generalized forms, indicating that a broad taxonomic and ecological diversity of crocodyliforms existed in mid-Cretaceous Appalachia.

Grant Information**:**
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ORNITHOMIMID MATERIAL FROM THE LOWER SCOLLARD FORMATION (UPPER MAASTRICHTIAN) OF ALBERTA, CANADA, CONFIRMS THE PRESENCE OF ORNITHOMIMIDS, INCLUDING ONE LARGE-BODIED TAXON, AT THE END OF THE CRETACEOUS PRIOR TO THE CRETACEOUS-PALEOGENE BOUNDARY

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Although abundant in Campanian and lower Maastrichtian sediments of Alberta, Canada, diagnostic remains of ornithomimids are largely unknown from the upper Maastrichtian. This lack of fossils creates a gap in our understanding of ornithomimid diversity and evolution leading up to the Cretaceous-Paleogene (K-Pg) mass extinction. Here we report on two ornithomimid specimens, housed at the Royal Tyrrell Museum of Palaeontology (TMP), from the lower Scollard Formation of southern Alberta. TMP 1993.104.1 consists of an articulated left forelimb (distal half of the humerus, antebrachium, and manus), articulated gastralia, the distal right antebrachium, and isolated right metacarpals and phalanges. The moderately-curved, non-raptorial manual unguals are characteristic for the family Ornithomimidae and the length proportions of the metacarpals (MC), where MC I > MC II > MC III, is diagnostic of the genus *Ornithomimus*. The small size of the specimen and presence of only two lines of arrested growth (LAGs) in the humerus indicate that TMP 1993.104.1 is a juvenile individual. TMP 1998.026.1 consists of disarticulated hind limbs of large size, including left and right tibiae, right fibula, left metatarsals II-V, right metatarsals IV and V, a nearly complete right pes, and two phalanges from the left digit II. Pedal unguals have relatively straight ventral edges and possess a ventral depression without a flexor tubercle. The distal shaft of metatarsal III is wedge-shaped in cross-section and the distal plantar surface is pinched proximal to the articulating surface with the first pedal phalanx of digit III. Taken together, these features indicate the specimen is referable to Ornithomimidae. With metatarsal lengths exceeding 40 cm, TMP 1998.026.1 is within the size range of the large Asian ornithomimid, *Gallimimus bullatus,* and represents the largest ornithomimid remains known from the Edmonton Group Formations of Alberta. Tibia histology reveals the presence of five LAGs and absence of an external fundamental zone, indicating TMP 1998.026.1 is a sub-adult. The temporal and stratigraphic separation of TMP 1993.104.1 and TMP 1998.026.1 from other Alberta ornithomimids suggests that the Scollard specimens belong to different taxa, though comparison with upper Maastrichtian ornithomimids from the United States is necessary to determine if they represent entirely novel taxa. Ultimately, the Scollard material confirms the presence of ornithomimids in Alberta prior to the K-Pg extinction.

Grant Information**:**
NSERC Discovery Grant to DKZ

Technical Session XVII (Saturday, August 26, 2017, 12:00 PM)

THE ROLE OF GRASSES IN EAST AFRICAN VEGETATION DURING THE PAST 30 MILLION YEARS: NEW RESULTS AND PERSPECTIVES FROM PLANT SILICA (PHYTOLITH) ANALYSES

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Today, many animal species are specifically adapted to life in the savanna environment, which in Africa occupies ~50% of the land surface. The savanna biome is characterized by a continuous grass substratum, which feeds zebras, rhinos, and a variety of bovids, all known for possessing tooth morphologies adapted to processing abrasive grasses and soil particles indirectly ingested with them. We seek to document the history of savannas — i.e., grasses (Poaceae) — in the geologic past of Africa, in order to elucidate what could have triggered the expansion of these ecosystems in this part of the world. On other continents, grass silica remains (phytoliths) indicate that the first grass-dominated habitats appeared asynchronously during the Oligocene to Pliocene epochs, and either before or after grasses became a significant part in the diet of herbivorous mammals. In Africa, carbon isotope ratios of mammal tooth enamel suggest a diet of mainly (C_4) grasses for many species by the late Miocene (10-9 Ma) of East Africa, whereas some paleoenvironmental data indicate a significant expansion of (C_3) grass-dominated environments at least two million years earlier, likely during the early Miocene (15-13 Ma). However, most of these paleoenvironmental reconstructions are either not based on direct, paleobotanical remains, or they are based on very sparse plant fossils that cannot reliably infer grass community composition (e.g., they cannot differentiate C_3 from C_4 grasses) and relative abundance in past vegetation of East Africa. To fill this gap, and test previous hypothesis for the timing and causes for the emergence of African savannas, we have conducted phytolith analyses in a series of deposits dated from before, during, and after grass-dominated vegetation is thought to have expanded in East Africa. Specifically, we will discuss results from study of phytolith assemblages from terrestrial paleosols and sediments from the Chilga (28-27 Ma) and Mush (22 Ma) localities in Ethiopia and one locality from Rusinga Island (ca. 18 Ma) in Kenya, and marine core sediments off the East African coast and dated from 8 to 1 Ma. Preliminary results indicate that PACMAD grasses were present at least by the time of deposition of the Rusinga site R3, although it is not yet clear how abundant they were. This adds to the previous interpretation of this site as a forest by showing that grasses existed in the understory or in forest openings.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE DEVIL IS IN THE DETAILS: NEW EVIDENCE OF THE PRIMITIVE SNAKE *DIABLOPHIS* FROM THE JURASSIC OF UTAH, U.S.A.

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A locality in the Morrison Formation of eastern Utah that is stratigraphically and depositionally comparable to microvertebrate localities in the Fruita Paleontological Area (FPA) of western Colorado has produced lepidosauromorphan specimens including a dentary of the snake *Diablophis gilmorei*, a snake vertebra, and squamate quadrate. Like the holotype mandible of *D. gilmorei* from FPA the new dentary combines the non-snake lizard features of multiple mental foramina (also present in the primitive snakes *Eophis*, *Portugalophis*, *Pachyrachis*, *Najash*, and *Yurlunggur*) and a well-developed subdental lamina enclosing a subdental sulcus (also in *Portugolophis* and weakly developed in *Eophis* and *Yurlunggur*) with the snake features of conical, recurved teeth with medial and lateral carinae, and tooth bases attached atop 3-sided alveoli. The new dentary additionally preserves the posterior portion of the element demonstrating the snake-like feature of a deeply incised posterolateral margin for articulation with the compound bone with a toothed portion of the dentary overlapping the intramandibular joint. The vertebra possesses the snake-like combination of a circular condyle surrounded by a narrow bony ridge of the centrum, tall synapophyses, trefoil-shaped neural canal, and small zygosphene platform. This anatomy is identical to vertebrae referred to *D. gilmorei*

(FPA) and very similar to those referred to *Parviraptor estesi* (Early Cretaceous; England). The quadrate has a well-developed conch with a suprastapedial process, and a narrow saddle-shaped articular condyle. The quadrate is trapezoidal in shape, but the medial margin/pterygoid flange of the inferior portion is broken. Among snakes, the general shape and dimensions of this quadrate are similar to those of *Eupodophis* and *Haasiophis*, but is much narrower than that of *Pachyrachis* and much taller than those of *Cylindrophis*, *Dinilysia*, and *Najash*. The new quadrate is consistent with, but not definitively snake; referral to a non-snake lizard cannot be ruled out. However, both the dentary and the vertebra confirm the presence of at least one snake in the Morrison Formation possessing a serpentian vertebral form and a mandibular anatomy that combines derived aspects of snake cranial construction while retaining some primitive/non-snake lizard features. A nearly identical dentary anatomy is known for *Portugalophis lignites* from the paracontemporaneous Guimarota coals in Portugal confirming a wide distribution of this form of primitive snakes across much of Laurasia by the Late Jurassic.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MOLES (TALPIDAE) FROM THE GRAY FOSSIL SITE, TN

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The Gray Fossil Site (GFS), a late Miocene/early Pliocene aged (7 – 4.5 Ma) quarry site in northeastern Tennessee, is one of the richest Cenozoic localities in the eastern United States. To date, thousands of microfauna specimens have been collected, but few small mammals have been identified and thoroughly studied. This study described the first talpid specimens recovered from the GFS. Using measurements and comparisons of dental and humerus morphology, we identify 4 talpid species (*Parascalops breweri*, *Quyania europaea*, "*Scalopoides*", and an unidentified desman) occurring at the GFS. GFS *Parascalops breweri* is morphologically identical to, and falls within in the biogeographic range of, extant *P. breweri*, representing the first pre-Pleistocene record of the genus in North America and earliest record globally. "*Scalopoides*" is known from the North American fossil record at many middle and late Miocene sites, as well as late Miocene and Pliocene records from Germany, Bulgaria, France, and Spain. The GFS specimens are the first late Miocene/early Pliocene occurrences of "*Scalopoides*" in the eastern United States. *Quyania europaea* is only known from the Plio/Pleistocene of Poland, making the GFS specimens the first occurrences of this taxon outside of Europe, and also represents the earliest shrew-mole (Neurotrichini) in North America. The tribe Desmanini is well known from the fossil record of Eurasia, but very few specimens have been found in North America, making the GFS specimen the third occurrence of a desman in North America. The GFS talpids are important because they improve our understanding of talpid dispersals between North America and Eurasia, and help reveal how they have evolved through time.

Technical Session IV (Wednesday, August 23, 2017, 2:15 PM)

MESOWEAR METHOD COMPARISONS DEMONSTRATE NARROWER ORDINAL SCALES ARE MORE PREDICTIVE OF DIETARY AND ECOLOGICAL VARIABLES

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Mesowear is a paleo-dietary proxy that measures degree of facet development on selenodont ungulate molars. It is primarily used to calculate attrition and abrasion, wherein attrition reflects tooth-to-tooth contact and abrasion reflects food-to-tooth contact. Facets are created by the process of attrition and are obliterated by the process of abrasion. When these factors are quantified, they are thought to reliably predict diet across a spectrum of grazing, browsing, mixed-feeding, and frugivory. In addition to diet, mesowear scores also signal general habitat structure and food availability, as validated using stable isotopes. Due to its utility as both a dietary and ecological proxy, mesowear scoring has become increasingly popular in paleoecological literature, and a number of elaborations to the original method have been developed. These elaborations vary in the range of their ordinal scaling, from 0-to-3 to 0-to-6. Currently, the equivalency of these methods and their relative efficacy in predicting ecological parameters remains enigmatic.

Here we compare three mesowear metrics (0-to-3, 0-to-4, and 0-to-6) across 30 species within Euungulata, evaluating their relative similarity and their correlation with ecological variables including precipitation (average mm/month) and average percent dietary grass, as well as diet and habitat categories. We examined relative similarity using stochastic character mapping within a phylogenetic comparative framework. Discrepant mesowear intensities were returned for 37% of species (11/30), suggesting that not all methods share similar efficacy. We next tested the predictive power of all three mesowear metrics against our series of ecometrics using multivariate partial least squares regression. Correlation values returned by this series of regressions indicate that 0-to-3 marginally outperforms 0-to-4 as the most predictive of all ecological variables ($r > 90\%$), with 0-to-6 having uniformly weak correlations ($r < 80\%$). Based on these results, we recommend the use of mesowear scoring methods with narrower ordinal ranges.

Grant Information**:**
Irene Levy Sala CARE Grant

Technical Session VII (Thursday, August 24, 2017, 2:45 PM)

THE TROPHIC HABITS OF EARLY BIRDS

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Although direct associations that reveal diet are extremely rare in the fossil record, the rich Lower Cretaceous Jehol lagerstätten has produced dozens of specimens preserving ingested items that reveal the early evolution of the avian alimentary canal. Direct evidence indicates *Jeholornis* and *Sapeornis* ate seeds and like living granivores utilized a gastric mill although only the more derived *Sapeornis* possessed a crop for food storage. Despite their fewer numbers in the Early Cretaceous, most direct evidence pertains to the Ornithuromorpha, indicating a structurally and functionally modern alimentary canal was present in even the earliest members of this clade. Similar evidence is altogether lacking in the Enantiornithes suggesting this clade was characterized by a primitive alimentary canal, potentially factoring into the ultimate extinction of this successful Cretaceous lineage. Gastroliths coincide with reduced dentition in all known ornithuromorphs with the exception of *Hongshanornis* indicating the role of the gizzard in the loss of teeth in Aves is more complex than in non-avian theropod lineages. Positive selection for specialized tooth morphologies persists throughout the evolution of Aves and in the Ornithuromorpha appears to be linked to piscivory. Although represented by the greatest numbers, no direct indicator of diet preference is preserved in any confuciusornithiform or enantiornithine suggesting these clades utilized different nutritional strategies. The absence of teeth and gastroliths in all confuciusornithiforms suggest this lineage may be secondarily carnivorous. Similarly, the absence of gizzard stones in enantiornithines also suggests carnivory while their small body size suggests Early Cretaceous species would have fed on invertebrates. The diversity of recognized dental patterns including enamel specializations observed in Jehol enantiornithines suggests effective resource partitioning of available invertebrate faunas.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

WELL-PRESERVED PELVISES OF PLOTOPTERID BIRDS FROM THE ASHIYA GROUP (LATE OLIGOCENE), NORTHERN KYUSHU, JAPAN

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More than ten plotopterid birds have been described from the Eo-Miocene marine sediments of North Pacific regions, however some species were based on fragmentary or disarticulated materials. From the Ashiya Group (Late Oligocene) of northern Kyushu, Japan, two species were described; *Copepteryx hexeris* based on articulated upper body elements, some isolated limb elements, and not well-preserved pelvic region, and *Copepteryx titan* based on the large left femur. In other plotopterid fossils, few well-preserved pelvises have been reported. Two well-preserved and two partial pelvises of plotopterid birds are found from the Ashiya Group. While the well-preserved specimens are hourglass-like shapes in dorsal views, which is recognized in *Copepteryx hexeris*, these pelvises are smaller and more slender than that of *Copepteryx hexeris*. At least five foramina intertransversaria are recognized in the synsacrum region of the well-preserved specimens. The edge of ala preacetabularis ilii of both the well-preserved specimens are well rounded and wider than those of *Hokkaidornis abashiriensis* and *Tonsala hildegardae*. Regarding the two well-preserved specimens, the widths of each ala postacetabularis ilii region are different (slender and wider types). In the wider type, the spina dorsolateralis ilii is thicker and fossa iliocaudalis is well developed compared with the slender type. The sulcus ventralis synsacri of the slender type is more concave than that of the wider type. It indicates that the two well-preserved specimens belong to different species from *Copepteryx hexeris* and *Copepteryx titan*, and also suggests that the plotopterid birds were diversified in the northwestern Pacific region as well as the northeastern Pacific region.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

ACCOMPLISHMENT REPORT: SPECIMEN RESCUE PROJECT WITH THE TSUNAMI RELIEF FUND RAISED IN THE 2011 SVP MEETING, LAS VEGAS

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The 2011 Tohoku earthquake struck off the coast of northern Japan and triggered destructive tsunami waves, which caused the lost of tens of thousands of lives and massive economic crisis in coastal areas. Japanese participants at the 71st Society of Vertebrate Paleontology (SVP) annual meeting in Las Vegas urgently gave a poster presentation about the local museums severely damaged by the disaster and about the Specimen Rescue project for recovering and repairing damaged the paleontological specimens of the museums. Along with the presentation, we received many encouraging messages and relief donations from SVP participants. The messages were sent to the organizers of Specimen Rescue, and the relief fund was transferred officially from SVP to the Palaeontological Society of Japan (PSJ).

The Specimen Rescue Committee of PSJ decided to use the SVP relief fund for restoration of the cast specimen of *Tsintaosaurus* damaged by the disaster at the lobby of the Hirono town office, Fukushima, Japan. In addition to SVP relief fund, donations from PSJ and cloud funding also contributed to the restoration project. The cloud funding achieved its goal with the donations from more than 400 participants. The restoration was completed in January 2016, and the repaired *Tsintaosaurus* specimen was exhibited at a traveling exhibition in Tokyo, Kitakyushu, and Osaka from March 2016 to January 2017. A total of more than 780,000 visitors attended this exhibition and saw the repaired cast. It was returned to the lobby of the Hirono town office after the tour. On February 14, 2017, the unveiling ceremony for the newly repaired specimen was held with attendance of the mayor of Hirono town, elementary school students of Hirono town, and involved parties. The SVP contribution to this project is shown on a plaque placed in the *Tsintaosaurus* exhibition. We sincerely appreciate the understanding and cooperation of SVP and SVP members for their kind support.

Grant Information:
This project was supported by the donations of SVP and PSJ.

Podium Symposium (Wednesday, August 23, 2017, 9:00 AM)

PALEOHISTOLOGY OF A HUMERAL GROWTH SERIES FROM THE CRETACEOUS PLESIOSAUR *DOLICHORHYNCHOPS*: NEW INSIGHTS ON PLESIOSAUR ONTOGENY

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The recent description of a pregnant specimen of *Polycotylus latipinnis* demonstrates that plesiosaurs were viviparous. To widen the base of data concerning ontogeny and life history of plesiosaurs, we gathered both morphologic and histologic data on a securely identified growth series of polycotylids from the Pierre Shale of South Dakota. This material consists of three specimens, an adult, a small juvenile, and a fetus. The adult and juvenile are partial skeletons recovered from the same locality, each comprising a skull and partial postcranium referable to *Dolichorhynchops bonneri*. The fetus is an isolated humerus and is referable only to Polycotylidae. Relative size estimates were calculated from humerus and femur lengths. The juvenile is 40% the size of the adult, very close to the birth size estimated for the fetal material in *Polycotylus*, and hence we predict it is a neonate. The isolated humerus is 28% of adult size, smaller in relative terms than the fetus from the pregnant *Polycotylus*, and hence we predict it is a pre-term fetus.

Paleohistological thin sections were prepared from the three humeri; sections were taken from the shaft three quarters distally. Analysis using plain and polarized light of the adult shows a dense, heavily remodeled cortex consisting entirely of longitudinally oriented secondary osteons. This cortex grades gradually into the endosteum, comprising large vascular canals surrounded by laminar endosteal bone, and lacking a marrow cavity. The fetal humerus possesses an endosteum similar to that of the adult, but the cortex differs. This is a relatively thin layer of periosteal bone, radially vascularized, and interfingered with columns of osteoblasts surrounded by rapidly-deposited extracellular matrix. The neonatal humerus resembles the fetus, and its endosteum is identical in both size and histology. The cortex is also similar but much thicker, consisting entirely of rapidly deposited radial bone. The cortex carries a birth line near its surface. This is not a LAG, but a sudden change in vascular angle and increase in bone density. The birth line indicates a change in growth regime, possibly in response to increased hydrodynamic forces after birth. The birth line indicates that the neonate was just under 40% of maternal length when born, consistent with previous estimates. Our histological evidence demonstrates that polycotylids were viviparous, birth size was large, and fetal growth rates were very high.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

FIRST OCCURRENCE OF A LARGE PLEISTOCENE ALLIGATORIDAE FROM THE CENTRAL BRAZIL

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Extant Alligatoridae are find in Eastern North America, Central America, South America and Eastern China. In Brazil there are at least six extant species recognized: *Paleosuchus palpebrosos*, *Paleosuchus trigonatus*, *Melanosuchus niger*, *Caiman crocodilus*, *Caiman latirostris* e *Caiman yacare*. Pleistocene alligators have been record in North, Northeast, Southeast and South regions from Brazil. Herein we reported the first occurrence of Pleistocene alligator in Central Brazil. The fossils consist in three dorsal osteoderms labeled RF14, RF15 and RF17, housed in the collection of Laboratório de Zoologia (Universidade Federal de Mato Grosso do Sul, Brazil) collected on Formoso river (lat -21.097749°; long -56.229375°) about 30 km Eastern Bonito city. Such fluvial deposits are placed in the context of hydrographic basin of Miranda river, where several mammals and gastropod shell fossils of late Pleistocene/early Holocene ages have been deposited. Both RF14 and RF15 are fragmented, which makes it difficult to recognize their original shape. The osteoderms showing abrasion signs in shape of broken and roudend extremity, evidencing a long-distance transport. Nonetheless, the element RF15 displays a circular shape. The diameters vary among 4 and 6 cm for all osteoderms analyzed herein. On dorsal surface is present a central keel, which is more conspicuous for RF14 and RF15. Sculpting like pits enlarge from the center to external margins. REF15 showing a more discrept sculpting, with large ridges and few pits. RF14 and RF17 the ridges are thin and the pits are large. This allow to interpret RF15 as a juvenile specimen while RF14 and RF17 are more mature individuals. According to description aforementioned, we attribute the material analyzed to Caimaninae. The large size of osteoderm is compatible to extant alligator *Melanosuchus niger*, living in the Northern South America including part of Brazil. However, there is no information enough to identify the species. Another possibility would be consider the osteoderm belonging to giant extinct caimans, like *Melanosuchus fisheri*, from Miocene/Pliocene from Venezuela. In any case, the material identified herein are the larger alligators specimens reported for late Pleistocene/early Holocene from the Central Brazil. Nowadays *Melanosuchus niger* are found in more northerly regions of the Amazon River basin in South America. The presence of *Melanosuchus* genus in central parts of South American, if confirm, can attest a more widely distribution to this genus prior Holocene.

Technical Session XVIII (Saturday, August 26, 2017, 9:15 AM)

PATTERNS OF TOOTH REPLACEMENT IN THE EARLY DICYNODONT *ABAJUDON* AND THE ORIGIN OF MULTIPLE TOOTH ROWS IN *ENDOTHIODON*

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Early in their evolution, several amniote clades independently adopted an herbivorous diet and experimented with different ways of processing high-fiber plant material. Several taxa evolved multiple rows of marginal teeth to cut and grind food. This mode of herbivory is found in the dicynodont genus *Endothiodon*, with some specimens of *E. bathystoma* possessing multiple tooth rows on the maxilla and premaxilla. It has been determined that these extra rows represent multiple *Zahnreihen*, or waves of replacement teeth, that are fully erupted contemporaneously. The mechanism by which teeth of older *Zahnreihen* were retained longer is unclear. Newly collected material of *Abajudon kaayai*, the sister taxon to *Endothiodon*, can shed light on the evolution of this character. We used micro-CT scans to visualize the incoming replacement maxillary and premaxillary teeth in *Abajudon*. Tooth replacement was rapid in *Abajudon*, with replacement teeth already developing adjacent to fairly young teeth. Mapping the *Zahnreihen* of *Abajudon* reveals a pattern of alternating tooth replacement that is very similar to what is seen in the functional teeth of *E. bathystoma*. This similarity suggests that the multiple tooth rows of *E. bathystoma* originated by each *Zahnreihe* drifting labially, allowing older teeth to avoid erosion, similar to what has been proposed for captorhinid reptiles with multiple tooth rows. In captorhinids, the teeth are ankylosed to the jaw bone within shallow sockets and multiple tooth rows are formed by asymmetrical growth and remodeling of the jaw bone, causing erupted teeth to drift labially relative to the stationary dental lamina. In contrast, the teeth of *Abajudon* are set in deep sockets, with a relatively large periodontal space, which suggests a soft-tissue attachment to the surrounding bone (gomphosis). If a gomphosis occurred in *E. bathystoma*, it would be the first vertebrate with multiple tooth rows and this tooth attachment type, indicating that ankylosis is not a prerequisite for multiple tooth rows to evolve. The alteration of *Zahnreihen* in unrelated taxa with different types of tooth attachment shows that this is a common way to evolve multiple rows of marginal teeth, and it may be expected in other amniotes with multiple tooth rows.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THE SYSTEMATIC REVISION OF THE EARLY MIOCENE *PSEUDOEPICRATES* (SERPENTES, BOIDAE) SHEDS LIGHT ON THE EVOLUTIONARY AND HISTORICAL BIOGEOGRAPHY OF THE WEST INDIAN BOID SNAKES (*CHILABOTHRUS*)

ONARY, Silvio Y., USP, Brazil, Ribeirão Preto, Brazil; HSIOU, Annie S., Ribeirão Preto, Brazil

The early Miocene genus *Pseudoepicrates* (Boidae, Boinae) is a North American boid snake with taxonomical controversial problems. Originally, the fossils were described by Vanzolini (1952) as belonging to the genus *Neurodromicus* with two species: *N. stanolseni* and *N. barbouri*. Auffenberg (1963) revaluated the material, proposing the species *Pseudoepicrates stanolseni*, which included all referred material into the taxon. Kluge (1988) considered one specimen as a junior synonym of the extant boid *Boa constrictor*, although supporting the species *P. stanolseni*. Recently, Albino (2011) proposed the synonymization of all specimens of *Pseudoepicrates* as *B. constrictor*, arguing that were not observed morphological differences between the Miocene fossils to the extant species. Due to the several interpretations regarding this taxon, here we provide the review of the systematic affinities of *P. stanolseni*, showing its paleobiogegographical and evolutionary implications within Boinae. The redescription was based on all attributed material of *Pseudoepicrates* deposited at the American Museum of Natural History (AMNH) and the Museum of Comparative Zoology (MCZ), together with the comparison with specimens of extant genera of boids. Our analysis suggests that the genus is an invalid extinct taxon, as well as, the fossils cannot be attributed to *B. constrictor*. Instead, the fossils here are synonymized as the extant West Indian boid genus *Chilabothrus* sp. due to the following combination of vertebral characters, exclusively shared among the group: (1) zygosphene with the anterior border crenate with a weakly projection of the median lobe and rounded lateral edges; (2) neural spine well developed, shortened anteroposteriorly, nearly perpendicular in relation to the vertebral centrum, being ellipsoidal shaped in dorsal view. The proposal of synonymization as *Chilabothrus* evidences the oldest record of the genus, marking at least the age of ±18.5 Ma. for the origin of the clade. The presence of *Chilabothrus* in the early Miocene of Florida supports the biogeographical analysis proposed in previous molecular studies, indicating that the genus could be reached the West Indian island complex around 22 Ma., dispersing to the North American territory by at least 18.5 Ma., being posteriorly extinct during the Neogene/ Quaternary boundary due to climatic oscillations, once currently the species do not inhabit the continent.

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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HEMPHILLIAN CARNIVORANS FROM THE INLAND NORTHWEST

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The Inland Northwest of North America has yielded a diverse Late Miocene vertebrate fauna. This large fossil record, along with the region's position as a biogeographic crossroads, its active tectonics, and its detailed paleoenvironmental record have made it a natural paleoecological laboratory. Deposits from the Hemphillian North American Land Mammal Age, most notably the Rattlesnake, Drewsey, and Thousand Creek Formations and the Dalles Group, are particularly rich and have been the focus of extensive study. The carnivoran fauna of the Hemphillian Inland Northwest is of particular interest, not only due to a wealth of both cranial and postcranial material, but to some of the earliest reported North American occurrences of ursine bears and large felids, among the last occurrences of *Barbourofelis*, and the presence of a wide diversity of musteloid and canid taxa. However, several early descriptions of carnivorans in the area are based on fragmentary material or have been attributed to *nomina dubia* and many important fossils from the Snake River and Dalles Basins have never been formally described, leaving our understanding of Hemphillian carnivores in the region incomplete. We present a survey of published material from the Hemphillian of the Inland Northwest augmented by previously undescribed specimens from regional collections and by recent fieldwork in the Dalles Basin. The only feliforms previously reported from the region are *Barbourofelis*, *Pseudaelurus*, and *Machairodus*, but a partial skeleton from the Chalk Hill

Formation of western Idaho indicates the presence of the endemic North American felid *Nimravides*. Postcrania previously attributed to *Machairodus* likely actually represents *Nimravides*, leaving the evidence for true machairodontines in the region ambiguous at best. Caniforms are much more common, with ursids, procyonids, mephitids, canids, and mustelids all present. The latter two families are especially well represented. Canids from the Inland Northwest reflect patterns of diversity seen on a continental scale, with a small number of large-bodied borophagines and many taxa of small-bodied canins and vulpins. The region's mustelid fauna presents several opportunities for more detailed research, comprising multiple taxa and a spectrum of body sizes ranging from *Plionictis* to *Plesiogulo*. Musteloid remains are especially common from the Dalles Basin, and ongoing fieldwork in the area is likely to further elucidate the diversity of Hemphillian procyonids, mephitids, and mustelids.

Technical Session V (Wednesday, August 23, 2017, 2:00 PM)

A BAYESIAN APPROACH TO TERRESTRIAL PALEOECOLOGY: PALEOENVIRONMENTAL MIXING IN VERTEBRATE MICROFOSSIL ASSEMBLAGES FROM THE DINOSAUR PARK FORMATION (UPPER CRETACEOUS)

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Vertebrate microfossil bonebeds (VMBs) often yield assortments of different taxa in different relative abundances, suggestive of paleoenvironmental differences among sites. Different taxon relative abundances between stratigraphically older and younger VMBs within the same sequence may reflect faunal responses to paleoenvironmental change over time. However, different local factors can cause taxon specimen counts to vary considerably among similar deposits, limiting our ability to isolate and quantify broader faunal responses. For example, although VMBs at the opposite ends of a transgressive sequence may appear generally distinct from one another, specimen counts from individual sites may differ in ways that obscure broader patterns and complicate our ability to quantify marginal faunal changes over time.

Bayesian mixing models may allow us to account for variability among VMBs and quantify the extent to which intermediate sites reflect distinct end-member compositions. We applied a standard Bayesian mixing model to quantify faunal changes associated with a marine transgression in the Upper Cretaceous Dinosaur Park Formation, using published data on specimen counts from 30 separate VMBs. Four of these have been described as 'transitional' assemblages. We characterized these sites relative to three different end-member conditions represented by other assemblages—upland, lowland, and marine—using a three-source, two-tracer mixing model. Different percent abundances of different common taxa provided the habitat signal 'tracers' necessary to quantify the proportional similarity of the 'transitional' deposits to each end-member habitat.

We ultimately ran the model on 75 different combinations of taxa, of which 26 allowed us to effectively differentiate the habitat end-members. Only one combination yielded well-constrained posterior distributions that permitted estimation of habitat similarity. Comparing the percent abundance of salamander-like lissamphibians (Caudata + Allocaudata) and Chelydridae identified the 'transitional' assemblages as primarily 'marine' with limited terrestrial influences: 83.6 ± 0.06% marine, 9.7 ± 0.06% lowland, and 6.7 ± 0.05% upland terrestrial. This result suggests estuarine expansion concurrent with the accumulation of these deposits, which provides a context for evaluating the abundance and diversity of non-marine taxa at these sites. The results confirm that Bayesian mixing models can be used to quantify faunal differences among VMBs with compositional overlap.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

HOLD ME CLOSER TINY FOSSIL: A RICH MICROVERTEBRATE FAUNA FROM THE ARLINGTON ARCHOSAUR SITE (WOODBINE FORMATION, CENOMANIAN) OF NORTH-CENTRAL TEXAS

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The Arlington Archosaur Site (AAS) is a locality within the Woodbine Formation of north-central Texas, outside the city of Dallas. The AAS has produced a rich terrestrial flora and fauna representing a complex coastal deltaic paleoenvironment. This site was located on the southeastern margin of the Western Interior Seaway and is an important representative of the poorly known Mid-Cretaceous (Cenomanian) fauna. No other documented Appalachian sites from this time period contain a faunal diversity comparative to the AAS. This project reevaluates previously collected microvertebrate material and introduces taxa recovered from recent sediment screenwashing, some of which may be newly documented taxa within Appalachia. Specimens described from the AAS to date have mainly consisted of larger vertebrates, including dinosaurs and multiple crocodyliforms. In addition to these specimens there is a remarkable microvertebrate fauna. Recently, small-scale screenwashing work has resumed, focused on mudstone matrix recovered from field jackets collected over the last four years from the AAS. Matrix samples are placed in window screen bags and soaked in water for 24-48 hours, rinsed, and air-dried prior to being examined under a microscope. The remains include isolated skeletal elements, mostly less than five millimeters in size, and consist of a wide variety of teeth, vertebrae, small limb elements, and scales. Some of these microvertebrates represent well-known taxa from the Woodbine Formation including myledaphine ray teeth and dermal spines, ginglymodian ganoid scales, and *Onchopristis* oral and rostral teeth. Other recovered elements represent new occurrences of taxa for the Woodbine Formation, including: vertebrae from Serpentes (cf. *Coniophis)*, a sirenid salamander vertebra, elasmobranch teeth, and osteichthyan teeth, vertebrae, and skull bones. The presence of these microvertebrate remains in the Cenomanian of Appalachia offers a more comprehensive representation of taxonomic diversity during this time and place in North America. The taxonomic composition and diversity within the AAS is comparable to coeval deposits from Laramidia and offers insights into the complex paleoecology of southern Appalachia and early diversification of vertebrate faunas on either side the Western Interior Seaway.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 10:30 AM)

A RASH OF RHIZODONTS: CHARACTERIZING A VERTEBRATE BIOTA IN THE IMMEDIATE POST-DEVONIAN WORLD

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The end-Devonian mass extinction has been framed as a turning point in vertebrate evolution, enabling the radiation of tetrapods, chondrichthyans, and actinopterygians in the Carboniferous and beyond. Until very recently 'Romer's Gap' rendered the early Carboniferous a black box standing between the Devonian and the later Carboniferous, but now new early Carboniferous (Tournaisian, 359-347Ma) localities are filling this interval. Recent work has recovered Tournaisian tetrapod and lungfish diversity in contrast with previous expectations. However, the question still remains of what kinds of faunas these animals constituted. Are early Carboniferous assemblages populated by Devonian hangovers, or are they more similar to later Carboniferous faunas?

Here we report on a Tournaisian vertebrate fauna from a well-characterized, narrow stratigraphic interval from the Ballagan Formation exposed at Burnmouth, Scotland. Microfossils suggest brackish conditions and sedimentology indicates a low-energy vegetated floodplain debris flow. A range of bone sizes is preserved. Among vertebrates, rhizodonts are represented by the most material. Though rhizodonts are present elsewhere in the Ballagan, their dominance in this interval is unusual. Lungfish are represented by several species. There is one named tetrapod, *Aytonerpeton*, a small colosteid-like form, with at least two others represented by additional specimens. Gyracanths and actinopterygian fishes are represented by rarer material. Faunal similarity analysis using a dataset of Devonian-Carboniferous (Givetian-Serpukhovian) sites corroborates a persistent Devonian/Carboniferous split.

Results indicate that vertebrate ecosystems were established and diverse in the early Carboniferous and that they were not composed of Devonian relicts or disaster taxa. Rhizodonts and lungfish flourished in defiance of historical conceptions, and tetrapods were diverse and had attained a range of body sizes. The Devonian/Carboniferous split from the faunal analysis contrasts with work on tetrapods that suggests some blurring of the Devonian/Carboniferous boundary in the evolution of certain groups.

Grant Information**:**
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Technical Session XII (Friday, August 25, 2017, 10:15 AM)

PALEOECOLOGICAL IMPLICATIONS OF THE INNER EAR MORPHOLOGY OF THE AUSTRALIAN FOSSIL SNAKES *YURLUNGGUR* AND *WONAMBI* (SQUAMATA, SERPENTES, MADTSOIIDAE)

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Madtsoiids are an extinct group of basal snakes whose first appearance in the fossil record dates back to the Upper Cretaceous (Cenomanian), and although most representatives of this lineage went extinct by the end of the Eocene, some survived in Australia until the late Pleistocene.

The paleoecology of these snakes is still very poorly known, and its knowledge may be key to our understanding of potential climatic factors that were involved in their evolution and extinction. We micro-CT scanned the braincase of two of the best-known madtsoiid snakes, *Yurlunggur* and *Wonambi*, from respectively Oligocene and Pleistocene deposits of Australia. The morphology of the most complete digital endocast, i.e. that of *Yurlunggur*, was then compared to that of the inner ears of 80 extant species of snakes and lizards with known ecological preferences using three-dimensional geometric morphometrics. The results of our principal components analysis, canonical variates analysis, and statistical tests show that phylogenetic signal can affect the grouping of closely related taxa, but also that there is a significant correlation between morphology and ecology overall.

While some ecological groups (aquatic and fossorial/semifossorial) are fairly well defined, other ecological groups tend to show a broader overlap (e.g. generalist and arboreal) groups. The inner ear of *Yurlunggur* most closely resembles both that of certain semiaquatic snakes (e.g. the homalopsid *Cerberus*) and that of some semifossorial snakes (e.g. the elapid *Simoselaps*). While the digital endocast of the inner ear of *Wonambi* is too incomplete to be included in a geometric morphometrics analysis, a comparison of the available features to those of *Yurlunggur* indicates that its inner ear most likely had a fairly different morphology. Inner ear morphology in these two madtsoiids therefore does not seem to be strongly conserved, suggesting that the differences may indeed be ecologically correlated.

A semiaquatic or litter-swimming lifestyle in *Yurlunggur* in a wet-tropical northern Australia would be consistent with the extinction of its lineage being driven by aridification at the end of the Miocene. The morphologically different inner ear of *Wonambi* suggests that its ecology differed from that of *Yurlunggur*, consistent with the markedly cooler and drier environment of the Plio-Pleistocene in southern Australia.

Grant Information:
Australian Research Council
Sir Mark Mitchell Research Foundation

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

MORPHOLOGY OF THE PETROSAL AND STAPES OF *BOREALESTES SERENDIPITUS* (MAMMALIAFORMES, DOCODONTA) FROM THE JURASSIC OF SKYE, SCOTLAND

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The anatomy of the petrosal and inner ear of early mammaliaforms is key to understanding the early evolution of the mammalian ear. Docodonta are basal mammaliaforms with a Laurasian distribution, and are known from the Middle Jurassic to the Early Cretaceous. They are relatives of the living mammals, but the order is of particular interest as they have recently been found to be unexpectedly ecologically diverse. The only docodont petrosal for which the anatomy has been described, is *Haldanodon exspectatus*, from the Late Jurassic of Portugal.

For the first time, we describe the petrosal and the stapes of the basal docodontan mammaliaform, *Borealestes serendipitus*, from the Middle Jurassic of Scotland. We used microCT scans of the petrosal from a so far undescribed skeleton from the Isle of Skye to digitally reconstruct the petrosal. We generated an inner ear endocast and revealed most of the inner ear structures of *Borealestes*. The high quality of the scan includes the innervation and blood supply in exceptional detail.

Borealestes and *Haldanodon* are similar in many inner ear features. As in *Haldanodon*, there is no bony ridge (i.e., the secondary lamina) on the medial surface of the cochlear canal. Unfortunately the caudalmost portion of the cochlear canal is missing, and we cannot therefore say whether it has an inflated tip like *Haldanodon*. However, the cochlear canal body is clearly curved. The high quality of the microCTscan allows us to trace the blood supply along the length of the cochlear canal. We repositioned the broken portions of the crista intrafenestralis, and have been able to trace the path of the greater petrosal nerve, the geniculate ganglion, facial nerve VII, and foramen for the cochlear nerve.

As in other Mesozoic mammals, the perilymphatic duct sits in a bony sulcus and is not separated from the fenestra cochleae as in modern mammals: the perilymphatic duct and fenestra cochleae are confluent forming the perilymphatic foramen. The base of the crus commune, anterior semicircular canal ampulla and posterior semicurcular canal ampulla are preserved, but the semi-circular canals are broken. We also recovered and reconstructed the fragmentary remains of the stapes from within the petrosal, including the stapedial footplate and anterior crus.

Borealestes is the stratigraphically earliest docodontan to have an intact petrosal described, giving us a unique insight into the basal morphology of this structure in Docodonta. It also adds to the growing body of important fossil material coming from the Bathonian rocks of Scotland.

Grant Information:
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Technical Session XII (Friday, August 25, 2017, 8:45 AM)

HOMOLOGIES OF THE ILIAC PROCESSES IN MOSASAUROIDS AND NEW INSIGHTS IN THE PLESIOPELVIC–HYDROPELVIC TRANSITION

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Based on the morphology of the sacral region, mosasauroids can be divided into: (1) plesiopelvic taxa, where a bony articulation between the pelvic girdle and sacral ribs is retained; and (2) hydropelvic taxa, where such articulation is lost. However, the question concerning the mode of the plesiopelvic-hydropelvic transition in mosasauroids remains largely unanswered. Our analysis of new material assignable to *Tethysaurus*, and the revision of mosasauroid appendicular skeletons, contribute to clarifying the morphological details of this transition. Among the new material, one specimen has a complete pelvic girdle with the ilium bearing two distinct articular facets for the sacral ribs on the posteriorly elongate iliac process, and also a short, squared off preacetabular process overlapping the pubis. Interestingly, this specimen lacks any evidence of the supracetabular iliac tubercle exhibited in many lizards. The preacetabular iliac process that extends anteroventrally is also found in other plesiopelvic mosasauroids and most extant lizards, even though its morphology appears very different in the latter, where complete fusion of the pelvic bones can occur during ontogeny. The preacetabular iliac process in plesiopelvic mosasauroids contributes to a sinusoid outline of the pubic articular facet on the ilium, whereas the same facet becomes straight in hydropelvic forms. The anterodorsal iliac process of hydropelvic mosasauroids lacks any trace of articular facets for sacral ribs, hinting to its non-homology with the postiliac process of plesiopelvic forms. Moreover, while in tylosaurines there is no evidence of a postiliac process, a mosasaurine ilium still exhibits a small posterior projection in the same anatomical position where the postiliac process of most extant lizards and plesiopelvic mosasauroids is located. Our observations suggest that the anterior iliac process of hydropelvic mosasauroids may be derived from the elongation of the anterodorsal supracetabular tubercle of a plesiopelvic ancestor, based on: (1) the lack of articular facets for sacral ribs, present instead on the postiliac process of most lizards; (2) the anatomical position of the anterodorsal process in hydropelvic taxa, similar to the supracetabular tubercle of many lizards, and possibly some basal mosasauroids; and (3) a distal facet present on the elongate iliac process of hydropelvic mosasauroids for possible attachment of the iliopubic ligament, which in extant lizards connects the supracetabular tubercle to the anterior process of the pubis.

Technical Session XVII (Saturday, August 26, 2017, 9:30 AM)

USING FOSSIL FRAGMENTS AND NEW ALLOMETRIES TO REVEAL THE BODY SIZE COMPOSITION AND COMMUNITY ECOLOGY OF LATE QUATERNARY CANIDAE COMMUNITIES IN TEXAS

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The North American Canidae, a widespread and diverse group of carnivores, largely persisted through the Pleistocene megafauna extinction. The catastrophic loss of biodiversity from this event likely had many indirect effects on ecological communities and species that survived. While Canidae may have been survivors, we lack a full understanding of how changes in North American ecosystems altered aspects of their lifestyle. Here, we examined body mass in surviving canids before and after the event. Body mass is closely linked to interspecific interactions among carnivores and thus, changes can indicate reorganization of the carnivore guild. Our study region is the Edward's Plateau in south central Texas, an area with a good Canidae fossil record, and a history of occupation by megafauna throughout the Pleistocene. Samples spanned the full glacial (~21,000 yr B.P.) to modern.

Using modern museum specimens, we developed allometric relationships between 24 cranial, dental, and skeletal measurements and canid body mass for animals spanning 1.5 orders of magnitude. All allometries yielded robust relationships with high r-squared values (>0.9) and low average prediction error (<16.5%). We used these allometries to estimate body mass of Canidae from seven late Pleistocene and eleven Holocene fossil assemblages across the Edward's Plateau. We then tested for intraspecific body mass changes over time.

We found that intraspecific body mass did not change significantly following the Pleistocene megafauna extinction. However, the Holocene community was characterized by an apparent reduction in the abundance of small canids in addition to the extinction of the largest species (*Canis dirus*, the Dire wolf).

Interestingly, our findings differ from results at other late Quaternary localities which have documented changes in body size of some Canidae, which may reflect regional variation in the strength of ecological interactions within communities. The Edward's Plateau also housed a diverse suite of carnivores, which may have constrained potential adaptive shifts to incorporate new prey resources. Our results suggest that generalities cannot be made regarding responses to environmental perturbations without looking across the entire geographic distribution of a species. We suspect that the strength of interspecific competition may not have changed sufficiently to influence canid body mass on the Edward's Plateau following the extinction.

Technical Session XXI (Saturday, August 26, 2017, 2:30 PM)

ICHTHYOSAUR PALEOPATHOLOGY: DIAGNOSING INJURY AND DISEASE IN EARLY JURASSIC 'FISH-LIZARDS'

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Paleopathologies document skeletal damage occurring in fossil populations, and can be used to infer the causes of traumatic injury, as well as interpret aspects of related biology, ecology and behavior. Such studies in Jurassic marine reptiles are relatively few, and in particular ichthyosaur pathologies have never been analyzed at population level. Here we analyze the distribution of skeletal injuries and disease in a densely sampled coeval ichthyosaur assemblage from the Early Jurassic (Toarcian) Posidonia Shale of southwestern Germany, to draw paleoecological inferences. We consider taxonomy, body size, trophic position, anatomical unit affected, and the type of pathology in 107 ichthyosaur specimens. Only those skeletons of >50% overall completeness were considered, so as to avoid sampling biases caused by fragmentary material.

Our results found that the macrophagous predator *Temnodontosaurus* showed the highest frequency of pathological specimens (3/10; 30%), followed by *Eurhinosaurus* (1/5; 20%). The species that show proportionally the fewest pathologies are the smaller species *Hauffiopteryx* (1/8; 13%) and *Stenopterygius* (8/81; 10%). The most frequently affected skeletal regions were the ribs and gastralia (6 cases), followed by skull (5 cases), forelimbs (4 cases), and caudal region (3 cases). The presacral vertebral column and hind limbs manifested the least evidence of injury. Examples of healed osteo-trauma were most common, as were ankyloses. The least documented pathology is articular diseases (including avascular necrosis), affecting only one individual in our sample.

The propensity for apex-predator ichthyosaurian taxa to more frequent sustain injuries might reflect their aggressive predatory lifestyle. Alternatively, these larger-bodied species might have been more likely to survive a serious wound. The comparative rarity of articular disease in the Posidonia Shale ichthyosaur population is unexpected, and could reflect either adaptive differentiation of populations during the Jurassic or a lack of deep-diving behaviors within this particular ecosystem. Pointedly, the rarity of pathologies in the vertebral column is at odds with records from Cretaceous mosasaurid squamates and extant cetaceans, in which pathologies in the vertebral column predominate. This may suggest functional differentiation in the axial skeleton of these analogous taxa. This survey raises questions regarding behavioral and functional similarities within Jurassic ichthyosaurs, and also across secondarily aquatic tetrapods.

Grant Information:
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Technical Session XIII (Friday, August 25, 2017, 3:00 PM)

A PARTIAL EGG OF *DEINONYCHUS ANTIRRHOPUS* CONTAINING EMBRYONIC BONES, FROM THE UNIT VI CHANNEL STRATUM OF THE EARLY CRETACEOUS CLOVERLY FORMATION OF CENTRAL MONTANA

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A partial egg from *Deinonychus antirrhopus* in four fragments and some smaller eggshell pieces have been recovered from a site within the Middle Dome region of the Early Cretaceous Cloverly Formation of central Montana. The largest fragment is 30.46 mm in length, 20.64 mm in width and 8.24 mm in thickness. It is somewhat flattened, with the broken ends of hollow limb bones exposed along the broken edges between the sides of the compressed eggshell. We substantiate our identification of this egg based on cortical patterning and egg shell histological comparisons that were conducted between these fragments and the egg shell directly associated with *D. antirrhopus* specimen AMNH 3015. This egg and associated fragments were found within the mudstone layers representing the fresh water channel deposits of Unit VI of the Cloverly Formation.

These fragments were not found in any nesting pattern or nesting environment. Through x-ray and micro CT analysis, embryonic material has been observed inside the larger egg fragments. A set of two asymmetric circular tooth holes penetrate one side of the largest eggshell fragment. Several other eggs representing at least four other ootaxa have also been recovered. This field research has revealed that within Unit VI, beneath the most prominent upper hard sandstone stratum, there are further strata made up of both far more friable sandstone and low energy, depositional sand layers, all of which contained coprolites, mollusks, egg fragments, small bones, burrow casts, petrified root and wood fragments. The consistent preservation of embryonic material within these *D. antirrhopus* egg fragments as well as in all the other differing eggs and associated fragments may be due to their rapid deposition within relatively sterile fresh water channel mudstones, associated with some volcanic ash, all of which has been designated as Unit VI of the Early Cretaceous Cloverly Formation. Similar preservation may occur in fresh water mudstone channel deposits within other geologic formations. This egg/embryo discovery helps to increase our understanding of the earliest ontogenetic development of *D. antirrhopus* and the preservational capacity for eggs and embryonic materials within freshwater mudstone channel deposits.

Technical Session XI (Friday, August 25, 2017, 11:45 AM)

THE EVOLUTION OF PINNIPEDS FROM A TERRESTRIAL ANCESTOR: THE POSSIBILITY OF PARALLEL EVOLUTION WITHIN A MONOPHYLETIC FRAMEWORK

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Monophyly of pinnipeds is well-established. However, it is difficult to reconcile a monophyletic origin of pinnipeds with the disparate locomotor modes and associated skeletal morphologies observed between the extant families. Furthermore, the fossil record suggests many of the conventional pinniped synapomorphies arose independently, as many are not present in fossil taxa (*Eotaria, Prototaria, Devinophoca*) that have been firmly established as early-diverging crown members of the three extant families (e.g., homodont dentition, loss of fossa muscularis, reduction of nasolabialis fossa, loss of M2/m2, fusion of tibia and fibula, reduction of fossa for teres femoris). Herein, we test the hypothesis that otarioids (otariids + odobenids) and phocids share a common ancestor that was not yet fully aquatic.

In the present analysis, a total evidence approach was employed to investigate the relationships of 19 extant and 37 fossil caniforme genera. Our analysis sampled five genes totalling 5490 bp and 184 morphological characters, sampled relatively evenly across morphological partitions (cranial, dental, postcranial). With *Canis* as an outgroup, Bayesian inference produced strong support for a monophyletic origin of pinnipeds, and recovered *Puijila* and *Potamotherium* as early-diverging pinnipedimorphs (Ursidae(Musteloidea(*Potamotherium*(*Puijila*(*Enaliarctos,* (Desmatophocidae(Phocidae,(Odobenidae, Otariidae)))))))). Similar results were obtained from Bayesian and parsimony analyses of a morphology-only data set, a cranial-only data set, a craniodental-only data set, and a post-cranial-only data set. Bayesian inference of morphology-only partitions recovered *Mustelavus* and a sister grouping of *Allocyon* + *Kolponomos* along the stem to later-diverging pinnipedimorphs. The parsimony analysis recovered 20 synapomorphies of *Potamotherium* + *Puijila* + Pinnipedimorphs, and nine synapomorphies for a crown group Pinnipedia, to the exclusion of the pinnipedimorphs.

In spite of a reinterpretation of the plesiomorphic state of many previously proposed pinniped synapomorphies, there remain more than enough pinniped synapomorphies to exclude the semi-aquatic pinnipedimorphs, thereby challenging our hypothesis of a dual origin of flippers. However, this may be an artifact of a Bayesian model of morphological inference which, among other limitations, cannot model direction evolution, and thus, may be incapable of capturing parallel evolution in such a context.

Grant Information**:**
NSERC-CGS-M to Ryan Paterson

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

ALLOSAURUS CRANIAL ELEMENTS SUPPORT THE UTILITY OF USING PERIOSTEAL AGING TO ASSESS MATURITY IN ISOLATED THEROPOD CRANIAL ELEMENTS

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Periosteal textures on bone surfaces have been previously recognized in extant birds. It has also been reported in ceratopsian dinosaurs and used to group animals into distinct ontogenetic growth classes. In fast growing juveniles, linear bone surface textures are apparent, while in adult, slow growing animals the texture is characterized by an interwoven clotted texture. This method has been used to assess the maturity of limb material of *Ornithomimis velox*, but has never been used to assess maturity in theropod cranial elements.

Allosaurus fragilis specimens from Cleveland Lloyd Dinosaur Quarry (CLDQ) provide an ideal test of the idea of periosteal aging because there is a vast range of well preserved elements of all sizes. The CLDQ *Allosaurus* specimens are disarticulated, so having a size independent proxy for maturity is useful. Skull elements grow at a different rate than the rest of the body, however, cranial elements such as the maxillae and dentaries show dense surface textures throughout the entire bone at all sizes. Periosteal aging provides an alternative to the common method of limb scaling for ontogeny in dinosaurs, which requires an entire limb, whereas this method needs only a small sample of bone to determine age.

Cranial elements of *Allosaurus* from CLDQ were photographed macroscopically to document bone surface textures and categorized into three groups based on bone surface texture, independent of proposed size from limb scaling. Juveniles demonstrated a linear, or mostly linear, bone surface texture. Adults have a highly woven texture, with very little remaining linearity. Subadults show a gradient between linear and woven textures. Next, proposed ages based on textures were compared to proposed ages based on element size extrapolated from known articulated skeletons. A high correlation was found between the textures and sizes of individuals, suggesting that periosteal aging has utility in assessing theropod cranial maturity in isolated specimens.

Technical Session VI (Thursday, August 24, 2017, 11:45 AM)

EVIDENCE FOR REGIONAL VARIABILITY IN RECOVERY OF TETRAPOD ASSEMBLAGES FROM THE END-PERMIAN MASS EXTINCTION: SETTING THE STAGE FOR THE AGE OF DINOSAURS IN SOUTHERN PANGEA

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The patterns of mass extinction events and subsequent recoveries are among the most powerful contributions of paleontology to evolutionary theory. Mass extinctions are recognized as global events; however, studies of single localities or regions deepen our understanding of extinction and recovery by revealing heterogeneity in timing and process. For terrestrial tetrapods, data on the end-Permian mass extinction (EPME) comes primarily from the Karoo Basin of South Africa, which contains a near-continuous record of middle Permian to Middle Triassic vertebrate evolution. This record shows that ecologically stable assemblages collapsed during the EPME. By the Middle Triassic taxonomic diversity and ecological stability increased, but not to pre-EPME levels. Across southern Pangea, late Permian tetrapod assemblages are recognized as broadly similar, while those of the Middle Triassic share few features.

To understand the underlying drivers of post-EPME dissimilarity I studied successive terrestrial tetrapod assemblages from Zambia and Tanzania, compiling a database of 2,992 vertebrate specimens combining historic museum collections and discoveries from fieldwork over the last decade. Biostratigraphy ties the Zambian and Tanzanian assemblages to middle Permian, late Permian, and Middle Triassic Karoo assemblages, providing alternative in situ model systems of tetrapod evolution before and after the EPME. After employing apomorphy-based specimen identification, I calculated taxonomic richness, evenness, and relative abundances, and assigned taxa to ecological guilds (estimated biomass + inferred diet) to calculate ecological guild richness and relative abundances. My results support a cosmopolitan late Permian fauna in southern Pangea with extremely similar measures of taxonomic and ecological diversity, including many shared genera and species. During the post-EPME recovery in the Middle Triassic the three regions are notably dissimilar. Not only are constituent taxa different (e.g., carnivores, large-bodied taxa, and archosaurs are diverse and abundant in Zambia and Tanzania, but relatively uncommon or absent in South Africa), but signals for recovery are discordant. Ecological diversity levels of the Zambian and Tanzanian assemblages equal or exceed Permian ecological diversities, whereas those of the Karoo lag. These discrepancies could be due to actual geographic heterogeneity, but could also be the result of a temporal mismatch between the regions via inexact biostratigraphy.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

BAYESIAN INFERENCE OF PARAVIAN PHYLOGENY WITH THE THEROPOD WORKING GROUP DATASET

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Paraves, traditionally known to comprise Dromaeosauridae, Troodontidae and Avialae, is among the most well-studied dinosaur groups thanks to its importance in investigating the dinosaur-bird transition. Recent studies with different data matrices generated various maximum parsimonious topologies of paravians and thus challenged the traditionally recognized monophyly of Deinonychosauria and the affiliation of *Archaeopteryx* as avialans. In spite of the efforts to solve this mystery under the maximum parsimonious criterion, here we applied Bayesian techniques to reconstruct the paravian phylogeny with the latest Theropod Working Group (TWiG) coelurosaur dataset which we supplemented with new data from recently described Mesozoic paravian taxa. Despite reconstructing the evolutionary relationships, Bayesian inference would also give us information on the evolutionary rates and divergence time of relevant clades. Preliminary analyses were performed with Beast v1.84 with tip dating using the Lewis Markov model, which enabled ordering of multistate morphological characters in Bayesian analyses. Beast could infer tree topology, divergence time, and evolutionary rates simultaneously using the relaxed clock model, which is now the standard practice in phylogenetic analyses with molecular data. Our preliminary result generally agrees with the maximum parsimonious trees recovered from the same dataset. The traditional sister group status of Dromaeosauridae and Troodontidae is reaffirmed. Jurassic paravians from the northeastern China have been recovered as the most basal avialans. Unlike the maximum parsimonious result where all *Archaeopteryx* specimens formed a polytomy with more derived avialans, the Solnhofen *Archaeopteryx* has been recovered as a more derived taxon than the clade formed by other *Archaeopteryx* specimens in our result. Increased evolutionary rates have been detected along the stem branches of the tree, as suggested in previous likelihood-based studies with different datasets. The divergence time of major coelurosaurian clades generally matches previous speculations, but the divergence time is dependent on the constrained age at the root. An alternative analysis with MrBayes 2.3.6 was carried out with the same TWiG dataset using the Lewis Markov model without tip dating. However, a slightly different topology has been recovered compared with the result from Beast.

Grant Information:
supported by the University of Hong Kong Seed Fund for Basic Research

Technical Session XI (Friday, August 25, 2017, 11:15 AM)

A NEW KENTRIODONTID (ODONTOCETI) FROM THE PACIFIC NORTHWEST SHEDS NEW LIGHT ON THE TEMPORAL AND GEOGRAPHIC RANGE OF THE ENIGMATIC DOLPHIN FAMILY

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The family Kentriodontidae (Cetacea, Odontoceti) includes a diverse group of relatively small dolphins represented by taxa on either side of both the Atlantic and Pacific oceans and spanning most of the Miocene. Despite this broad temporal and geographic range, the family has not been studied in detail, and is likely a paraphyletic group that requires further analysis and subsequent reorganization. Here, we describe a nearly complete, new kentriodontid from the Pacific Northwest (Astoria Formation, Washington State). This specimen, from the early Miocene, represents one of the oldest kentriodontids known, and extends the range of the family from Baja California up to Washington State. Accordingly this specimen sheds light on the temporal and geographic range of the family, and has the potential to bear on the issue of family level monophyly.

Here we report a phylogenetic analysis with seven "kentriodontids" (the most of any phylogeny to date), and provide further evidence that the family is paraphyletic. We suggest that individual subfamilies may still be monophyletic, and illustrate the need for a complete phylogenetic analysis to resolve family level relationships of the group. This new kentriodontid also extends the known range of the family north from Baja California to Washington State. We thus suggests that the early Miocene kentriodontid, which have reached Japan by the middle Miocene, do so by moving along shallow coastline habitat, rather than crossing the expansive Pacific Ocean. This new kentriodontid represents the first step in a large-scale attempt to reevaluate a long understudied yet critical and diverse dolphin family.

Grant Information:
Work for this project was funded by the 2016 Paleontology Collections Grant from the Burke Museum of Natural History and Culture.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

***EUNOTOSAURUS* (PARAREPTILIA) FROM THE MIDDLE PERMIAN OF THE REPUBLIC OF MALAWI**

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Eunotosaurus is a Middle Permian parareptile, easily recognized by its expanded ribs, purported to be the sister taxon to modern turtles, and heretofore recognized only in the Karoo Basin, South Africa. Here we report a partial skeleton of *Eunotosaurus* from west of Karonga Boma, far northern Malawi, some 2,400 km from its nearest occurrence in South Africa. The specimen is contained in a Karoo-type nodule holding an articulated skeleton extending from the skull to the region immediately anterior to the pelvic girdle. CT data obtained from the specimen are of exceptional quality and reveal the presence of the complete pectoral girdle and partial humeri. The remaining articulated skull and mandible are well preserved; however, erosion has damaged much of the skull roof and right dorsolateral side of the skull. Some of the braincase elements are missing, but a complete basicranium is retained. Karoo Supergroup sediments are found in a number of basins along the faulted margin of the East African Rift System in northern Malawi and have been correlated with the Ecca, Dwyka, and Beaufort Groups of the Karoo Basin. The Malawian *Eunotosaurus* was recovered from the Mwesia Formation. In South Africa, *Eunotosaurus* has a limited stratigraphic range in the upper *Tapinocephalus* and the overlying *Pristerognathus* Assemblage Zones of the Beaufort Group. Thus, the Mwesia Formation is correlated with similar aged *Eunotosaurus*-bearing strata in South Africa. An upper limit of 260 Ma has been placed on the range of South African *Eunotosaurus* based on radiometric dates reported from the *Pristerognathus* zone. Previously known Karoo vertebrate fossils from Chiweta, Malawi, are correlated to the Late Permian *Cistecephalus* Zone in South Africa (256 Ma), younger than the *Pristerognathus* Zone. The *Cistecephalus* Zone is separated from the *Pristerognathus* Zone by the intervening *Tropidostoma* Zone. This specimen of *Eunotosaurus* from Malawi is the first known outside of South Africa, the first Middle Permian tetrapod fossil from Malawi, and the first tangible evidence that a more comprehensive Middle Permian fauna can be obtained in the fault basins of northern Malawi.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

ISOTOPIC INFORMATION ON PLEISTOCENE MAMMALS FROM THE STATE OF MORELOS, MÉXICO

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For the State of Morelos, México, there are records for 13 localities assigned to Late Pleistocene, and that have fossil remains of diverse mammal species. All of those fossils have been identified taxonomically and discussed on regard to biogeographic realms, since the localities are located in an area where the Neotropical and Nearctic regions merge. This study deals with the assays to learn more in regard to paleoecological issues for the known species through the use of carbon and oxygen stable isotopes analyses from dental enamel of several taxa: horse (*Equus* sp.), gomphothere (*Cuvieronius* sp.), American lion (*Panthera atrox*), mastodon (*Mammut americanum*), and mammoth (*Mammuthus columbi*) collected at the localities of *Calera* (18º32´26" N, 99º16´25" W, 908 masl), *Cuentepec* (18º52´27" W, 99º20´15" W, 1540 masl), *Itzmatitlán* (18º54´32" N, 99º00´35" W, 1271 msal.), and *La Nopalera* (18º48´04 N, 99º03´12" W, 1125 msal). Carbon and oxygen isotopic values indicated that horse and mammoth only fed upon C4 plants and lived in grasslands, while gomphothere was a C3/C4 mixed feeder and inhabited in forest, and mastodon ate C3 plants and also lived in forest. American lion predated upon C3 herbivores, and inhabited forested zones. The above results suggest a change in vegetation, from the grassland and tropical forest in the Pleistocene to the low deciduous forest in Holocene, surely product of regional climatic changes in the transitional zone between the two biogeographic regions.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A SINGULAR UPPERMOST CRETACEOUS DINOSAUR NESTING AREA IN THE VILLALBA DE LA SIERRA FORMATION (GUADALAJARA, CENTRAL SPAIN)

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Several outcrops providing fossil remains of dinosaurs and other reptiles from the uppermost Cretaceous (Campanian and Maastrichtian) are known in the Villalba de la Sierra Formation (Central Spain), in the provinces of Cuenca and Guadalajara (Castilla-La Mancha). Numerous osseous remains of several clades of reptiles, the most abundant being the turtles (especially Bothremydidae), crocodiles (Allodaposuchidae) and dinosaurs (especially Titanosauria), were found in Lo Hueco fossil site (Cuenca). Remains of eggs were not identified there. However, they were recognized in the nearby site of Portilla (Cuenca) by abundant isolated fragments attributed to *Megaloolithus siruguei*. However, osseous remains are not present in this site.

Only an isolated dinosaur remain was so far known in the Villalba de la Sierra Formation levels of the adjacent province of Guadajalara: a caudal vertebra of a titanosaurian found in the area of Buendía (Sacedón). Recent paleontological surveys have been carried out for the first time in this area. As a result, several fossiliferous levels have been identified. Several remains of a medium-size theropod, probably corresponding to an abelisaurid ceratosaurian, are included among the new osseous elements. This finding is relevant considering the very scarce available record of this clade in the Iberian Upper Cretaceous record. Buendía is the first region of the Villalba de la Sierra Formation where both osseous and eggs remains are found. Thus, a level with abundant small fragments of eggs has also been recognized. However, the most relevant of the findings performed there is another level with abundant complete eggs. Although they correspond to dinosaur eggs probably belonging to Megaloolithidae, they cannot be attributed to *Megaloolithus siruguei*.

Therefore, the fossiliferous area of Buendía is recognized as singular considering several aspects. The only so far known outcrops of the Villalba de la Sierra Formation with remains of vertebrates in the province of Guadalajara are located there. Contrasting with the fossil sites previously identified in this Formation (Lo Hueco and Portilla), both bones and eggs are recognized in Buendía. Remains of medium-size theropods, poorly represented in this Formation, have been found. The ootaxon hitherto known in this Formation, *Megaloolithus siruguei*, is not the one found in Buendía. The first complete eggs of Central Spain, and also the first dinosaur nesting area of this region, are recognized for the first time.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A SERRANID FISH (ACTINOPTERYGII, PERCIFORMES) FROM THE EARLY MIOCENE OF THE PROVINCE OF ARAUCO, CHILE

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In Chile, the Paleogene - Neogene fossil record of marine Actinopterygii (Osteichthyes) is extremely scarce. Five specimens have been at least roughly identified so far. Philippi in 1887 mentions the presence of one specimen from the Tubul area (37°14' S; 73°26' W), where Plio-Pleistocene rocks are exposed. However, no further taxonomical precision was made. Three other specimens have been described from Bahía Inglesa Formation (Fm) (mid Miocene - Pliocene), Coquimbo Region (30°18' S; 71°36' W). These are: *Makaira sp.*, *Thunnus sp.* and Serranidae indet. Finally, a *Steindachneria svennielseni* Nolf, 2002 was identified from an otolith material collected from the Navidad Fm. (lower Miocene in Matanzas (33°57'27" S; 71°52'15" W).

In this work, we describe and attempt to provide a taxonomical identification of new material from the Miocene of the Biobio Region, Arauco Province (37°46' S; 73°20' W). This fossil is a tridimensionally preserved articulated skull preserved within a concretion of about 20x12x8 cm. Visible bones comprise: opercular and orbital series, most of the dorsal neurocranium, splanchnocranium with the exception of the dentary and the anterior portion of the right articular bone. Also the first four semi-articulated vertebrae.

Serranidae is characterized by the presence of three spines on the distal edge of the opercle. Our fossil clearly presents the first two and the base of the third, even though the apical portion was eroded out in both right and left sides. Other characteristics are found to be comparable to the Anthiine Subfamily: 1) the presence a of a supramaxillary bone of similar proportions, 2) serrations on the distal edge of the preopercle, 3) spines on the preopercle. Particularly, *Hypoplectrodes* genus (included within the Anthiinae Subfamily) exhibit a spine on the preopercule vertex, and one to three antrorse spines. The vertex spine and at least one antrorse can be seeing in the Arauco´s specimen. Therefore, we conclude that the material is assignable to *Hypoplectrodes sp.* Up to this point of the research, we believe that may be the first fossil representant of this genus in the world.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DENTAL CARIES IN THE EXTINCT SHORT-FACED BEAR (ARCTODUS SIMUS) AND INTRA-GUILD COMPETITION DURING THE LATE PLEISTOCENE

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During the late Pleistocene of North America 36,000 to 10,000 years ago, sabre-toothed cats, American lions, dire wolves, and coyotes competed for prey resources at Rancho la Brea. Despite the fact that short-faced bears (*Arctodus simus*) were the largest land carnivoran present in the fauna, there is no evidence that it competed with these other carnivores for prey. Here, we report for the first time, dental pathologies in *A. simus* preserved in the asphalt deposits at Rancho La Brea that may be related to competition among large predatory mammals that characterized the late Pleistocene. By using scanning electron microscopy (SEM), analyses of teeth mineralization computed from micro-CT data, and a large comparative dataset of living bears, we identified tooth pathologies as carious lesions. Our results reveal that *A. simus* from Rancho La Brea relied heavily on carbohydrates that resulted in caries, and this may suggest they were more omnivorous than populations in the Northwest that are considered to be highly carnivorous. We hypothesize that severe intraguild competition among large predatory mammals during the Late Pleistocene contributed to this dietary niche displacement. Overall, our findings help to clarify the long-standing debate on the feeding ecology of this emblematic species from the North American megafauna.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

IT'S ALL IN THE WRIST.... OR IS IT: THE USE OF AERODYNAMIC MODELLING TO UNRAVEL THE ORIGINS OF AVIAN FLIGHT

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Powered flight is a major locomotor novelty that has only occurred three times in the 500+ million-year history of vertebrates: in birds, bats and the pterosaurs. Of these, birds are unique in having a geologically extensive and rich fossil record documenting the series of morphological changes that characterize the transition for terrestrial theropod dinosaur to volant birds. Recently, a series of taxa bridging this transition have been discovered possessing long feathers not only on their forelimbs but on their hind limbs, as well. This has been taken by some researcher to denote the presence of a "four-winged" gliding stage in the origin of flight, but this interpretation is contradicted by several lines of anatomical evidence which suggest that flight first appeared in a ground based ancestor, that gliding was not possible in non-avian theropod taxa, and that the "hind wings" did not provide weight support in flight. This latter interpretation raises question on the origin and function, if any at all, of the "hind wing". Here we present work seeking to test the aerodynamic implications of having a set of feathers on the hind limb to better understand how flight first appeared in the ancestors of modern birds. 3-D printed models were created for several key taxa (Anchiornis, Microraptor and Archaeopteryx) along this transition that incorporated mechanisms to simulate a flapping flight stroke. These were then run in Queen's Optical Towing Tank to examine the effects of drag and vortex shedding in our models based on the addition and variation in dimensions of the hind limb feathers. These results were then incorporated into mathematical models for takeoff potential to see how much, if any, locomotory benefit long leg feathers gave to non-avian dinosaurs and early birds. This work is a major step forward in testing our hypothesis about the adaptive nature of this unique feature and helps us better understand how and when flight first arose in the lineage leading to modern birds.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

COMPARISONS OF FIDELITY IN THE DIGITIZATION AND 3D PRINTING OF VERTEBRATE FOSSILS FOR OUTREACH, EDUCATION, AND RESEARCH

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Until recently, 3D surface digitization such as laser-texture scanning, and automated replication, such as 3D printing, were infeasible for many researchers and educators due to the overhead costs associated with high-fidelity digitization and replication devices and limitations of the technology, such as low print resolution. However, innovations in the development of digitization and replication techniques have led to significant reductions in the cost and complexity of their applications. The new availability of these technologies has opened up new venues for vertebrate paleontology in areas of research, education, and outreach. While the lowered cost and increased options for entry-level commercial printing and laser scanning units have led to their implementation in many research laboratories and classrooms, the question of fidelity and accuracy for their use as research and teaching aides has not been fully investigated. This study explores the quality of digitization and resolution of 3D printed specimens in quantitative terms to determine whether the usage of entry-level digitization and 3D printing units is feasible for the needs of most vertebrate paleontologists and educators, or if the technologies need further development to compete with traditional means of specimen reproduction. In order to test the fidelity of these techniques, resin casts of a *Tyrannosaurus rex* tooth (FMNH PR 2081) and crocodilian osteoderm (FMNH PR 3703) were digitized using two different techniques: white-light structured scanning and laser-texture scanning. Each resulting stereolithographic (STL) digital model was compared using standard T-Test and Chi2 statistical analyses ($p < 0.05$) to detect differences in morphology based on point cloud volume and average triangle surfaces. Next, the resulting digital models were printed on two commercially available models of fused deposition modeling (FDM) printers. Photomicrographs were taken and characterized in order to detect differences from the original digital file. The results of this study suggest that while differences in digitization methods and 3D printing units exist, they are virtually indistinguishable. However, observed differences were exacerbated by morphological variations of the original object; flat-shaped to tabular objects showed the greatest variability among digitization techniques. As such, even low-cost digitization and 3D printing systems are suitable for many paleontological research initiatives as well as the reproduction of high-quality teaching specimens.

Technical Session IX (Thursday, August 24, 2017, 2:30 PM)

MELANOSOME EVOLUTION IN VERTEBRATES

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The discovery of melanosomes, melanin-containing organelles, in the exceptionally-preserved integument and eyes of fossil animals has opened doors to aspects of paleontology previously thought unattainable. The preservation of color patterns can inform us about the anatomy, environment, and potential colors and behaviors of extinct animals. The color of feathers and hairs is correlated to melanosome morphology: elongate melanosomes produce black and sub-round melanosomes produce rusty-red colors. Here, we make inferences about the evolution of melanosome morphology in vertebrates with a focus on eyes and integument. In vertebrates as old as 300 million years, the retinal pigment epithelium of the eye has at least two distinct layers of arranged elongate and ovoid melanosomes. These are comprised predominately of eumelanin and the distinct layering may function to increase light absorption from varying directions. Melanosomes in integument appear to have a different evolutionary drive, although thus far studies of melanosomes preserved in fossil integument have been limited to amniotes. We therefore examine melanosome morphology preserved in Middle-Late Jurassic amphibians and lampreys from the Jiulongshan and Tiaojishan Formations in China. We compare the preserved melanosomes to those in modern amphibians and fish as well as previous data for both fossil and modern amniotes. Melanosomes in both fossil and extant anamniote skin are uniformly small (less than 1μm) with a near-spherical morphology. Our findings corroborate recent studies of the skin of basal amniotes and integumentary filaments of non-maniraptoran dinosaurs and pterosaurs, suggesting that this melanosome morphology is the basal form for vertebrate integument. Like eye melanosomes, melanosome morphology in non-mammalian and non-maniraptoran vertebrate skin is not correlated to color or melanin type. Indeed, there are several examples of extinct maniraptoran dinosaurs that preserve a variety of melanosome morphologies similar to the high morphological diversity of melanosomes in modern bird feathers, leading to plausible melanin-based color reconstructions of their feathers. Convergent diversification of melanosomes in mammals and maniraptoran dinosaurs may have been caused by the evolution of novel integument types (ie. feathers and hairs) and their lack of chromatophores, which produce colors in squamates, fish, and amphibians. Alternatively, it could be linked to convergent physiological shifts between basal amniotes, Mammalia, and Maniraptora.

Technical Session V (Wednesday, August 23, 2017, 3:30 PM)

NEW METHOD FOR PALEOECOLOGICAL RECONSTRUCTION AND ECOMORPHOSPACE ANALYSIS: SAMPLING THE SPATIAL DISTRIBUTION OF DATA ACROSS MORPHOSPACES

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Morphospaces are two-dimensional representations of the morphological variation in a group of organisms. Change in disparity or the Euclidian distances between data points are standard tools for analyzing and interpreting morphospaces. These methodologies provide information about data dispersion and relative distance between data points but not about the shape of their spatial distribution. Thus, we might fail to discriminate between two datasets if they have the same dispersion or relative distance from the centroid, but fit in a different area of the morphospace. I designed a new method to compare and analyze morphospace distributions for traits that are environmentally correlated and commonly preserved in the vertebrate fossil record (e.g. body size). This approach uses quadrant field sampling analysis in order to account for the shape of distributions in a morphospace and improves fidelity in paleoecological and paleoenvironmental reconstruction.

In order to test the reliability of the method, I simulated 64 different stratigraphic ranges with variable number of localities, and species per locality. The localities in each stratigraphic range were divided in three temporal zones, each with different environments, simulating that the environment changed over time (e.g. drier or colder conditions). I randomly selected three optimal combinations of measurable traits (e.g. body length and width) for the species in each environment. Each of the species in a locality had a value for these two traits based on the average and standard deviation of the optimal traits for their environment. I obtained a bi-dimensional morphospace (each of the two traits in a different axis) for all species in each stratigraphic range, and then created individual plots containing only the traits of the species in each locality. I then applied spatial sampling analysis to the plots for each individual locality by dividing the morphospace in 9 different quadrants and counting the species in each of the quadrants. This allowed discrimination between environmental conditions for stratigraphic ranges with as little as 10 localities with 5 species each and a standard deviation of 0.25. Additionally, it also detected changes in disparity in a given ecomorphological specialization. Depending on the nature of the plotted data, this approach can be applied to the study of physiological, or paleoecological data as well as research in evolution and conservation biology: from functional diversity to ecosystem characterization, or climatological inferences.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

IDIGFOSSILS: ENGAGING K-12 STUDENTS IN INTEGRATED STEM VIA 3D DIGITIZATION, 3D PRINTING, AND PALEONTOLOGY

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iDigFossils is an NSF-funded initiative involving the Florida Museum of Natural History, University of Florida College of Education, MorphoSource, and science educators. The goal is to create curricula using high-quality 3D models for a K-12 audience. Fossils are delicate or rare, and often not suitable for classroom use. Therefore, 3D scanning and printing technology provides a unique opportunity to make these specimens available for K-12 education. In addition, paleontology is an interdisciplinary and engaging area of study that provides distinctive opportunities for STEM integration.

STEM integration is an instructional method that aims to emphasize the connections between Science, Technology, Engineering, and Math. This method introduces concepts in these subjects in a meaningful way to students and replicates the way science is practiced. Students acquire new skills and improve STEM literacy when they understand relationships between disciplines and apply them to real-life issues. Instruction through STEM integration and meaningful application is more relevant to students and increases motivation, self-efficacy, college readiness, and can promote interest in science careers.

iDigFossils advances our understanding of the value of 3D technology in K-12 science learning. This approach to incorporate 3D technology can improve the relevance of educational practices in our schools and broaden the impact of digitization efforts of paleontological collections. Lessons that we have developed are rooted in the idea of STEM integration including topics related to GABI (Great American Biotic Interchange), providing multiple opportunities for K-12 educators. Lessons have been designed to teach concepts of adaptation and biological evolution (science) using 3D printed fossils (technology). Students replicate scientific processes by asking questions, engaging in evidence-based argument, and obtaining, evaluating, and communicating information. Ultimately, they gain deep understanding of how the Isthmus of Panama formed and the consequences for the fauna in North and South America. Like the study of GABI, there are other lessons for elementary school students. One example is a comparison of the similarities and differences of a mammal skull and a reptile skull. Furthermore, making specific fossils available for 3D reproduction can help educators introduce examples of important topics, such as climate change, fostering new learning opportunities in issues of current societal relevance.

Grant Information**:**
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GABI RET NSF #1358919
MorphoSource NSF BCS 1552848 (to D M Boyer)

Technical Session XIII (Friday, August 25, 2017, 4:00 PM)

MOSAIC EVOLUTION IN AN ASYMMETRICALLY FEATHERED TROODONTID DINOSAUR WITH TRANSITIONAL FEATURES

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Troodontids are important towards our understanding of avian origins because they are considered as the closest relatives of birds, either on their own or together with dromaeosaurids. Here we report a new troodontid *Jianianhualong tengi* gen. et sp. nov. from the Lower Cretaceous Jehol Group of China, that has anatomical features that are transitional between long-armed basal troodontids and derived short-armed ones, shedding new light on troodontid character evolution. This taxon displays a mosaic of plesiomorphic and apomorphic features with a distinct spatial organization, like *Sinusonasus*, another troodontid with transitional anatomical features. *Jianianhualong* has forelimbs and a pelvis closely resembling those of basal troodontids, but a cranium and hindlimbs that are more similar to those of derived troodontids. *Sinusonasus* has a cranium that closely resembles those of basal rather than derived troodontids and a pelvis and hindlimbs that are more similar to those of derived troodontids than to basal ones. This new information helps to develop a foundation for investigating modular evolution in this clade, a phenomenon known in birds.

Several recent phylogenetic studies have questioned the troodontid affinities of *Anchiornis*, *Xiaotingia* and *Eosinopteryx* making *Jianianhualong* the only unequivocal troodontid with preserved feathering. This indicates that troodontid feathering is similar to *Archaeopteryx* in having large arm and leg feathers as well as frond-like tail feathering, confirming that these feathering characteristics were widely present among basal paravians. Most significantly, this troodontid has asymmetrical feathers in the form of long, narrow and square-tipped tail feathers. Parsimony-based ancestral state reconstruction of paravian feather symmetry suggests that asymmetrical arm feathers were ancestral to Paraves, whilst asymmetrical tail feathers were ancestral to a more inclusive paravian clade that excludes Scansoriopterygidae and Avialae. Asymmetrical feathers have been associated with flight capability, but are also found in species that do not fly. Among non-avialan theropods, they are also known in microraptorine dromaeosaurids and have been linked to gliding behaviours. The asymmetrical tail feathers of *Jianianhualong* presumably kept the frond stable in an airflow, whilst its 'slotted' and distally-expanded shape presumably aided drag reduction. Biomechanical modeling and more fossil discoveries will be important towards uncovering the function of early asymmetrical feathers.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DINOSAUR ECOSYSTEMS, A FREE ONLINE SCIENCE COURSE BY THE UNIVERSITY OF HONG KONG

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Dinosaur Ecosystems is a free online science course (MOOC) by the University of Hong Kong. It introduces learners to how palaeontologists reconstruct the ecosystems that dinosaurs lived in, and complements existing palaeontology MOOCs. Our course is structured round filming trips to a Gobi desert field site, world famous science museums and institutions as well as interviews with international experts. The videos made heavy use of palaeoart, other scientific drawings and animations as well as photos of fossil and living animals and plants.

Traditionally, MOOCs have been divided into two main categories. The first is xMOOCs which focus on a more traditional lecture style where the instructor directly transfers knowledge to the student. The second category is cMOOCs which focus more on learning through the connections built between learners. Dinosaur Ecosystems was an experimental hybrid of both MOOC types in order to try and achieve synergies associated with both MOOC types. This is because pedagogical best practice has yet to reach a consensus across the MOOC community. This is also why the course included formal introductory videos as well as casual conversational interviews.

Assessments were designed to encourage course completion and to cater for non-specialist learners. We employed ungraded continuous assessment in knowledge check questions after each video as well as graded weekly summative assessment that measured learning outcomes each week. Interactions between learners on the online discussion forums were emphasised to encourage peer learning. Course staff monitored the forums and used WhatsApp to discuss and report unanswered posts to deliver more thorough and timely replies to learners. With such active discussion forums, our instructional design cycle was frequently reviewed allowing us to deliver more relevant materials to learners through weekly roundup videos that featured answers to FAQs.

The course received a 5* rating and attracted 9000+ learners from 115 countries. 63% of learners were from Hong Kong and 11% from North America. Surprisingly, less than 1% of our learners were from mainland China despite the provision of simplified Chinese subtitles. This could be partly related to the lack of Chinese on the rest of the edX platform. The course had similar enrolment from both sexes (female: 45%, male: 55) and a median learner age of 27. 32% of learners had an education level at or below a high school diploma. The statistics show that there is a significant interest in the subject locally and an opportunity to build interest in China.

Grant Information:
MOOC fund of the University of Hong Kong

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

THE MASTICATORY CYCLE IN ACUTE ANGLED SYMMETRODONTS

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Symmetrodontans represent a paraphyletic group of Mesozoic mammals with a mainly Laurasian distribution. They are characterized by a reversed-triangle molar pattern with two on one occlusion and the lack of a talonid. Mammals with this molar type appeared in the Upper Triassic (Norian) and went extinct in the Upper Cretaceous (Maastrichtian). In the evolution of mammalian molars, the symmetrodont pattern is intermediate between that of triconodonts with cusps in linear arrangement and the reversed triangular molar pattern with talonid of cladotherians. According to the angulation of their molars, symmetrodontans can be divided into two groups, one with acute and another with an obtuse angled cusp arrangement. Apart from the molar morphology, little is known about the masticatory cycle of symmetrodontans.

The chewing path of two symmetrodontan taxa, *Maotherium sinense* from the Yixian formation (Barremian) of Liaoning, China and *Spalacolestes cretulablatta* from the Cedar Mountain Formation (Albian – Cenomanian) of Utah, USA were reconstructed and compared.

To define the chewing movements high resolution epoxy casts of molars were examined with a scanning electron microscope and the occlusal surfaces were mapped. 3D models of the teeth were generated with X-ray computed microtomography (µCT) data. The chewing path of each taxon was reconstructed with the Occlusal Fingerprint Analyser (OFA) software and 3D models of two lower and one upper molar.

For *Maotherium sinense* the upper second, the lower second and the lower third molar of one individual were used. Due to the lack of a matching molar series for *Spalacolestes cretulablatta,* two successive lower molars from one individual and one upper molar from another individual were combined.

The reconstruction of the chewing cycles confirms a single-phase chewing path for *M. sinense* and *S. cretulablatta*. During occlusion the mandibles of both taxa moved almost orthal with a lateral shift towards lingual which allowed a deep intercuspation. The occlusion of *S. cretulablatt*a was more precise than the occlusion of *M. sinense*. The dentition of *M. sinense* allowed a higher variability of interlocking and direction of movement than the dentition of *S. cretulablatta*.

During mastication both taxa first fixed and pierced the prey with the molar main cusps. With further occlusion, *M. sinense* mainly stretched and sheared the food particles between the molar flanks whereas *S. cretulablatta* first cut the prey with the molar crests and then sheared the chunks between the molar prevallid and postvallid surfaces.

Technical Session XV (Friday, August 25, 2017, 2:30 PM)

RECONSTRUCTING EXTINCT MAMMAL LOCOMOTION THROUGH OPTIMAL CONTROL THEORY

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Understanding how extinct animals behaved is one of the most important and challenging goals of paleontology. Until now, paleontologists have relied on inference from the behaviour of similarly-proportioned extant animals. However, this relies on a clear linkage between form and function– often difficult to establish–, and on modern analogues to extinct types. We propose an alternative method for inferring locomotion from morphology that takes advantage of a close link between gait choice and work-based energetic optimization. We have designed a mechanical model of a quadruped whose proportions can be adjusted to match those of a variety of forms. Using optimal control theory, this model allows us to predict gait choice for a given form at given target speeds. We validate this model using extant organisms with varied morphology, and show that the optimal control solution closely matches natural gaits in footfall timing, ground reaction force profiles and kinematics. We suggest cases where our model could be applied to extinct forms, potentially answering important questions in the evolution of terrestrial locomotion.

Grant Information**:**
National Sciences and Engineering Research Council of Canada

Podium Symposium (Wednesday, August 23, 2017, 12:00 PM)

MACROECOLOGY OF LIMBS: ECOMETRICS, COMMUNITY ASSEMBLY, AND CLADE SORTING IN LIMB TRAITS IN NEOGENE CARNIVORA

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Limb proportions are an important factor locomotor function. Performance of any given limb proportion varies across environments. Using a proxy for limb proportion measured in the calcaneum, we have shown that average limb proportions are sorted according to dominant vegetation and by ecological province in extant Carnivora in North America. The strength of sorting is strong enough that vegetation type can be reconstructed with reasonable fidelity (Kappa = 0.536) from the distribution of limb proportions in carnivoran communities. Yet limb proportions are also strongly correlated with phylogeny, with nearly 60% of their variance explained by phylogenetic structure (Blomberg's K = 0.58).

Here we present results on the evolution and sorting of North American carnivoran by limb proportions through the Neogene. We show that extant taxa are strongly sorted by clade based on the functional characteristics of their hind limbs (note that this does not preclude them being sorted in additional ways by other functional features). Furthermore, we show that the pattern of sorting is highly dynamic and has been restructured on timescales of tens of thousands of years by the environmental changes of Quaternary glacial-interglacial cycles and on timescales of centuries by anthropogenic environmental changes. Trait turnover was slower during the climatic changes of the Miocene, but was accompanied by wholescale clade turnover in some groups, notably the replacement of borophagine canids with the clade Caninae at the beginning of the Quaternary. The phylogenetic patterning and geographic distribution of the functional characteristics of limbs are a closely linked to processes driven by paleoclimatic and paleoenvironmental history.

Grant Information:
NSF EAR-1338298

Technical Session XIV (Friday, August 25, 2017, 1:45 PM)

OSTEOHISTOLOGY OF PALEOGENE CARNIVORES REVEALS EXTENDED TIME TO MATURITY IN BOTH CARNIVORAMORPHA AND "CREODONTIA"

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Today carnivorans are the dominant carnivorous mammals. By contrast, in the early Paleogene, both "creodonts" and carnivoramorphans were common, with a shift to carnivoramorphan-dominated communities occurring in the Oligocene before the subsequent extinction of "creodonts". The causes of this shift are poorly understood, and the possible role of differential growth rates has not been explored. Faster growth would have been advantageous if it reduced the time before reaching adult size, or shortened generation times. Dental studies have suggested some "creodonts" show slower growth, but this has not been confirmed using long bone histology, which can be used to track changes in body size at different absolute ages.

To test whether late eruption in "creodonts" correlated with skeletal signals of maturity and assess growth in extinct carnivorans, I sampled 15 carnivore femora including "creodonts", carnivoramorphans (e.g. miacids), Caniforms (e.g. Hesperocyon), and Feliforms, (e.g. nimravids). This sample is twice as large as prior studies and departs from these by sampling homologous regions of bones to control for intraskeletal variability.

Paleogene carnivorous mammals were found to share a general pattern of bone tissue organization with some extant carnivores: a thick inner circumferential lamellar layer, a middle well-vascularized zone usually containing secondary osteons, and an outer lamellar layer (OLL) extending to the periosteal surface. Annual lines of arrested growth (LAGs) are present in all taxa sampled (the first described for any Paleogene carnivore). Small miacids and "creodonts" typically exhibit 3 or more LAGs, whereas larger taxa show many more (at least 6 in a large specimen of Hyaenodon). This contrasts sharply with living carnivores, even large species, such as Panthera leo which reaches maturity in under 3 years. Additionally, many specimens had an external fundamental system, suggesting it took several years to reach a growth asymptote.

Bone histology demonstrates somatic that growth in both early carnivorans and "creodonts" was protracted compared to their extant mammalian ecological counterparts. Eocene miacids and the Oligocene stem canids and feliforms were also slow to reach somatic maturity compared to extant mammals of similar size, suggesting that growth rate and time to adulthood were unlikely to be factors in the turnover between "creodont" and carnivoramorph diversity at the end of the Eocene.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW INTERPRETATION OF THE PROATLAS ARTICULATION IN TYRANNOSAURID ATLAS-AXIS COMPLEXES

POWERS, Mark J., University of Alberta, Edmonton, AB, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The atlas-axis complexes of dinosaurs are often covered up by other bones or missing even in associated or articulated skeletons. Due to the general absence of these bones, the interpretation of how the different parts of the complex articulate with each other and the skull can be difficult to determine. Isolated elements of the atlas-axis are commonly all that is found of the complex, leaving it purely to interpretation. The smallest elements of the complex, the proatlas, are often missing. The lack of a proatlas has been interpreted, in some cases, as the loss of the proatlas as a discrete anatomical element. When they are present, they have usually shifted from their anatomical positions. In most reconstructions, they arch over the occipital condyle and contact the exoccipitals as in more basal archosaurs, but sometimes have been interpreted as ribs for the first cervical vertebra. In this study, a nearly complete atlas-axis complex of a *Daspletosaurus* sp was examined to determine the connection between the proatlas and the skull. Worn bone texture on the rounded anterior surface of the proatlas suggests the proatlas had a connection with the occipital condyle. This new interpretation suggests the proatlas was incorporated into the anterior surface of the atlas and neuropophysis to create a more complete, cup-like articulating surface. This form is very similar to those of extant birds and supports the close phylogenetic relationship of the latter with more basal coelurosaurian clades. The similar morphologies in tyrannosaurids and extant birds of the atlas-axis complexes relates to their highly mobile necks. Feeding ecologies are highly variable in extant birds, in part because of their highly flexible, elongate necks. Non-avian theropods clearly also showed strong correlations between neck elongation and feeding behaviours.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ONTOGENY AND EVOLUTION OF THE FRILL OF NEOCERATOPSIAN DINOSAURS

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Neoceratopsians are a clade of ornithischian dinosaurs having a parietosquamosal frill extending caudodorsally over the neck. Variation in frill size and shape forms a critical set of characters for understanding neoceratopsian systematics and evolution, but fundamental questions on its biological and evolutionary role remain debated. We address key questions regarding frill evolution and ontogeny: was peramorphosis involved in frill evolution? Does ontogeny recapitulate evolutionary frill changes? Does the frill constitute a cranial module implying a function? Did its function shift during evolution?

Frill shape variation was quantified using Procrustes superimposition and the outline-based Square Root Velocity Function method. Frill modularity was evaluated using the RV coefficient and comparison of ontogenetic trajectories for various taxa allowed evaluation of frill heterochrony. We sampled 25 species (three basal ceratopsians, four basal neoceratopsians, and 10 chasmosaurine and eight centrosaurine ceratopsids). Frill ontogeny was analyzed in a growth series of *Protoceratops*.

Most variation in the ceratopsian frill consists of expansion of its caudal and caudolateral margins. In ceratopsids, frill variation concentrates on the caudolateral border in chasmosaurines and laterally in centrosaurines. Frill modularity is rejected in neoceratopsians both at evolutionary and ontogenetic levels, but is supported in basal ceratopsians with only an incipient frill. Such evolutionary loss of modularity may indicate release from a functional constraint related to anchoring the feeding musculature, thus allowing the posterior skull to be exapted for other functions such as display. Initial expansion of the frill in the lineage leading to Coronosauria may have followed a peramorphic process, though this is weakly supported. Among neoceratopsians, however, there is no evidence for simple scaling process driving frill evolution, and basal neoceratopsians, chasmosaurines and centrosaurines occupy non-overlapping regions in morphospace. This result is further underscored by changes in frill shape occurring independent of size across most of the growth series of *Protoceratops*.

Grant Information:
This project was supported by a Bass Postdoctoral Fellowship from The Field Museum

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THE EARLIEST SKELETAL RECORD FOR THE ORDER BATRACHOIDIFORMES (TELEOSTEI, PERCOMORPHA) - AN OLIGOCENE TOADFISH FROM PARATETHYS SEDIMENTS OF MORAVIA, CZECH REPUBLIC

PRIKRYL, Tomas, Institute of Geology of the CAS, v.v.i., Prague, Czech Republic; CARNEVALE, Giorgio, Università degli Studi di Torino, Torino, Italy

Batrachoidiform fishes are a group of primarily coastal benthic fishes distributed in tropical to temperate marine and brackish waters of the Atlantic, Indian and Pacific oceans with a few species being restricted to the freshwaters of South America. The order contains the single family Batrachoididae with about 23 extant genera in four monophyletic subfamilies: the Batrachoidinae, Halophryninae, Porichthyinae, and Thalassophryninae. Fossil articulated skeletal remains were reported only from the Miocene of Algeria, Austria and Italy, while isolated bones from Miocene to Pleistocene deposits of the Middle Atlantic Coastal Plain of North America and the otolith record of toadfishes extends back at least to the early Eocene of the Europe. The Menilitic Formation (early Oligocene; ca. 32 mya) of the Loucka locality (Moravia, Czech

Republic; Silesian Unit) provided first and only Oligocene articulated toadfish skeleton apparently representing the oldest skeletal record of the whole order Batrachoidiformes.
The head skeleton is moderately well preserved while the axial skeleton is only partially. Despite its incompleteness, it exhibits a set of features that support its recognition as a member of the batrachoidiforms, including the typical toadfish physiognomy, possession of an hypertrophied first epineural, supracleithrum with condylar articulation with ankylosed posttemporal, and mesethmoid unossified.
The cephalic part of the body is broad and dorso-ventrally compressed and only partially recognizable due to inadequate preservationThe fossil is characterized by a peculiar combination of features that clearly demonstrate its separate generic status within the Batrachoidiformes, primarily related with morphology of the subopercle, opercle, preopercle, hyomandibula, pelvic fins, as well as with the presence of two pairs of enlarged epineurals. This unique combination of features does not allow to include this new taxon within any of the known extant subfamilies.
Grant Information**:**
The research was financially supported by Czech science foundation (GACR) project 16-21523S.

Technical Session X (Friday, August 25, 2017, 8:30 AM)

A TINY, EARLY PAN-ARCHOSAUR FROM THE UPPER TRIASSIC OF CONNECTICUT AND THE DIVERSITY OF THE EARLY SAURIAN FEEDING APPARATUS

PRITCHARD, Adam C., Yale University, New Haven, CT, United States of America; BHULLAR, Bhart-Anjan S., Yale University, New Haven, CT, United States of America; GAUTHIER, Jacques A., Yale University, New Haven, CT, United States of America

The fossil record of early-diverging pan-archosaurs and pan-lepidosaurs in the Triassic is biased towards large-bodied animals (1+ meters). The Triassic Newark Supergroup of eastern North America has produced tantalizing specimens of small reptiles, hinting at high diversity on the continent. Among these is a remarkable diapsid skull (~2.5 cm length) lacking teeth and a mandible, from the Upper Triassic New Haven Arkose of Connecticut that has been referred to as one of the oldest sphenodontians from North America (referred to herein as the New Haven Reptile).
Following further preparation, we re-assessed the affinities of the New Haven Reptile using three-dimensional reconstruction of microCT data. The ontogenetic state of the New Haven Reptile is uncertain; despite the extensive reinforcement of the skull, the skull roof exhibits a large fontanelle between frontals and parietals. The feeding apparatus of this species is distinct from most small-bodied Triassic diapsids, with a strongly reinforced rostrum, a narrow sagittal crest on the parietals, and transverse expansion of postorbitals and jugals. The latter two conditions suggest transverse expansions of deep and superficial adductor musculature in a manner very similar to derived Rhynchosauria. This may suggest a specialized herbivorous diet similar to rhynchosaurs, although the New Haven Reptile is smaller than most modern herbivorous diapsids.
A phylogenetic analysis suggests that the New Haven Reptile is not a sphenodontian but an early pan-archosaur, representing a distinctive and previously unrecognized lineage. Regardless of its affinities, the New Haven Reptile differs from other small-bodied Triassic Sauria in its hypertrophied jaw musculature suggesting a greater dietary specialization in these taxa than previously understood. It underscores the importance of geographically undersampled regions in understanding the true ecomorphological diversity in the fossil record.
Grant Information:
Funded partially by NSF DBI 1523871 to ACP and BSB.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

AN EXCEPTIONALLY PRESERVED FULMARINE PROCELLARIIFORM FROM THE MIOCENE OF CALIFORNIA

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The influence of global climatic and oceanic change on seabird diversity is key to understanding seabird evolutionary history as well as the effects of future climate change on marine avifauna. Phylogenetic and specimen-based approaches indicate that climatic conditions during Middle Miocene Climatic Optimum and subsequent cooling into the Plio-Pleistocene are correlated with mixed patterns of diversification and extinction in multiple seabird lineages. The most diverse of these lineages, Procellariiformes, are well represented by fossils from this time in California: 11 species are described and hundreds of specimens are catalogued in museum collections. However, understanding of the relationship between Earth System change and procellariiform diversity during this key interval is hampered by the fact that most specimens are isolated elements, none of which have been examined in a phylogenetic framework. Articulated seabird skeletons, though rare, grant an unmatched window into extinct procellariiform morphology and evolutionary history by enabling evaluation of extinct procellariiform morphological evolution, morphological variation, and taxonomy. We report on a new exceptionally preserved procellariiform skeleton with feathers from the Miocene Monterey Formation of San Luis Obispo County, California. The fossil represents the second reported articulated skeleton from the state and the first reported from San Luis Obispo County. Initially catalogued as a member of the genus *Puffinus*, we assign this new fossil to the fulmarine clade based on a dorsoventrally high rostrum and mandibular tip, strongly ventrally deflected posterior mandible, as well as the shape of the humeral dorsal supracondylar process and pygostyle. Notably, the specimen preserves feathers, representing the first record of fossil procellariiform feathers. We use a phylogenetic dataset of over 300 morphological characters sampled across 38 extant and 14 extinct taxa to evaluate the affinities of the new specimen. This matrix also includes published molecular sequence data (349 nuclear loci for 9 taxa representing deep divergences in Procellariiformes and cytochrome b and CO1 sequences for the remaining 29 taxa) to inform estimation of divergences among extant Procellariiformes.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

REVIEW OF THE PLIOCENE SPECIES OF THE FLAT-HEADED PECCARY *PLATYGONUS* (MAMMALIA: ARTIODACTYLA) FROM NORTH AMERICA

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The Pleistocene and Miocene species of flat-heated peccaries (*Platygonus*) are well known, but the Pliocene species are in a state of taxonomic confusion. Careful analysis of all the available specimens in U.S. museums suggest that there are only two valid species: a smaller species, *P. pearcei* Gazin 1938, best known from the Hagerman fauna of Idaho, but also found in the Blancan beds of the High Plains (Texas, Oklahoma, Nebraska, Kansas). In addition, it occurs in the Ringold fauna of Washington, in the Blancan of Benson, Arizona, and the Palmetto Mine local fauna of Florida. The type material of *P. pearcei* consists of a complete articulated adult skeleton and two juvenile articulated skeletons (long on display in the Smithsonian). A much larger species with more bulbous cusps is *P. texanus* Gidley 1903, which is found only in the Blancan beds of Texas, Oklahoma, Kansas, and Nebraska. It is known from partial skulls and numerous jaws and teeth. The oldest name applied is *P. bicalcaratus* Cope 1892, based on a non-diagnostic tooth fragment from the Blanco beds that could belong to either taxon. Based on its poor condition, it cannot be definitively assigned to any taxon, so it is a *nomen dubium*.

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

CRESTS, CUSPS, AND DIET OF ASIADAPIDS (ADAPOIDEA, EUPRIMATES) FROM VASTAN MINE (GUJARAT, INDIA)

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The Cambay Formation (early Eocene) at Vastan Lignite Mine in Gujarat has yielded the oldest euprimates known from India including two adapoids, *Marcgodinotius indicus* and *Asiadapis cambayensis* (Asiadapidae, Adapoidea), which have been reconstructed as small-bodied, generalized arboreal quadrupeds. Vastan asiadapids have been suggested to occupy a basal position within Adapoidea and most closely resemble European cercamoniine adapoids in dental features. Here we assess the dietary niches of Vastan asiadapids and potential differences in diet from *Donrussellia gallica*, a primitive cercamoniine, by evaluating lower second molar (m2) shearing potential and cusp tip sharpness.
A sample of extant prosimians of known diet was used to assess the diets of the fossil adapoids. Shearing quotients (SQ), a measure of shearing potential, were calculated as the residuals from a least-squares line fitted to extant frugivorous prosimians, with sum of shearing crest lengths plotted against tooth length in log space. Cusp tip sharpness provides an estimate of cusp pressure on food. High SQ values in small-bodied primates are associated with insectivorous diets, whereas more acute cusp tips are associated with an increased efficacy in piercing tough foods. Application of both of these metrics allows us to better distinguish the potential food sources utilized by Vastan asiadapids and other early adapoids.
Our results indicate that the SQ values of *M. indicus* and *A. cambayensis* overlap with both extant prosimian frugivores and insectivores. This suggests that both of the Vastan asiadapids likely were mixed-feeding insectivores/frugivores. In addition, there is considerable overlap in cusp acuity between *M. indicus* and *A. cambayensis*. However, both taxa have blunter cusp tips than the extant prosimian insectivores, suggesting that the items included in their diet may have been easier to pierce than those consumed by primarily-insectivorous extant prosimians. Given the similarity in these two dental metrics between *Marcgodinotius* and *Asiadapis*, it is likely that the Vastan asiadapid primates overlapped in food resources.
Relative to the Vastan asiadapids, *D. gallica* has a lower mean SQ value, and similar cusp tip sharpness. If the Vastan asiadapids are indeed basal adapoids, this would suggest that only a subtle dietary shift occurred early in the dispersal of adapoid primates.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

FILLING A DATA GAP WITH ANALYSIS OF FOSSIL EGGSHELL FROM THE LATE CRETACEOUS UPPER TWO MEDICINE FORMATION OF MONTANA

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Paleontologists have characterized the Two Medicine Formation as possessing three stratigraphically distinct ecological communities representing the Lower, Middle and Upper portions of the unit. These three communities were originally recognized based on skeletal data. Whereas, fossil eggs and eggshells are known from the Lower and Middle Two Medicine, including many nesting sites for *Maiasaura* and *Troodon*, no material is described from the upper formation in Teton County. Here we describe eggshell material from the upper section that fills in this temporal gap. The new locality yielding these eggshell specimens exhibits evidence consistent with those found at nesting sites. It has an unusually high concentration of eggshell in a small location with likely some partial eggs preserved. The site consists primarily of a calcareous mudstone with veins of calcite. The examined eggshell exhibits a surface ornamentation ranging from discrete nodes to connecting ridges suggesting dispersituberculate to sagenotuberculate patterns. Scanning electron microscope imaging of radial sections gives a thickness of between 0.608 and 0.650 mm with two distinct microstructural layers: an internally massive mammillary and a more continuous squamatic layer. The overall morphology suggests the eggshell belongs to a theropod dinosaur with some diagenetic overprinting. Further details may be revealed by examination of petrographic thin sections, cathodoluminescence, and preparation of field jackets collected from the site. Preliminary analysis of this material suggests it may represent an ootaxa different from those found in

the Lower and Middle units of the Two Medicine. This new material helps fill in transitions with eggshell assemblages collected from the Lower Two Medicine and Judith River Formations through the Hell Creek Formation. This vast of a chronologic sequence of egg material would be significant for future studies.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW LIZARD OF THE GENUS *CALLOPISTES* GRAVENHORST 1838 (SQUAMATA; TEIIDAE) FROM THE LOWER MIOCENE OF ARGENTINA, AND THE FOSSIL RECORD OF TEIIDS IN SOUTH AMERICA

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Although squamates are commonly found in most Caenozoic south american fossil beds, complete skeletal materials are rare. Only a few examples exist, with most findings representing fragmentary cranial or jaw materials or isolated vertebrae. Among the known South American vertebrate fossil localities, the Chichínales Formation (Colhuehuapense age) rendered recently a mostly complete skull of a previously unknown teiid lizard. Here we show that this fossil represents a new species of the extant genus *Callopistes*, presenting unique characters such as a pineal foramen and a high-number of pterygoid teeth compared to other teiids. We also provide a detailed description of the new fossil teiid *Callopistes rionegrensis* based on both stereoscopical and high-resolution X-ray computed tomography (CT Scan) analyses. The phylogenetic analysis resulted in twelve equally most parsimonious (optimal) trees. The strict consensus of all twelve trees was calculated. In all twelve optimal trees, the fossil lizard was recovered within the genus *Callopistes*, nested within the family Teiidae. Nevertheless, we were unable to establish which of the two *Callopistes* species present in the analysis were more closely related to the fossil. The current distribution of the two extant species of *Callopistes* and the locality from where the new taxon was recovered indicate that this genus had a much broader distribution in the past, reaching cis-Andean areas of Patagonia, apart from the trans-Andean areas where the two extant species are restricted.

Grant Information**:**

We would like to thank Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação de Amparo à Pesquisa do Estado de São Paulo (Fapesp) for funding.

Preparators' Session (Thursday, August 24, 2017, 10:45 AM)

3D-VISUALIZATION OF VERTEBRATE COPROLITES THROUGH PHASE-CONTRAST SYNCHROTRON IMAGING UNRAVEL NEW ASPECTS OF PALEOECOLOGICAL RELATIONS

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Coprolites (fossil feces) often contain food residues, parasite remains and other fossils that provide clues to ancient paleoecological relations. Some of these inclusions are delicate remains and fossilized soft tissues, which in many cases are more likely preserved within the coprolites than in the host rock. The main factor of preservation of the inclusions is thought to be an early mineralization of the feces, largely influenced by bacterial processes, and especially facilitated in carnivore coprolites rich in phosphate. However, composition, size and the chaotic organization of the inclusions within the coprolites makes them difficult to analyze based on classic techniques, such as analyses of thin sections under the microscope or SEM studies, which both are require destructive preparation and are based on 2D sections. To overcome this problem, coprolites were scanned through propagation phase-contrast synchrotron microtomography (PPC-SRμCT) at the European Synchrotron Radiation Facility, France. Contents from two coprolites from rich Upper Triassic bone beds Poland were segmented into 3D models. One of the coprolites is spiral, composed of a single scroll, and contains fragmented bivalve shells and a partly articulated fish, probably a redfieldiid. The fish remains include fin rays, scales and bones that were fractured and sheared during ingestion/digestion. However, the scales overlap one another like in the living fish, and the lateral line scales are aligned. The pelvic girdles are preserved in approximate life position, one with the pelvic fin still attached. Based on the spiral morphology, the contents, and the body fossil occurrences in the bone bed, the coprolite was assigned to the dipnoan *Ptychoceratodus*. The other coprolite contains various fully three-dimensional beetle remains, including two different elytra, a tibia, and other fragmented exoskeletal parts. The fine details of the ornamentation and attachments sites of the elytra are almost perfectly preserved. The coprolite is 53 mm long and 23 mm in maximum width and was produced by a medium-sized terrestrial animal that evidently targeted small beetles as prey. Likely candidates include a cynodont or an archosaur. These examples underline the capability of coprolites to act like small konservat-lagerstätten, and that they have an underestimated potential in unraveling paleoecological relations from ancient ecosystems. PPC-SRμCT is shown to be an invaluable technique to extract this information non-destructively, in high-quality, and in 3D.

Grant Information:

The coprolites were scanned at the ESRF (Grenoble, France) as a part of the proposal ES145.

Technical Session XII (Friday, August 25, 2017, 12:00 PM)

SOFTSHELL TURTLES BREAK DOLLO'S LAW: PHYLOGENETIC EVIDENCE FOR THE REVERSAL OF PERIPHERAL ELEMENTS IN THE SHELL OF THE INDIAN FLAPSHELL TURTLE

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Softshell turtles (Pan-Trionychidae) are a highly specialized extant group of strictly aquatic taxa with a long evolutionary history dating back to the Early Cretaceous. Their most peculiar character is the heavily reduced shell with the complete loss of the peripheral bony ring of the carapace. The only species with a partial peripheral ring are the Indian flapshell turtles (*Lissemys* spp.). Structural and developmental homology of this partial peripheral ring with the peripheral bones of other turtles has been previously demonstrated based on histology and ontogeny but whether they represent primarily ancestral or secondarily reversed states remained unclear because of the basal position of *Lissemys* and the phylogenetic uncertainty around the stem lineage of softshell turtles. The earliest fossil taxa already fully developed the "classic" softshell turtle morphology and therefore it has been impossible to resolve whether they are stem members or are within the crown. We comprehensively revised previous morphological datasets of living and extinct pan-trionychids through the help of first-hand observations of key Mesozoic taxa and the addition of skeletal data of a new taxon from the Early Cretaceous of Zhejiang, China. Morphological character optimization on a molecular topology of extant trionychids demonstrated that high levels of homoplasy are primarily responsible for poor phylogenetic resolution among extinct taxa. Moreover, equal character weighting resulted in a topology that is fundamentally inconsistent with molecular divergence date estimates of deeply nested extant species. In contrast, implied weighting retrieved Lower Cretaceous fossil taxa as stem-trionychids, which is fully consistent with their stratigraphic occurrence and an Aptian-Santonian molecular age estimate for crown-trionychids. These results indicate that the lack of peripheral elements (i.e. the condition in crown-trionychines) is primitive for softshell turtles and were subsequently reacquired in *Lissemys*. The Indian flapshell turtle therefore demonstrates a homologous reversal of dermal bone loss and provides a counter-example for Dollo's law of character evolution irreversibility. On the other hand, the secondary plastron of *Lissemys* is apparently non-homologous to the primary plastron of other turtles which well illustrates the complexity of reversibility. Such complexity implies that homologous character reversibility largely depends on the retention or loss of genetic regulators of the anatomical structure in question.

Grant Information:

European Union's Seventh Framework programme under the Marie Sklodowska-Curie grant agreement No 609402 - 2020 researchers, Train to Move (T2M) & VW Foundation Grant to MR.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

MAPPING MAMMALIAN MORPHOLOGICAL TRAITS TO DIETS WITH MACHINE LEARNING

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Reconstructing trophic relationships between extinct species is fundamentally challenging because explicit records of species interactions are rarely preserved. Body size ratios between predators and prey have been shown to accurately predict higher trophic level relationships, however herbivore/plant interactions are generally constrained by chemical and mechanical factors. Such information is more difficult to untangle from the fossil record, however the morphological traits of herbivores -- to some extent -- provide a good initial estimate of which resources were likely important, yet there is not a comprehensive framework for combining morphological indicators of diet with other lines of evidence to establish predictions of trophic interactions

Here we use a machine approach to map the morphological traits of modern herbivores to known diets, and then apply these algorithms to estimate past herbivore diets from extinct ecosystems, specifically those from the Rancho La Brea (RLB) ecosystem.

Our trait-to-diet mapping is established using an artificial neural network algorithm, which we train with herbivore traits and diets from contemporary mammalian species from East Africa. Herbivore traits that are used to establish the trait-to-diet mapping represent a broad suite of morphological characteristics accessible for both modern and fossil mammals, and include skeletal measurements, body size estimates, and dental morphology. Because the morphological diversity of the East African mammalian community roughly approximates the mammalian community from La Brea, it is well-suited to establish a first order approximation of herbivore diets. We aim to update these initial estimates from morphological traits with additional information that incorporate constraints such as the abundance of potential resources, nutritional quality, and landscape-scale estimates of primary productivity. Ultimately, these tools will be used to reconstruct multiple food webs from the last interglacial to the late Pleistocene in an effort to assess the impacts of both climate change as well as the advent of human populations to the North American continent.

Romer Prize Session (Thursday, August 24, 2017, 11:45 AM)

DRIVERS AND CONSTRAINTS OF SHAPE EVOLUTION IN THE VERTEBRAL COLUMN OF FELIDAE (CARNIVORA, MAMMALIA)

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The mammalian vertebral column is unusual in being highly conservative in terms of presacral count across an otherwise ecologically and morphologically diverse clade. Whereas most other tetrapods greatly vary in vertebral count, almost all mammals have seven cervicals and 19-20 thoracolumbars. This meristic constraint is hypothesized to drive higher regionalisation in the mammalian axial skeleton, with modification of form being the principal route of adaptation to discrete niches.

Using 3-D geometric morphometrics I analysed vertebral column shape change across the mammalian family Felidae, in which all species display 27 presacral count but vary in ecology and body mass. With a dataset of 109 whole-skeleton specimens and >1710 vertebrae, I investigated the morphological evolution of the vertebral column by first quantifying ecological and phylogenetic influences on shape, including a novel use of the Phenotypic Trajectory Analysis to conduct a combined analysis across the vertebral column, overcoming the long standing issue of analysing morphology along serial structures. I incorporated an evolutionary-developmental perspective by reconstructing patterns of intra- and intervertebral trait covariation and modularity. I further assessed the relationship between trait correlations and disparity to test fundamental hypotheses on the evolutionary significance of integration. Finally, I conducted the first analysis of

integration across the whole skeleton with Partial Least Squares analysis of 29 elements spanning the vertebrae, limbs, girdles, and cranium.
My results show regionalisation of vertebral column shape and function: a highly integrated posterior region between the diaphragmatic vertebra and the last lumbar displays the highest levels of ecological specialization, contrasting with a phylogenetically conserved neck region. A developmental two-module model of intravertebral shape covariation is widespread across the vertebral column. Deviations from this model occur at boundaries of large vertebral modules and suggest functional overprinting of developmental patterns. Further, intravertebral shape analyses provide empirical support to the hypothesis of phenotypic integration promoting higher disparity. Finally, I demonstrate modular organisation at the organismal level, with decoupling of the vertebral column from other skeletal structures, potentially allowing for greater ecological specialisation of the appendicular skeleton and cranium relative to the more conservative vertebral column.

Technical Session VII (Thursday, August 24, 2017, 2:00 PM)

PYGOSTYLE DEVELOPMENT AND ITS IMPLICATIONS FOR THE CRETACEOUS LONG- TO SHORT-TAILED AVIAN TRANSITION

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During the Cretaceous transition of long- to short-tailed birds, the avian tail sustained several changes, including a reduction in the number of caudal vertebrae and fusion of the distal caudal vertebrae into a pygostyle. Short fused tails have been highly adaptive for birds, with advantages to flight aerodynamics and sexual selection. To understand how these morphological changes occurred, we have employed an evolutionary developmental biology approach, studying the development of tail structures and fusion of the pygostyle in modern birds. Previously, we examined vertebrate mutations that cause tail truncation and/or caudal vertebrae fusion. Using these analyses as a guide, we followed the development of tail embryo structures affected in those mutations to find clues to Cretaceous evolutionary events. Interestingly, we discovered alterations in somite formation that may account for much of those morphological changes. Somites, the embryonic precursors of vertebrae, exhibit perturbations in their anterior/posterior (AP) polarity specific to the pygostyle region in chicken embryos. Mouse mutations in somite AP polarity generally lead to short, fused tails. Additionally, vertebrate somite AP polarity mutations also result in loss of spinal nerve formation, which we discovered terminates precisely at the border between the pygostyle and the free caudal pre-vertebrae in early chicken development. These analyses indicate that the pleiotropic effects of one or a few genetic mutations could be responsible for the seemingly abrupt transition from long to short tails, and the lack of intermediate forms, in the Cretaceous.
Further implications for interpretations of Cretaceous bird specimens have been inferred from our analyses of pygostyle fusion. Unexpectedly, we discovered that fusion occurs postnatally, and in the chicken requires months to complete. Comparisons of pygostyle fusion among several extant birds reveals that the timing of fusion varies greatly, with the most significant differences observed between neoavian and non-neoavian neornithines. The longer timeframes required for pygostyle fusion in gallanseriforms and paleognaths indicate this may be the ancestral condition. These findings cast some doubt over whether *Zhongornis haoae*, a juvenile short-tailed Cretaceous bird lacking a pygostyle, is indeed a transitional form between long and short-tailed birds. Our study emphasizes the role of ontogeny in evaluating avian specimens at the long- to short-tailed transition.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE ANATOMY, TAXONOMY AND SYSTEMATIC POSITION OF THE ENIGMATIC THYREOPHORAN DINOSAUR *PARANTHODON AFRICANUS*

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The first African dinosaur, *Paranthodon africanus*, was discovered in 1845 in the Lower Cretaceous of South Africa. Taxonomically assigned to numerous groups since discovery, in 1981 it was described as a stegosaur, a group of armoured ornithischian dinosaurs characterised by bizarre plates and spines running from the neck to the tail. The type material consists of a premaxilla and maxilla, a nasal and a vertebra, and contains no synapomorphies of Stegosauria. The description has no mention of the morphological similarities with ankylosaurs, no description of the vertebra mentioned and since it was published, there have been numerous discoveries of thyreophoran material, and new methods of analysis are now available. This study provides a detailed re-description, including the first description of the vertebra, and numerous phylogenetic analyses, to determine the systematic positioning of *Paranthodon*. It is referred to Stegosauria based upon phylogenetic placements, and a medially extending maxillary palate is the only autapomorphy of the genus. Two previously referred teeth are therefore indeterminate thyreophoran. A new ankylosaurid phylogeny is presented, with higher resolution in Ankylosauridae than ever before, based on the use of `New Technology' searches. *Crichtonpelta* is found outside of Ankylosaurinae, meaning it is not the oldest ankylosaurine. The use of basal taxa as exemplifiers for supraspecific taxa is discussed, and shown to be potentially phylogenetically unjust. Phylogenetic super-matrices are recommended to ascertain uncertain evolutionary relationships.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE RELATIVE ABUNDANCE OF MAMMALIAN CARNIVORES FROM NATURAL TRAP CAVE, WYOMING (LATE PLEISTOCENE-EARLY HOLOCENE)

REDMAN, Cory, Drake University, Des Moines, IA, United States of America; MEACHEN, Julie, Des Moines University, Des Moines, IA, United States of America; LOVELACE, David, UW-Madison Geology Museum, Madison, WI, United States of America

Natural Trap Cave (NTC) is a well-known fossil locality located in the Bighorn Basin of Wyoming that has produced a diverse vertebrate assemblage from the Late Pleistocene to early Holocene. This study examines changes in the relative abundance structure of NTC's mammalian carnivores (>10 kg), using the disarticulated, skeletal elements collected from 1974-1978 by the University of Kansas. This study is restricted to collections made from 1974-1978, because it has the strongest provenance data and the largest sample size. Six genera of mammalian carnivores (*Arctodus, Canis, Gulo, Miracinonyx, Panthera,* & *Vulpes*) have been recovered from NTC. Abundance counts were tallied for specimens over 50% complete and identifiable to the genus level, for a total of 1240 specimens from 18, non-sequential stratigraphic levels excavated at 15.24 cm (6 inch) intervals.
Rank abundance curves maintain a convex-down shape throughout the 3.5 meters of section included in this study. *Canis* is the most abundant carnivore for the upper 1.5 meters of section. *Miracinonyx* and *Canis* are equally abundant or alternate as the most abundant carnivore for the lower 1.5 meters of section. These changes may be an artifact of a reduced sample size (<50 specimens), though all six genera of carnivores are found throughout the 3.5 meters. Incorporating abundance counts from post 1978 expeditions is currently underway and will be key to statistically testing the robustness of relative abundance trends of NTC's mammalian carnivores.
Grant Information:
NSF EAR Grant (# 1425059)
Cave Conservancy Foundation

Technical Session XVI (Saturday, August 26, 2017, 8:15 AM)

REASSESSMENT OF THE PHYLOGENETIC RELATIONSHIPS OF BASAL SAUROPODOMORPH DINOSAURS AND THE ORIGINS OF QUADRUPEDALITY

REGALADO FERNÁNDEZ, Omar R., University College London, London, United Kingdom; UPCHURCH, Paul, University College London, London, United Kingdom; BARRETT, Paul M., The Natural History Museum of London, London, United Kingdom; MANNION, Philip, Imperial College London, London, England; MAIDMENT, Susannah C., University of Brighton, Brighton, United Kingdom; GOSWAMI, Anjali, University College London, London, United Kingdom

Sauropodomorph dinosaurs represent the first radiation of herbivorous dinosaurs and comprise the Sauropoda and taxa traditionally referred to Prosauropoda. Following recent phylogenetic analyses some degree of prosauropod paraphyly has become widely accepted. This has placed the origins of sauropod quadrupedality among 'prosauropods' and an increase in the resolution of the inter-relationships of basal sauropodomorphs is required to provide a framework for understanding this transition.
Some of the more derived 'prosauropods', close to the base of Sauropoda, show adaptations that potentially represent a transition from the plesiomorphic bipedal-stance to quadrupedality. These adaptations to a quadrupedal stance are also evident in juvenile sauropods, contrasting with the juveniles of more basal sauropodomorphs, such as Mussaurus and Massospondylus, which experienced appendicular heterochrony. A near-comprehensive phylogeny is presented here after the compilation and revision of all previously published phylogenetic data matrices and characters of basal sauropodomorphs (following standardization of character statements and their consistent application to all taxa). Specimens from Germany, China, and England have been assessed first-hand. The revised data matrix, comprising 783 characters and 77 taxa, was analysed in TNT. After demonstrating that there is a difference between the topologies based solely on discrete characters and on discretised continuous characters, we assessed the impact on the topology of using continuous data.
This new phylogeny provides a better framework for understanding the anatomical modifications towards quadrupedality. Anchisauria shows a trend towards quadrupedalism, and a core 'Prosauropoda' comprising Massospondylidae + Plateosauridae, indicates that bipedality was well-established in this part of the tree. Riojasauridae, previously placed within the obligate quadrupedal clade Melanorosauridae, is retrieved here as either the sister taxon of, or at the base of, Anchisauria. This means that in this group the development of an anterolateral process of the ulna was convergent with that in melanorosaurids, and the reduced fourth trochanter and the transversely broad ilium is convergent with features present in quadrupedal ornithischians. Quadrupedality originated at least twice within Sauropodomorpha (Riojasauridae and Melanorosauridae) and most of the taxa traditionally referred to as 'prosauropods' were bipeds.
Grant Information:
Consejo Nacional de Ciencia y Tecnologia, Mexico

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW SPECIES OF NOTOSUCHIAN CROCODYLIFORM FROM THE LATE CRETACEOUS OF MOROCCO

REGO, Adam I., Amaranth, ON, Canada; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

A new species of notosuchian from the middle Cretaceous (Cenomanian) Kem Kem Beds of Morocco is described based on a specimen composed of a tooth-bearing partial left dentary and partial splenial. The dentary is complete from the mandibular symphysis to the tenth alveolus, and is thus lacking its posterior portion. The splenial lies on the lingual and ventral surfaces of the dentary from the mandibular symphysis to a break on its lingual surface below the seventh alveoli. The mandible is distinguished from other crocodyliforms primarily in its dentition; the tooth crowns are mesiodistally expanded,

with multiple cusps arranged along a single row. The specimen was scanned using computerized tomography and virtually segmented to observe the germ teeth beneath the presently erupted teeth. Germ teeth provide greater understanding of tooth morphology in the specimen, as they display no wear when compared to erupted teeth, thus providing a more complete view of tooth cusps. Cusps are of varying size, with the largest cusps placed at the center of the crown and smaller cusps radiating towards the distal edges of each tooth. Teeth are faintly convex on the lateral surface, and similarly concave on the lingual surface. The tenth alveolus is extraordinarily large, and contains fragments of a root that imply a large 'tusk-like' tooth.
Phylogenetic analysis places this species as the sister taxon to *Simosuchus clarkii* within Notosuchia. These taxa are closely related to *Uruguaysuchus* and *Libycosuchus,* which have very similar dentition, with all species containing flattened teeth with a single row of cusps in the cheek teeth. The leaf-shaped dentition, which is characteristic of many herbivorous reptiles implies that the new Moroccan taxon was partially or entirely herbivorous. Given the phylogenetic placement and similarities to *Simosuchus,* the phylogeny would imply that herbivory in this lineage evolved in a continental setting, rather than due to island isolation in *Simosuchus*.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

LATE QUATERNARY DRAGON LIZARDS (AGAMIDAE: SQUAMATA) FROM WESTERN AUSTRALIA

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Late Quaternary fossil Agamidae from Western Australia have been the subject of limited study. Agamid fossils are typically identified to the family level, thus the fossil record of genera and species is relatively unknown. To aid in identification, the maxillae and dentaries of extant Australian species have been examined, and diagnostic characters for various groups have been established. In thestudy presented here, fossil agamids from two late Quaternary localities in Western Australia, Hastings Cave and Horseshoe Cave, are examined, grouped into morphotypes, and identified to the lowest unambiguous taxonomic level using established diagnostic characters and an extant agamid collection. In addition, morphometric analyses are conducted to compare morphotypes, and test the validity of each group. From Hastings Cave there are two maxilla morphotypes and three dentary morphotypes; identifications include *Pogona* and *Ctenophorus*. Horseshoe Cave contains three maxilla morphotypes and two dentary morphotypes; identifications include *Pogona*, *Tympanocryptis*, and *Ctenophorus*. Morphometric analyses show good separation between groups; however, the dentary morphotype separation was not as clear. These results report the first fossil record of *Pogona*, *Ctenophorus*, and *Tympanocryptis* in Western Australia. All morphotype identifications match species living in the respective localities today, but species level identifications are cautious. In order to identify the morphotypes to more specific levels, additional studies need to be conducted on extant skeletal specimens to determine characters that are diagnostic at the species level. Once species identification is achieved, additional questions in regards to shifts in species presence, ecology, and climate can be examined.

Technical Session XVII (Saturday, August 26, 2017, 11:00 AM)

PALEOSOL-BASED NICHES OF OLIGOCENE MAMMALS FROM THE JOHN DAY FORMATION OF OREGON

RETALLACK, Gregory J., University of Oregon, Eugene, OR, United States of America; SAMUELS, Joshua X., East Tennessee State University, Johnson City, OR, United States of America

Paleosols are evidence of past environments independent of fossils, but few collections have been made with attention to exact location of fossil within paleosols. Over the past decade we recorded exact locations of 489 *in situ* fossils and measured the depth to nodules in paleosols of the Oligocene (Whitneyan-Arikareean), Turtle Cove Member, John Day Formation, near Dayville, Oregon. Previously published work showed fluctuation of depth to calcic horizon with alternation of desert shrubland and subhumid wooded bunch-grassland on Milankovitch obliquity time scales. Depth to calcic horizon also has been shown to be related to mean annual precipitation (MAP), so that niches of precipitation range can be determined for each species. Mammal, snail, and trace fossils of the John Day Formation are segregated into semiarid shrubland and subhumid, wooded bunch-grassland species. Semiarid snails include "*Polygyra" expansa* (MAP 457±46 mm, n 17) and *Monadenia dubiosa* (MAP 460±57 mm, n 10), while subhumid snails include *Vespericola dalli* (MAP 810±81 mm, n 26) and *Monadenia marginicola* (MAP 849±196 mm, n 14). Semiarid trace fossils include cicada burrows (*Naktodemasis bownii* MAP 451±66 mm, n 50); subhumid trace fossils include dung beetle balls (*Pallichnus dakotensis* MAP 804±105 mm, n 38) and earthworm castings (*Edaphichnium lumbricatum* MAP 829±97, n 10). Hypertragulid species include the semiarid *Hypertragulus hesperius* (MAP 490±90 mm, n 29) and the subhumid *Nanotragulus planiceps* (MAP 935±97 mm, n 7). Other semiarid mammals include the aplodontiid *Haplomys liolophus* (MAP 479±91 mm, n 6), the geomyid *Pleurolicus sulcifrons* (MAP 509±112 mm, n 6), the castorid *Palaeocastor peninsulatus* (MAP 520±49 mm, n 4), and the leporid *Archaeolagus ennisianus* (MAP 542±133 mm, n 17). Other subhumid mammals include the oreodonts *Eporeodon occidentalis* (MAP 786±166 mm, n 32) and *Promerycochoerus superbus* (MAP 854±101 mm, n 7), the agriochoere *Agriochoerus antiquus* (MAP 924±17 mm, n 5), the equid *Miohippus annectens* (MAP 695±198 mm, n 14), and rhinos *Diceratherium annectens* (MAP 854±132 mm, n 16) and *Diceratherium armatum* (MAP 1067±183, n 8). Fossil mammals with adaptations for life in open, arid habitats, such as high crowned teeth, and semi-fossorial or cursorial limb structure, are strongly biased towards semiarid paleosols, while arboreal adaptations were found exclusively from subhumid paleosols.

Grant Information:
University of Oregon Faculty Support

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

MAMMALIAN COMMUNITY STRUCTURE THROUGH TIME: OREGON MIOCENE COMMUNITY CHANGE IN RESPONSE TO SPREADING GRASSLANDS

REUTER, Dana M., University of Oregon, Eugene, OR, United States of America; HOPKINS, Samantha S., university of Oregon, Eugene, OR, United States of America; FAMOSO, Nicholas A., University of Oregon, Kimberly, OR, United States of America

Food webs describe ecosystem function and energy flow and offer insights into ecological processes. Despite the difficulty of identifying ancient trophic connections from fossil assemblages, well-collected localities provide a unique opportunity to examine evolving community structure through time. To develop a better understanding of how mammalian communities respond to vegetation and climate change, we reconstructed food webs from before and after the spread of grasslands in Oregon. Specifically, we focused on the Mascall (~16-14 Ma) and Rattlesnake Formations (~7 Ma) found in the John Day Basin of Oregon. These formations have well-collected, highly fossiliferous localities, and were deposited in Oregon before and after the transition from a more closed habitat to an open grassland environment. Using body mass estimates from m1 area and the presence or absence of functional traits, such as enamel complexity or shearing blade length, we assigned species to trophic guilds and reconstructed inter-guild relationships. These food webs show a change in mammalian community structure between the middle and late Miocene in Oregon, with large browser diversity decreasing considerably and the number of large grazing and mixed feeding herbivores increasing. Large omnivores also increased in the Rattlesnake faunal assemblage compared with the Mascall faunal assemblage. The number of taxa present in the large carnivore guild did not change substantially but some of the genera occupying that trophic guild did change, with large amphycyonids being replaced by borophagine dogs. These food webs are just one piece of a larger project that aims at understanding how the spread of grasslands affected mammalian community evolution in Oregon. We hope that by studying the change that occurred in the Miocene we can create a framework to understand how mammal community function changes after vegetation turnover.

Technical Session XIV (Friday, August 25, 2017, 2:30 PM)

SABRE-TOOTHED CAT (*SMILODON FATALIS*) SUBADULTS FROM CORALITO, ECUADOR INTERPRETED AS MEMBERS OF THE SAME AGE COHORT

REYNOLDS, Ashley R., University of Toronto, Toronto, ON, Canada; SEYMOUR, Kevin L., Royal Ontario Museum, Toronto, ON, Canada

Carnivoran remains are relatively rare in the fossil record, particularly outside of carnivore traps and cave deposits, so it is notable when more than a few remains of a large apex predator are found at a single locality. Here we report on a multiple individual assemblage of sabre-toothed cats (*Smilodon fatalis*) that were recovered from Coralito, a Late Pleistocene bone bed on the Santa Elena peninsula in Ecuador.
Although no geological studies were published from the field collection of this site in 1961, based on field notes, site photographs, taxonomic composition, and geologic maps of the area, it appears to be an estuarine deposit that was later invaded with asphalt, rather than an entrapment deposit as seen at Rancho La Brea. Precise stratigraphic data is unavailable for Coralito, but field notes indicate that the bone layer was a relatively small sandy lens, so it is likely that all bone was deposited in one or a few events. In total over 4,000 specimens were collected from the site, of which 94.5% represent mammals, 5.3% reptiles, and less than 1% birds and amphibians combined. Of the mammalian specimens collected, 90.1% represent xenarthrans, 6.65% artiodactylans, and 1.7% carnivorans.
Of the carnivoran specimens, 57 (80.3%) are *S. fatalis* elements. Tooth wear and epiphyseal fusion indicate that most material came from subadult individuals. Among these subadult-sized elements, there is only one duplication, in the left dentary. However, a right ulna and right femur belong to at least one adult, indicating a minimum number of three individuals present. The two left dentaries are strikingly similar in size – within 3 millimetres – suggesting that these two individuals may have been subadults of the same cohort. Although all living felids will form small groups consisting of a female and her current litter, related female lions (*Panthera leo*) always form the core of a pride, and coalitions of two or more young males form in extant lions and cheetahs (*Acinonyx jubatus*). The two adult elements are more heavily tar stained than the subadult material, suggesting a different taphonomic history. It is therefore uncertain if they were associated with the subadults in life. We hypothesize that due to the small size of the bone layer, uniform tar staining, and minimal signs of transport, the two subadults died together, possibly as part of a social group. Further study of small deposits such as Coralito may help in understanding social behaviour in *S. fatalis*.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THEROPOD PELVIC MUSCULATURE AND THE TRANSITION TO KNEE-DRIVEN LOCOMOTION

RHODES, Matthew M., University of Alberta, Edmonton, AB, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada; FUNSTON, Gregory F., University of Alberta, Edmonton, AB, Canada

Theropod dinosaurs were obligate bipeds that relied on hindlimb bones and muscles for locomotion. Analyzing theropod pelvis and hindlimb anatomy with comparison to their closest living relatives allows reasonable identification of muscle configuration and attachment sites, which offers a new perspective on locomotory adaptations. Tail-driven locomotion is ancestral for theropods, however, living theropods (birds) exhibit knee-driven locomotion. This transition, regarding both anatomy and musculature, has significant implications and constraints concerning the evolution of bird-like, knee-driven locomotion. Hindlimb musculature is reconstructed based on extant phylogenetic bracketing and direct observation of muscle attachment sites for caenagnathids, dromaeosaurids, ornithomimids, troodontids, and tyrannosaurids from Alberta. The results indicate disparate locomotory styles in theropods from Alberta. Trends in the evolution of theropod pelvic musculature shed light on the stepwise transitions towards bird-like muscular configuration. The arrangement of locomotory musculature in caenagnathids and dromaeosaurids suggests they were not well-adapted for rapid

cursoriality. Ornithomimids and troodontids appear built for speed and capable of rapid cursorial locomotion. Tyrannosaurids possess powerful hips that served for attachment of strong muscles for supporting and moving their enormous body mass. The progressive change from tail-driven to knee-driven locomotion is tracked by the morphology of the pelvis and the rearrangement of pelvic musculature. The loss of the supraacetabular crest at the base of Pennaraptora probably coincides with a major transition towards primarily knee-driven locomotion and bird-like posture.

Grant Information:
Faculty of Graduate Studies & Research (University of Alberta), Government of Alberta, NSERC, Vanier Canada, Alberta Innovates, Alberta Historical Resources Foundation

Preparators' Session (Thursday, August 24, 2017, 10:30 AM)

HOW TO STRUCTURE AN EFFECTIVE VOLUNTEER TASK FORCE IN THE LAB AND COLLECTIONS: A CASE STUDY ON ESTABLISHING CRITERIA FOR RECRUITMENT, SELECTION, AND TRAINING

RHUE, Vanessa R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States of America

Over the decades, various volunteer programs have been in place at the Natural History Museum of Los Angeles County. Yet, until recently, there was no formal approach to evaluating the fittingness of potential volunteers for work in our Vertebrate Paleontology department. Since 2012, over 50 individuals of various ages, backgrounds, and interests have participated in our volunteer program. Initially, potential candidates were brought on if they had the availability to serve and a willingness to learn new skill sets. While this approach garnered enthusiastic individuals, it did not successfully retain trained volunteers and often left projects pending for some length of time.

Changes were made to how we informed potential volunteers of behind-the-scenes opportunities, the amount of information we queried from them, and how we conducted candidate interviews. Prospective volunteers perused informational flyers on our collections scope and program requirements. If their interest was piqued, specific project advertisements provided detailed descriptions of the work to be performed, the desired skill sets, and the expected time commitment. The written application was expanded to survey their motives for volunteering, their character, previous work experience, physical aptitude, technical skills, and aspirations. Conducting group interviews and conveying a sense of limited space availability allowed for some individuals to stand out from among other promising applicants. Task training involved a variety of approaches from one-on-one verbal and visual instruction to written guidelines and assigned reading to group workshops and practicums. Creating forums for volunteer feedback and appreciation were crucial for improving workflows and fostering a collegiate environment. As a result, we have seen a return on the investment of our staff time and expertise, which has not only proved efficient and effective, but has also benefited the museum community at large by preparing future professionals in related careers.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DID SIZE MATTER FOR SURVIVING THE CRETACEOUS-PALEOGENE MASS EXTINCTION EVENT?

RICHARD, Jacqueline M., Delgado Community College, New Orleans, LA, United States of America; BERCOVICI, Antoine, Smithsonian Institution, Washington, DC, United States of America; PEARSON, Dean, Pioneer Trails Regional Museum, Bowman, ND, United States of America

The Cretaceous–Paleogene (K–Pg) mass extinction event is associated with rapid restructuring of terrestrial ecosystems as a result of the Chicxulub asteroid impact event. A common hypothesis for explaining the observed extinction selectivity at the K–Pg is that large body-sized groups, such as non-avian dinosaurs, would be more sensitive to ecosystem devastation due to smaller population sizes compared to other smaller animals, such as mammals. These faunal changes are well documented thanks to the fossiliferous terrestrial deposits of the Hell Creek (HC) and Fort Union (FU) formations in Southwestern North Dakota.

We present new results from the first ~3 meters of the FU Formation at PRTM site V02017. Excavation was stratigraphically controlled at a centimeter scale and each individual rock unit, identified by lithology and/or color, was individually processed through a 380 µm screen using a new method involving water agitation through bubbling utilizing injected compressed air in a water tank. A total of 2,742 vertebrate fossil remains (fish, salamanders, frogs, turtles, crocodilians, champsosaurs, lizards, and mammals) were recovered from 5,162 kg of screen-washed material, across 20 distinct lithological units. Each specimen's long and short axis was measured to build a size-spectrum database. Vertical evolution of depositional environments at V02017 show a dark, massive mudstone sequence (Units 1 though 6) interpreted as a ponding event, followed by more energetic deposits of siltstone and sandstone (Unit 7 through 20) interpreted as fluvial and overbank deposits. The K–Pg boundary was identified at ~50 cm above the HC/FU formation contact using palynology.

Results show that despite unit 16 being the only unit producing visible fossils on the outcrop, all other units produced fossils when screen-washed, with the exception of unit 1 (lignite) and unit 7 and 8 (coarse sandstone, high energy). The vast majority of fossils recovered from the screenwashing are very small (1 % < 0.5 mm; 18 % < 1 mm; 40 % < 1.5 mm; 55 % < 2 mm long axis), emphasizing the importance of using the 380 µm screen. Fossils from the basal lacustrine mudstone sequence show a broader size range spectrum than the overlying fluvial siltstone and sandstones. While the immediate recovery fauna is represented by small body-sized vertebrates, large fossils from unit 16 include three large (> 50 cm diameter) *Axestemys* turtles indicating widespread post-impact freshwater aquatic environments favored opportunists with broad tolerances and rapid reproductive potential.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

PIONEERING DISCOVERY OF FISH-BEARING ROCKS OF EARLY DEVONIAN (EARLY LATE EMSIAN) AGE IN THE PARANÁ BASIN, SOUTHERN BRAZIL

RICHTER, Martha, The Natural History Museum of London, London, United Kingdom; BOSETTI, Elvio, Universidade Estadual de Ponta Grossa, Ponta Grossa, Brazil

We report on the first discovery of fish remains (Chondrichthyes) from two localities belonging to the Paraná-Apucarana sub-basin with a rich invertebrate fauna comprising molluscs, inarticulate brachiopods, echinoderms and palynomorphs that show affinities with the Malvinokafric Realm.

The apparent absence of fish fossils in these highly fossiliferous rocks, which have been extensively sampled by numerous geologists and palaeontologists since the 19th century, remained a mystery until now. The marine rocks of the Ponta Grossa and the São Domingos formations that yielded the fish remains cover a large geographic area in the State of Paraná, especially in the Campos Gerais region where they crop out along the BR 153 highway.

The fossils come from two localities about 18 km apart and were found in light yellowish-grey fine sandstones to coarse siltstones. They comprise partially articulated fin rays, a scapulochoracoid associated with fin rays, possible placoid scales and a small, disarticulated, slightly recurved spine, whose surface bears large denticles relative to its size, and faint striae. The fish remains are dark coloured and mostly preserved as natural moulds with a few flaky, dark fragments present on the spine and fin rays. No mineralized skeletal parts were found, but this could be due to unfavorable taphonomic conditions that could have dissolved the biogenic apatite.

Devonian fishes were already known from the Parnaíba and Amazon basins in North and Northeastern Brazil and from Bolivia, Venezuela and the Falklands Islands. The new material is compared with Devonian fishes found in South America, Africa and Australia, among which *Plagioselachus, Antarctilamna, Ctenacanthus, Pucapampella, Zamponiopteron* and *Mcmurdodus*. The apparent scarcity of fish fossils in Devonian rocks of the Paraná Basin supports the hypothesis of a vertebrate empoveriched, cold marine environment.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

MAMMAL COMMUNITY COMPOSITION AT A NEWLY-DISCOVERED LATE TIFFANIAN (TI-5) SITE IN SOUTHWESTERN WYOMING

RIDDER, Ryan A., University of Kansas, Lawrence, KS, United States of America; BEARD, K. Christopher, University of Kansas, Lawrence, KS, United States of America

A newly-discovered late Tiffanian (Ti-5) site called Twelvemile Bonanza sheds light on mammalian community composition in southwestern Wyoming during the late Paleocene. Late Tiffanian sites pertaining to the Ti-5 interval are apparently unknown outside of the Bighorn Basin. The Twelvemile Bonanza local fauna (12MBLF) therefore provides a unique opportunity to gauge faunal composition and turnover during the late Paleocene, and provides an independent test of whether patterns observed in the Bighorn Basin apply at a broader scale. The fossil-bearing horizon is a green mudstone, likely representing an overbank floodplain deposit. The 12MBLF was obtained by surface prospecting, a method known to be biased against smaller specimens. Younger faunas from nearby Clarkforkian sites, such as Mark's Locality, appear to have accumulated under similar circumstances and were collected by the same methods, making them comparable to the 12MBLF with only minimal taphonomic and paleoenvironmental biases. Most mammalian taxa currently known from the 12MBLF resemble those from contemporary sites in the Bighorn Basin (notably Princeton Quarry and nearby sites). Examples include the phenacodontid condylarths *Phenacodus* and *Ectocion*, the arctocyonid condylarth *Thryptacodon*, the carnivoran *Protictis* and the plesiadapiforms *Plesiadapis* and *Phenacolemur*. The hyopsodontid condylarth *Aletodon conardae* is well-represented in the 12MBLF, yet this genus has yet to be documented from contemporary faunas in the Bighorn Basin, where *Aletodon* is relatively rare. New taxa from the 12MBLF include a small and apparently basal species of microsyopid plesiadapiform, which is among the earliest representatives currently known for this family. Low community turnover at the family level and the similarity in family and species evenness between the 12MBLF and Mark's Locality suggest that the initial colonization of North America by rodents at the beginning of the Clarkforkian had minimal impact on overall mammal community composition in southwestern Wyoming.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

EARLY EOCENE HERPETOFAUNA FROM THE WASATCH FORMATION, WYOMING: DIVERSITY AND BIOGEOGRAPHY SURROUNDING THE PALEOCENE-EOCENE THERMAL MAXIMUM

RIEGLER, Mitchell, Virginia Tech, Blacksburg, VA, United States of America; STOCKER, Michelle R., Virginia Polytechnic Institute and State University, Blacksburg, VA, United States of America; ANEMONE, Robert L., UNC Greensboro, Greebsboro, NC, United States of America; NACHMAN, Brett, UNC Greensboro, Greensboro, NC, United States of America

The dawn of the Eocene (55 mya) was marked by drastic changes in global temperature through an event known as the Paleocene-Eocene Thermal Maximum (PETM). This global warming event shifted temperatures by approximately 6°C, and culminated in one final spike in temperatures at about 52 mya, called the Early Eocene Climatic Optimum (EECO). The Wasatch Formation in Wyoming spans the Paleogene, covering the entirety of this Paleocene-Eocene transition, and providing insight for the diversity changes of the small mammals through this time period. Though this formation is well known for fossils of small mammals, it also contains many understudied reptiles. We describe the fossil reptile assemblage from the Early Eocene (Wasatchian) Tim's Confession locality in order to shed light on the herpetofauna during a major global warming event. This

locality includes anguimorph squamates (xenosaurids and glyptosaurines), amphibians, crocodylians, and at least two kinds of snakes (alethinophidians and non-alethinophidians). The xenosaurid, represented by at least two dentaries, is one of the earliest representatives of this clade, helping better understand the biogeographic distribution of a relatively cryptic lineage. These dentaries share diagnostically narrow, conical teeth, with incipient cusps on the posterior marginal teeth. Also, the presence of a ventrally oriented Meckel's canal that remains open for its entire length is indicative of xenosaurid anguimophs. In addition to osteoderms, glyptosaurine anguimorphs are identified based on cranial material, including dentaries that preserve wide, knob-shaped teeth and pronounced dermal scales on the lateral surfaces. Two of the maxillae share a dentition that are consistent with xenosaurids, but are missing their ventral processes and much of the anterior portion. Lastly, anuran amphibians are represented by four dentaries with strong, concave curvature. The presence of an increasing number of recognized anguimorph lizards, both xenosaurids and glyptosaurs, and the appearance of rare amphibian materials informs us about the survivorship and geographic extent of Early Cenozoic herpetofauna, marking the farthest west extent of xenosaurids to date.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW DATA ON THE GIANT SNAKE *GIGANTOPHIS GARSTINI* FROM THE UPPER EOCENE OF NORTH AFRICA AND ITS BEARING ON THE PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF MADTSOIIDAE

RIO, Jonathan, London, United Kingdom; MANNION, Philip, London, England

Madtsoiidae is a speciose family of extinct snakes that achieved a wide Gondwanan and trans-Tethyan distribution by the Late Cretaceous, surviving until the late Pleistocene. *Gigantophis garstini*, the first and largest described madtsoiid, was recovered from the upper Eocene of Fayum, Egypt. The twenty vertebrae comprising the syntype have only received a brief description, hindering the referral of specimens to this taxon and our understanding of madtsoiid interrelationships. A detailed re-description of the syntype material demonstrates the validity of *Gigantophis*, based on two autapomorphies (including a strongly depressed neural canal in posterior trunk vertebrae) and a unique combination of characters. Referred material from the lower Paleocene of Pakistan differs significantly, and we restrict *Gigantophis* to the middle–late Eocene of North Africa. Using a model of morphological variation in extant snakes, we estimate that *Gigantophis* was 6.9 ± 0.3 m long. A phylogenetic analysis using the largest sample of putative madtsoiids (20 OTUs) and a revised and augmented matrix (148 characters), places *Gigantophis* as sister taxon to the latest Cretaceous Indian snake *Madtsoia pisdurensis*, interrupting the monophyly of *Madtsoia*. Unlike previous work, no basal dichotomy in body size is found, with the large Australian madtsoiids *Yurlunggur* and *Wonambi* outside the clade that includes *Gigantophis* and *Madtsoia*. As our topology might suggest that a dispersal route was present between India and North Africa in the latest Cretaceous–early Paleogene, we evaluate several putative dispersal mechanisms. Sweepstakes dispersal between India and Africa at this time is unlikely given the distance involved (~400 km), the lack of evidence for aquatic adaptations in madtsoiids, and the reduced likelihood of large vertebrates dispersing across ocean barriers. A potential direct link between Africa and India, the Oman-Kohistan-Ladakh Island Arc, is rejected given new geological information demonstrating the later timing (late Paleocene–early Eocene) of its contact with India. The paleobiogeography of Madtsoiidae is best explained by a poorly sampled, earlier widespread distribution in Africa, Indo-Madagascar and South America. In contrast, latest Cretaceous madtsoiid occurrences in Europe might be explicable by trans-Tethyan dispersal from Africa via the Apulian Route. Madtsoiids most likely reached Australia from South America via Antarctica, although the timing of the dispersal can only be constrained from approximately 90–50 Ma.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE ANKYLOSAURIA FROM MEXICO

RIVERA-SYLVA, Hector E., Museo del DesiertoLaboratory of Paleontology, Saltillo, Mexico; FREY, Eberhard, Staatliches Museum für Naturkunde Karlsruhe, Karlsruhe, Germany; STINNESBECK, Wolfgang, Universität Heidelberg, Heidelberg, Germany

Ankylosaur remains are considered to be extremely rare and poorly recorded from the Late Cretaceous of Mexico, contrasting the rich hadrosaurian assemblages reported from there. Nevertheless, the ankylosaur remains have repeatedly been described from Mexican strata, although most of these are undiagnostic.

Has been mention the presence of a metatarsal fragment of Ankylosauria from the Olmos Formation, and a phalanx from the Cerro del Pueblo Formation, both in Coahuila. Harley J. Garbani identified an osteoderm of an ankylosaurid from the El Gallo Formation in Baja California. Two vertebrae and a metatarsal of an ankylosaurid were reported from the San Carlos Formation (lower Campanian) of Aldama, Chihuahua but were not described because the specimens are housed in a private collection. In the Cerro del Pueblo Formation near La Parrita in southern Coahuila, concave osteoderms of Ankylosauridae were descriebed. Ankylosaur osteoderms have also been reported from Rincón Colorado and Las Aguilas in the municipality of General Cepeda, Coahuila. An ankylosaur femur from the Olmos Formation near Sabinas, Coahuila, was mentioned but neither properly described nor depicted, because it was housed in a private collection. An unnamed nodosaurid material was recovered from the Pen Formation (Upper Cretaceous, Campanian), south of San Miguel, Coahuila, Mexico.

In 2007, osteoderms and postcranial material of a nodosaurid were discovered in the Aguja Formation at the Las Jicoteas fossil locality in the municipality of Ocampo, northwest Coahuila, near the border between Chihuahua and Texas. The material was described to family level, and later referred to the genus *Edmontonia* because of its shape. Evidence for Nodosauridae comes from the El Jabón Creek locality, El Gallo Formation (Campanian), El Disecado member, Baja California, Mexico. This material includes a tooth, which resembles those of the nodosaurid *Aletopelta coombsi* from California. Additionally, the El Jabón Creek tooth is from the same stratigraphic and geographic range. In a report on the Campanian Aguja Formation is mention a vertebra from Los Altares, northeast Chihuahua, and four osteoderms from the El Rebaje locality, northern Coahuila, that were originally referred to *Panoplosaurus*. However this cannot be possible because ankylosaurian vertebrae are only diagnostic at family level. It has been described a nodosaurid caudal vertebra from the Cerro del Pueblo Formation, and has been mention the presence of nodosaurid osteoderms and a tooth from the same formation.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

NEW HIGH-RESOLUTION TAPHONOMIC, GEOCHRONOLOGIC AND PALEOENVIRONMENTAL RECORDS OF LATEST CRETACEOUS BIRD, DINOSAUR AND OTHER VERTEBRATE FAUNAS FROM VEGA ISLAND, ANTARCTICA PENINSULA

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The only known high-latitude Cretaceous Gondwanan vertebrate faunas are found within Upper Cretaceous strata of the James Ross Basin (JRB) of the Antarctic Peninsula. Over 25 years of collecting has begun to produce an important terrestrial vertebrate record, including the only unquestioned representative, *Vegavis iaai*, of a crown avian lineage (Anseriformes) yet known from pre-Cenozoic Strata anywhere in the World. *Vegavis*, along with additional new bird material and an array of dinosaur and marine vertebrate remains, were collected on Vega Island, in the northern part of the JRB. Our team recently identified what may be a K-Pg boundary near the top of the stratigraphic succession on Sandwich Bluff, as well as the possibility of temporary sea ice during the terminal Cretaceous of Antarctica. However, poor age control and limited taphonomic and isotopic analyses of fossil assemblages on Vega Island have proven to be obstacles for testing these hypotheses and fully exploring evolutionary and ecological questions about the fauna. In this study, we present new Sr-, C- and O-isotope results based on systematic sampling of marine invertebrate shells through the Late Cretaceous stratigraphy on Vega Island. A greatly improved Sr-isotope curve for the Cape Lamb Mbr of the Snow Hill Island Fm and the overlying Sandwich Bluff Mbr of the López de Bertodano Fm provides more precise age constraints on *Vegavis*, and other key bird and dinosaur fossil localities. Preliminary results indicate an early-to-middle Maastrichtian age for *Vegavis* and the base Sandwich Bluff Mbr, but additional samples are required to resolve the upper age boundary. O-isotopes values for this interval are consistent with paleobotantical and dinoflagellate cyst records that suggest rapid cooling and the possibility of temporary sea ice during this interval. Additional taphonomic investigations of fossil bird bone, wood and invertebrate shells were conducted via synchrotron Fourier transform infrared (FTIR) spectroscopy and Ramen spectroscopy, yielding valuable insights into the mode and tempo of fossil preservation in this high-latitude, shoreline system in Antarctica. Rapid burial and concretion formation occurred very early on or just below the seafloor, leading to preservation of some exceptional unaltered organic remains in wood (but not bone or shell); however secondary diagenesis and recrystallization affected some fossil remains.

Grant Information:
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

FIRST MESONYCHID KNOWN FROM THE CLARNO FORMATION (EOCENE) OF OREGON

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A recently identified left dentary of *Harpagolestes* sp. from the Al Hancock field collections represents the first mesonychid material known from the Eocene Clarno Formation. The specimen is from the Hancock Mammal Quarry (HMQ), which is in the uppermost subunit of the Clarno Formation (~40 Ma). The sediments of the HMQ were deposited by a meandering river system during the middle Eocene when north-central Oregon had a subtropical climate. Large herbivores including brontotheres, anthracotheres, rhinocerotids, tapirs, equids, and oreodonts occupied the landscape. The only carnivorous mammals previously known from the HMQ are an indeterminate nimravid and *Hemipsalodon grandis*, a large creodont. As with many other mammals from the HMQ, *Harpagolestes* participated in an Asian-North American faunal interchange; species of *Harpagolestes* are known from the middle to late Eocene of both continents. As with other mesonychids, *Harpagolestes* was carnivorous, and members of the genus were likely bone-crushers. Characteristic bone-crushing wear is visible on the occlusal surfaces of the HMQ specimen's premolars and molars. This type of wear is also seen on the HMQ *Hemipsalodon* specimens, but the *Harpagolestes* specimen is worn to a greater degree. The HMQ *Harpagolestes* contains the alveoli for c1 and p1-2 and preserves the crowns of p3-4 and m1-2. A third molar was likely present, but the distal portion of the dentary is badly fragmented and evidence of the m3 has been obliterated. The molariform teeth have a large, conical trigonid with a bulbous talonid. The protoconid of p3 and p4 is tilted posteriorly. The tooth crowns and alveoli are sufficiently damaged that dental measurements are difficult and a species level identification is not currently possible. CT scans will reveal the root morphology and should clarify the original size of the teeth, which will assist in making a species-level identification. Even without a species diagnosis, the specimen of *Harpagolestes* represents an additional large predator in the HMQ ecosystem, adds to the known diversity of the Pacific Northwest middle Eocene, and is the only known occurrence of a mesonychid in Oregon.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

USING A HIGH RESOLUTION 3-D PROFILOMETER TO EXAMINE DIETARY NICHE SPACE OCCUPATION AMONG THE EARLY EOCENE PRIMATES *CANTIUS*, *TEILHARDINA*, AND *TETONIUS*

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Application of dental topographic metrics to extinct mammals exposes differences and similarities in the functional food processing capabilities of the occlusal surfaces of mammalian teeth. Determining differences in dietary habits and capabilities of food processing in the earliest primates is essential to understanding the ecological and evolutionary relationships among the earliest members of the Order Primates. In this study, we apply a dental topographic analysis to early Eocene primates to determine the degree of overlap in functional food processing capabilities between taxa. Using a high resolution chromatic confocal optical profilometer, 3-dimensional models of the mandibular second molars of the primates *Cantius*, *Teilhardina,* and *Tetonius* were generated, and three topographic metrics were analyzed: Dirichlet Normal Energy (DNE); Relief Index (RFI); and Orientation Patch Count Rotated (OPCR). DNE measures curvature across tooth surface, RFI is the ratio between 3-dimensional and 2-dimensional surface areas of the occlusal surface, and OPCR measures relative complexity of tooth surfaces through a count of differently oriented faces on the tooth. From these metrics, we conducted a Kruskal-Wallis test between genera along with a *post hoc* Mann-Whitney pairwise comparison. DNE shows significant differences between *Cantius* and *Teilhardina* ($p<.008$) and *Cantius* and *Tetonius* ($p<.002$), while *Teilhardina* and *Tetonius* are statistically indistinguishable. OPCR shows significant differences between all three taxa ($p<.02$). RFI found no significant differences between taxa. This indicates there was little dietary overlap and competition for resources between the adapoid *Cantius* and the omomyoids *Teilhardina* and *Tetonius*, while there was likely some degree of overlap in dietary niche space occupation between *Teilhardina* and *Tetonius*.

Technical Session IX (Thursday, August 24, 2017, 3:15 PM)

TWENTY YEARS OF TAPHONOMIC OBSERVATIONS AND INSIGHTS IN THE UPPER CRETACEOUS MAEVARANO FORMATION, MADAGASCAR

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The Upper Cretaceous (Maastrichtian) Maevarano Formation of Madagascar is renowned for its amazing record of terrestrial vertebrates; over the years a wealth of spectacularly preserved fishes, frogs, turtles, lizards, snakes, crocodyliforms, nonavian dinosaurs, birds, and mammals have been discovered and described. Strata that yield these fossils have been described and formalized as new lithostratigraphic units, and depositional systems represented have been documented and interpreted. Aspects of vertebrate fossil preservation in the Maevarano Formation have also been studied, specifically in relation to vertebrate burial mechanisms (fine-grained debris flows in the Anembalemba Member), as well as bone modifications (e.g., insect borings in bone, tooth marks associated with dinosaur cannibalism) and burrow traces (lungfish). Here we focus more broadly on taphonomic data recovered from the Maevarano Formation (350+ localities), and explore key elements of the formation's taphonomic history. Whereas the present focus is on taphonomic insights provided by a few key bonebeds, isolated occurrences of solitary bones and single individuals (of variable quality) are plentiful; these too yield valuable information. Locality MAD93-18, an exemplar of bonebed taphonomy, is multitaxic (at least six higher taxa represented), with body sizes ranging from massive titanosaurian sauropods to birds. Adults and juveniles of terrestrial animals are preserved alongside amphibious and aquatic forms in three distinct layers (each a unique event of mortality and burial), and the remains are clearly time-averaged (variable states of articulation, association, and weathering). Locality MAD96-01 basically replays the taphonomic theme of MAD93-18 (albeit only once), but this locality offers additional insights into transport upon burial (minimally mere centimeters), and scavenging (heavy carcass utilization by both vertebrates and invertebrates). Locality MAD05-42 again follows the general taphonomic trajectory of Anembalemba bonebeds (multitaxic, time-averaged, burial by debris flow), but this site affords unique clues that point to a particularly lethal killing agent—toxic algal blooms. This reconstruction is consistent with the Maevarano bonebed record because cyanobacterial poisoning is a recurrent phenomenon today (as inferred for MAD93-18), is fast acting (it will kill animals, including birds, in their tracks), and it is not overly selective (consistent with the taxonomic diversity represented in Anembalemba bonebeds).

Grant Information:
National Science Foundation, National Geographic Society, the Dinosaur Society, and Macalester College.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

REDESCRIPTION OF THE POSTCRANIAL SKELETON OF *ENNATOSAURUS TECTON* (SYNAPSIDA, CASEASAURIA, CASEIDAE) AND ITS FIRST *IN VIVO* RESTORATION

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The Russian caseid *Ennatosaurus tecton* (Synapsida Caseasauria) is an important member of the group, being among the few "pelycosaurs" occurring in the Middle Permian, thus making caseids among the longest-surviving groups of non-therapsid synapsids. Although the cranial skeleton has been recently restudied in detail, the descriptions currently available for the postcranium are essentially limited to the original short account on the holotype provided by the original description from the 1950s. This contribution represents a new analysis of the postcranium of this taxon, using several different approaches. The postcranium of *Ennatosaurus* is informative with respect to both the taxonomy and phylogeny, with autapomorphic characters present particularly in the vertebral column. In addition, we conducted eight principal component analyses to investigate the position of the various appendicular elements of *Ennatosaurus* within the caseid morphospace. Members of all major groups of "pelycosaurs" were included in the morphometric analysis (along with selected outgroup taxa), allowing us to make some broader preliminary inferences regarding postcranial morphospace occupation of these basal synapsids for each individually-considered element. From the results of the principal component analyses, a major decoupling among the morphological patterns of stylopodial and zeugopodial elements is detected. Whereas femora and humeri exhibit a shared common pattern (with a wider overlap in their respective morphospace), the ulnae, radii, tibiae and fibulae show well-separated regions of morphospaces in the different clades. This result indicates the importance of such long bones also for taxonomic differentiation (in addition to their use for classical functional and biomechanical studies). Finally, a 3D photogrammetric model of the mounted specimen at the Paleontological Institute of Moscow has been used to obtain the first in vivo reconstruction of *Ennatosaurus tecton*, providing for the first time a potentially realistic picture of the Russian caseid in life.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

POSTCRANIAL MORPHOLOGY AND THE LOCOMOTOR ADAPTATIONS OF EXTANT AND EXTINCT CROCODYLOMORPHS AND LEPIDOSAURS

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Studies have shown that the morphology of the postcranial skeleton reflects the locomotor behavior of extant vertebrate taxa. Morphometric analyses can also be used to infer the locomotor modes of extinct taxa based on their morphological similarity to extant groups. Such studies have been conducted on many groups of mammals, however studies on reptiles are less common. As semi-aquatic, arboreal, and terrestrial locomotor specialists are seen in multiple groups of extant reptiles, among both crocodilians and lepidosaurs, the group provides the opportunity for examining potential convergent or parallel evolution within clades.

We have collected a series of linear measurements of the axial and appendicular skeletons of 56 extant crocodilian and lepidosaur taxa to determine if those engaging in similar locomotor behavior display similar morphology despite phylogenetic differences. A preliminary stepwise discriminant function analysis using 19 osteological indices reveals reptile locomotor mode can be accurately predicted (over 75% correct) based on morphology. Semi-aquatic taxa appear to be distinguished by a relatively longer scapula and a shorter distal hindlimb than terrestrial and arboreal taxa, potentially reflecting reduced drag while swimming. Semi-aquatic lizards from four families show parallel divergences from their terrestrial relatives, suggesting similar evolutionary responses in both lepidosaurs and crocodylomorphs. Arboreal taxa display a more elongate humerus and relatively smaller humeral proximal end, possibly to allow for a wider range of motion at the shoulder joint. This morphometric data can potentially be used to predict the locomotor behavior of a wide range of extinct reptile taxa, including both archosaurs and lepidosaurs.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW AZHDARCHID PTEROSAUR REMAINS FROM THE LATE CRETACEOUS (MAASTRICHTIAN) OF JORDAN

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During the Late Cretaceous, Jordan occupied a position on the northern margin of Afro-Arabia, partially ringed by the Neo-Tethys Ocean. Carbonate and phosphate deposits from the Maastrichtian of Jordan have preserved numerous marine vertebrates (e.g., sharks, turtles, mosasaurs, plesiosaurs, crocodilians), as well as nine specimens attributed to one of the largest pterosaurs, the azhdarchid *Arambourgiania philadelphiae*. The vertebrate fossil record of Afro-Arabia during the latest Cretaceous is quite scarce, especially in comparison to other Gondwanan landmasses such as South America, India, and Madagascar. For this reason, new discoveries are paleobiogeographically and evolutionarily significant. Here we report on recent fieldwork in uppermost Cretaceous deposits in central and southern Jordan that preserve important pterosaur remains. Prospection in the Phosphorite Unit of the Amman Formation in the Ruseifa phosphate mines uncovered the shaft of an exceptionally large humerus. Broken ends of this shaft reveal thin (2 mm) cortical bone surrounding trabeculae. The ratio of matrix to trabecular bone indicates a high Air Space Proportion (ASP), consistent with the interpretation of this bone as pterosaurian. The cross-sectional shape and measurements (transverse width = 79.8 mm; anteroposterior length = 59.8 mm at minimum shaft diameter) compare favorably with the humerus of *Quetzalcoatlus northropi* (89.3 x 69.1 mm). The locality and large size suggest that this humerus likely pertains to *A. philadelphiae.* In addition, exposures of the Muwaqqar Formation in south-central Jordan yielded a partial pterosaur skeleton with three-dimensional preservation. Material collected consists of cranial elements (elongate, toothless upper and lower jaw), vertebrae, and a nearly complete wing (humerus, radius, ulna, metacarpal IV, wing phalanx 1) that is estimated to have been 2.5 m long. The humerus of this individual has a different cross-sectional shape and is 2.5 times smaller (29.5 x 26.8 mm) than the probable *A. philadelphiae* humerus, and so it is unlikely to pertain to the same species. Rather, its distinct spatiotemporal context, body size, and long, edentulous beak suggest that it represents a new azhdarchid species. These new discoveries provide insight into the structure and functional anatomy of Late Cretaceous pterosaurs and the paleobiogeography of Afro-Arabia.

Grant Information:

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

OCCURRENCE OF NON-INFECTIOUS SPONDYLOARTHROPATHY IN A LATE CRETACEOUS HADROSAUR FROM SOUTHERN ALBERTA, CANADA

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Three articulated adult mid- to posterior dorsal vertebrae of an unidentified species of hadrosaur exhibit pathologic features interpreted as the result of an inflammatory form of arthritis, spondyloarthropathy. The specimen was collected from a hadrosaur and ceratopsian bonebed in the Oldman Formation (Campanian), Alberta, Canada. The affected vertebrae were recognized as hadrosauran on the basis of features including neural spine length and clearly distinguished from ceratopsian. High-quality bone textures was preserved throughout. Erosions with reactive new bone formation were present bilaterally in the zygapophyseal joints of the anterior most vertebra. Fusion in the posterior two vertebrae was associated with smooth fusion of the vertebra centra through its capsule (formerly considered anulus fibrosus, when intervertebral space misinterpreted as disk space), forming marginal syndesmophytes. A similar syndesmophyte linked the first two vertebrae. Rugose new bone obliterated the right rib articulations (the left side was not preserved). The sides of the neural spines were fluted in a dorso-ventral plane. There were raised patches of finely-textured bone transverse to their long axis. Appearing as ossified ligamentous soft tissue, they were compatible with the enthesial response often noted in spondyloarthropathy. They differed in appearance form the normal ossified dorsal tendons because they are simply rugose linear ridges. Alternative explanations for the observed pathology include congenital fusion, infection and diffuse idiopathic skeletal hyperostosis (DISH). However, the centra sizes appeared normal and presence of joint erosions excluded a congenital explanation. Isolated evidence of infection has been previously noted in fragmentary Albertan hadrosaur material, but the multi-joint disease reported here has not. Infection can cause erosions and fusion limited to a single joint, but would not cause the multiple joint erosions and fusion of the type observed. DISH is characterized by calcification/ossification and enthesial-attachment sites (e.g., along vertebral column) and such has been observed in sauropods and the tendon ossifications in hadrosaurs have been previously compared to that phenomenon. However, DISH does not cause erosions. Spondyloarthropathy is known among late Cretaceous ceratopsians, sauropods, and is suspected in the *Tyrannosaurus* Sampson, but this is the first report among the Hadrosauridae.

Technical Session XVIII (Saturday, August 26, 2017, 10:15 AM)

MIDDLE PERMIAN DICYNODONT (THERAPSIDA, ANOMODONTIA) STRATIGRAPHIC RANGES IN THE MAIN KAROO BASIN – IMPLICATIONS FOR CONTINENTAL BIOSTRATIGRAPHY

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The Karoo Supergroup of South Africa preserves the world's most continuous record of continental Permian to Jurassic tetrapod biodiversity, which has enabled a 10-fold biostratigraphic subdivision of this sedimentary succession. The three mid Permian (Guadalupian) biozones (*Eodicynodon*, *Tapinocephalus* and *Pristerognathus* Assemblage Zones) comprise half the total thickness of the Karoo tetrapod-bearing sedimentary pile in the proximal part of the basin. Biostratigraphic refinement of the Lower Beaufort Abrahamskraal Formation has been challenging, a fact that is exacerbated by the relative paucity of tetrapod fossils in the lowermost Beaufort Group, the difficulty in extracting them from very hard matrix, the thickness of this sedimentary succession, and the complex folding of these rocks over much of their exposure. Our recent biostratigraphic work has concentrated on the youngest mid Permian biozones and has allowed a more precise quantification of the late Guadalupian extinction event in the continental realm, as well as providing a TIMS date for this event in the Karoo Basin. More attention is now being paid to older mid Permian biozones and to broader biostratigraphic patterns, for which dicynodonts are at present the best tool due to their abundance, ease of identification and recently revised taxonomy. Compilation of three decades-worth of stratigraphic collecting and an improved understanding of the lithostratigraphic subdivisions of the Abrahamskraal Formation has enabled the recognition of a lower *Eodicynodon* range which extends through much of the Combrinkskraal Member, an *Eosimops* range which extends from the upper Combrinkskraal member to the top of the Poortjie Member, and a *Diictodon* range which extends from the Moordenaars Member up into the late Permian *Daptocephalus* Assemblage Zone. In combination with dateable volcanic ash layers in the lower Beaufort, recognition of these dicynodont range zones in the main Karoo Basin has significance for understanding temporal patterns of tetrapod diversity in the mid Permian and potentially for correlation with the rift basins of southern Africa.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SYNTHESIS ON THE VERTEBRATE PALEONTOLOGICAL HERITAGE IN CHILE

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With the awarding of official positions in vertebrate paleontology, national and international cooperation, the creation of a Master degree in paleontology, and the development of the Natural Heritage Area of the Consejo de Monumentos Nacionales, national research on vertebrate paleontology have experienced an impressive growth in the last decade in Chile. Despite the initial lack of paleontological knowledge respect to other countries in South America, Chilean law is strictly protective of all kinds of fossil records. This protective police together with professional assistance (last decade), has resulted in an important platform to the national territory survey for fossil assemblages, in general, resulting in the increased knowledge of the fossil vertebrates, compared to all Chile's previous history. So far the main developmental axis of this discipline in the country is concentrated on Mesozoic marine vertebrates, Cenozoic fishes, Meso and Cenozoic archosaurs, and Cenozoic mammals. Surveys in the southernmost regions of Chile have allowed the discovery of interesting dinosaur faunas from Jurassic and Cretaceous, along with other vertebrates. The northern coastal outcrops bear abundant remains of marine mammals, especially whales. Dinosaur footprints are another important national paleontological heritage, being large deposits in the northern regions of the country that date from the Jurassic and Cretaceous. By putting the paleontological findings in scientific value, the different regions of the country have placed on the agenda of local development, the creation of thematic exhibitions, museums, parks and interpretive centers. This assessment of part of the citizenship will give greater relevance to the care and protection of Chilean fossil vertebrates.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEW LOOK AT THE MATERIAL ASSIGNED TO *MACHAIRODUS* SP. CF. *M. COLORADENSIS* (HOMOTHERIINI: MACHAIRODONTINAE) FROM THE LATE HEMPHILLIAN OF GUANAJUATO, MEXICO

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In the well-known late Hemphillian locality of Rinconada, in the State of Guanajuato, Mexico, fossil material assigned to the homotheriine *Machairodus* sp. cf. *M. coloradensis* was described in the 90´s. The remains include a partial left upper canine (IGM 6667), a left P4 (IGM 6666), a right fractured hemimandible (IGM 6414) with i3, c1, p3, p4 and m1 but lacks the ascending process, and the left hemimandible (IGM 6415) only preserves the c1, p3, and p4. The original description considered the presence of strong serrations on some teeth, the large and laterally compressed upper canine, and the presence of a parastylid on p3 and p4 as characters that differentiated this material from other extinct North American felines (i.e. *Nimravides thinobates*, *Megantereon* sp., and *Pseudaelurus* sp.).

A new detailed morphological examination of this material arise doubts about its original taxonomic assignment. The presence of the strong serrations on c1, p3 and p4 confirms its identification as a Homotheriini. But, the teeth and the mandibular body are smaller than in *M. coloradensis*. Also, the m1 does not have a talonid (present in *Machairodus*), and the premolars and molars cuspids are oriented mesially, contrary to *Machairodus*, where they are vertical, among other differences. Finally, the presence of a very prominent flange in both hemimandibles, definitely confirms that it is not *Machairodus*.

All these characters allow concluding that this material cannot be assigned to *Machairodus,* as previously identified. In preliminary phylogenetic analyses, this material is placed within the tribe Homotheriini, but it is not grouped within *Machairodus*, supporting our observations, and it represents a new taxon of felid with a unique combination of synapomorphies. This new taxon adds information to understand the diversity and complex evolution of machairodonts during Miocene times in America.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

TAPHONOMIC ANALYSIS OF MAMMALIAN REMAINS FROM THE GENERATOR DOME LOCALITY OF PORCUPINE CAVE, PARK COUNTY, COLORADO

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Taphonomic analysis of mammalian postcranial remains found at Generator Dome Locality, within Porcupine Cave, Park County, Colorado, provides important insights into aspects of high-altitude Pleistocene (Irvingtonian North American Land Mammal Age) paleoecology. The cave is in an intermontane basin and is among the highest known Pleistocene fossil sites in North America. Packrats, *Neotoma* spp., have lived in the cave continuously since the Middle Pleistocene and, in general, are considered to be the agents responsible for dispersion of vertebrate skeletal material within caves. Packrats collect and carry back to their nests carnivoran scat, avian pellets, and bones. The resulting packrat middens, through taphonomic analysis, can be used to understand and interpret cave paleoecology. Modern taphonomic studies have been used to better understand and determine distinct differences between rodent and carnivoran bone modification. Rodents target dry bones that are easily accessible, commonly the fore- and hind feet. They also target bone margins appropriate to jaw gape; for this reason, the mid-shaft is a common location for gnaw marks. Characteristics of rodent gnaw marks are flat-bottomed, parallel grooves. Carnivorans, on the other hand, prefer the proximal and distal ends of long bones in order to extract marrow. Their bite marks consist of irregular grooves associated with pits and punctures. Polished edges are also common due to licking of the bone. Based on these differences, the majority of gnaw marks on the remains from Porcupine Cave have been identified as rodent. These gnaw marks were found almost solely on phalanges but were also observed on metatarsals, metacarpals, and a femur. All of these modified remains have been identified as belonging to Lagomorpha, which is the most abundant clade represented at the Generator Dome Locality, followed by Rodentia, Carnivora, Artiodactyla, and Perissodactyla. By analogy with studies of modern ecology, it is likely that carnivorans preyed upon lagomorphs that were then dragged near or into the cave, which likely served as a den. We hypothesize that various species of rodents gnawed on the lagomorph remains for two reasons: (1) to ingest calcium and other mineral content; and (2) to sharpen their upper and lower incisors. A deeper taphonomic analysis of the skeletal remains from the Generator Dome Locality will allow for a better understanding of how skeletons accumulated and how the bones were utilized by the cave-dwelling mammals that lived and died there.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

EXPERIMENTAL APPROACHES TO ASSESS THE EFFECT OF FOOD TEXTURE AND GRAIN COMPOSITION OF ABRASIVES IN THE CAUSE OF DENTAL MICROWEAR

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Debate has developed in the dental microwear literature concerning the relative influences of food and extrinsic non-food abrasives such as dust or sand in the dental wear of mammalian dentitions. Although most studies attempt to draw conclusions about either food or abrasives as independent wear agents, we hypothesize that food and abrasive food contaminants may not operate independently. For example, hard and soft foods may cause differential microwear fabrics themselves but they may also cause behavioral modification of bite force or bite vectors, thus altering the potential for contaminants to cause wear. To control for both food texture and the role of the material properties of added abrasives, we conducted feeding experiments with 136 rats, divided into groups of 8 different diets. Four of those diets involved the common food item for rats, pelleted chow. The other four diets involved a dough that is nutritionally equivalent but much softer. For each of these sets of four, one set of rats was left with a diet unaltered as a control for that food texture, and the others were given food with particles of calcium carbonate, diatomaceous earth, or quartz sand, added into the food during manufacture so that it was evenly distributed. We performed scans of the same 80X100um areas of M2s using a Sensofar Plu Neox at 150x. ISO 25178 roughness parameters were obtained and statistically evaluated. Posthoc analyses of ANOVAs revealed significant differences between all 8 feed groups. However, among the different pelleted diets, very few roughness parameters were significantly different. Likewise, with the exception of the rats fed dough-with-quartz-sand very few significant differences in roughness parameters were found between dough-fed rats and pellet fed rats. The majority of statistical differences in roughness parameters were between the rats fed the dough-with-quartz-sand diet and all other feed groups. Quartz sand had dramatic impact on the dental wear of dough fed rats, but did not greatly impact the wear of pellet fed rats. An accompanying light microscopy analysis reveals that dough-with-quartz-sand generated a microwear pattern with many fewer scratches than all other feed groups. We conclude that the impact of mineral abrasives on dental wear is dependent on the varying properties of food itself and how animals respond. We postulate that unknown behavioral modifications associated with mastication of a doughy diet may have allowed quartz to have a greater effect on wear in comparison to mastication of the more brittle pellet diet.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW CENTROSAURIN CERATOPSID FROM THE UPPER UNIT OF THE OLDMAN FORMATION (LATE CRETACEOUS: CAMPANIAN) OF SOUTHERN ALBERTA, CANADA

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The Campanian Belly River Group of southern Alberta has produced a number of new centrosaurine taxa over the past decade, including; *Xenoceratops* from the Foremost Formation, *Albertaceratops* & *Wendiceratops* from near the base of overlying lower unit of the Oldman Formation (OF); and, *Coronosaurus* from the middle unit of the OF. *Centrosaurus* occurs in the lower part of the Dinosaur Park Formation (DPF) at Dinosaur Provincial Park (DPP) and in the time-equivalent portion of the upper unit of the OF. A new bonebed (Lost River BB) discovered in the Milk River region of southern Alberta has recently produced an additional new centrosaurin from the base of the upper unit of the OF. The new taxon is characterized by numerous traits: a short, procurving, nasal horncore; straight, robust, dorsally directed postorbital horncores with a slight caudolateral orientation that are intermediate in length between *Coronosaurus* and *Albertaceratops*; a large, dorsally-oriented epiparietal spike (P1); and, a robust, wide-based, laterally oriented, spike-like P2 at the caudolateral corner of the frill. The parietal also likely had a laterally oriented, spike-like P3. The remaining imbricated epiparietals are unmodified.

A phylogenetic analysis recovers the new taxon as the sister clade to *Coronosaurus* in a partially resolved Centrosaurini. It differs from *Coronosaurus* in lacking its apomorphic accessory epiparietal ossifications and having spike-like P1&2s that also differ in size, shape and orientation from *Spinops*. It also differs from all other centrosaurins is the length of the postorbital horncores. Of note, the new taxon shares some features (length and shape of the postorbital & nasal horncores) with the partial holotype skull of '*Monoclonius recurvicornis'* (AMNH 3999) described by Cope in 1877 from older strata of the lower Judith River Formation of Montana.

The new taxon occurs ~12 m below the Canal Creek Tuff (77.1 Ma) and 8 m below the *Centrosaurus* McFeeters BB in the upper unit of the OF. The new taxon is likely coeval with *Centrosaurus* and/or *Spinops* from the Belly River Group of the DPP region. This occurrence of coeval centrosaurins has precedence in the coeval occurrence of *Albertaceratops*, *Wendiceratops* and *Medusaceratops* in the lower unit of the OF and equivalent Judith River Formation, and suggests that this clade had behaviors and/or habitat preferences that allowed for ecological segregation of otherwise morphologically very similar ceratopsids.

Romer Prize Session (Thursday, August 24, 2017, 12:00 PM)

CREATING FOSSILS IN THE LAB: REPLICATING FOSSILIZATION USING SEDIMENT-BASED MATURATION

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Understanding how fossils form is imperative to interpreting fossil data. Some taphonomic experiments induce decay while others artificially mature specimens in extreme heat and pressure, speeding up chemical reactions that naturally occur in diagenesis over deep time. Maturation is often limited by small size of the sample capsule; volatiles are trapped and analyzed alongside more resistant compounds, and taphonomic effects on anatomy are unobservable. Previous experiments using traditional maturation on keratin hydrolyzed it into a fluid not seen in fossils. We hypothesize that maturation in sediment, acting as a filter, will produce more accurate fossilization models where volatiles, such as protein degradation products, leach away from the sample. Here, new experimental procedures/equipment allow for much larger specimens to be matured within sediment (current sample diameter, ~1.9 cm). An initial compression phase in a multi-ton press traps the sample in a consolidated sediment tablet. The tablet is then moved to a custom built autoclave for maturation. Results on lizards, tadpoles, feathers, beetles, and leaves are extremely encouraging. Matured samples closely resemble fossils morphologically and ultrastructurally. Bones are compressed along a single axis and browned. Soft tissue structures, such as feathers and scales, leave imprints in the sediment, exhibit severe volume loss, and the organics that remain are brown/black stains, matching Jehol-type preservation. When examined using scanning electron microscopy, feather portions darkly pigmented *in vivo* reveal exposed melanosomes resting on the sediment with evidence of keratin protein degradation and loss, while originally white portions lack melanosomes, matching observations of fossil feathers and strongly refuting a bacterial origin for these microbodies. Not only do these results match fossils on the ultrastructural level, they point towards the relative importance of diagenesis in 'exceptional fossils', suggesting that decay is minimized in such taphonomic settings. We also successfully produced a crystalline, amber-like substance from tree sap. The experimental rig can control many variables and increased sample size allows various tissues/organisms to be treated. This ultimately means that many taphonomic hypotheses can be tested in a novel way for many years to come. Furthermore, the large sample size will make it possible to directly link experimental decay and maturation treatments on a single specimen.

Technical Session XIX (Saturday, August 26, 2017, 2:45 PM)

TWO NEW BASAL MEGARAPTORA (DINOSAURIA: THEROPODA) FROM THE EARLY CRETACEOUS OF THAILAND WITH COMMENT ON THE PHYLOGENETIC POSITION OF *SIAMOTYRANNUS* AND *DATANGLONG*

SAMATHI, Adun, University of Bonn, Bonn, Germany; CHANTHASIT, Phornphen, Sirindhorn museum, Kalasin, Thailand

Megaraptora is a clade of medium to large-sized theropod dinosaurs with large-clawed, strong pneumatization, and long and gracile legs. The basal member was found from the Barremian of Japan, whereas the more derived clade, the Megaraptoridae, is known from the Cenomanian to Santonian rocks of South America and Australia. Despite many discoveries and studies, the phylogenetic status of this group as derived Allosauroidea, basal Tyrannosauroidea or basal Coelurosauria is still debated.

Megaraptoran material discovered almost 30 years ago in Thailand was recently studied and consists of two specimens. The preliminary analyses based on tibiae, astragali, claws, and vertebrae suggests that the specimens represent one of the most basal members of Megaraptora which is similar to *Fukuiraptor* from Japan and *Australovenator* from Australia and share some characters with *Chilantaisaurus* from China.

In a subsequent analysis which focused on non-coelurosaurian tetanurans (63 taxa 351 characters), we found the two Thai specimens to nest within megaraptoran clade Neovenatoridae and the entire clade to belong to Allosauroidea. However, in an analysis that focused mainly on Allosauroidea and Tyrannosauroidea (44 taxa 284 characters), we found the two Thai specimens and *Datanglong* from Southern China (previously interpreted as a carcharodontosaurian) to nest within Megaraptora and this clade to belong to Tyrannosauroidea. Furthermore, we found *Siamotyrannus*, a problematic avetheropod from Thailand, to be a basal coelurosaur. Finally, in an analysis that included *Gualicho* (from Argentina) and *Chilantaisaurus* (49 taxa 288 characters), we found the two Thai specimens and *Datanglong* to nest within Megaraptora and this clade to belong to Coelurosauria more basal than the clade consisting of *Siamotyrannus* + (Tyrannosauroidea + 'derived' Coelurosauria).

This study shows that the two new theropod specimens from Thailand are basal Megaraptora closely related to *Fukuiraptor*, but the position of Megaraptora in theropod phylogeny is still unclear. Surprisingly, *Datanglong* from Southern China was found here to be a member of Megaraptora, sharing the pneumaticity of the ilium with other megaraptorans. Finally, an informative but problematic taxon from Thailand *Siamotyrannus* was found to be a basal coelurosaur, agreeing with some previous studies. *Siamotyrannus* could be one of the largest basal coelurosaurs found so far, but this depends on the affinities of Megaraptora, *Gualicho*, and *Chilantaisaurus*.

Grant Information:
Department of Mineral Resources, Ministry of Natural Resources and Environment, Bangkok, Thailand.
Ministry of Science and Technology, Bangkok, Thailand.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MID-TERTIARY CLIMATE CHANGE, EXTINCTION AND SPECIATION IN MADAGASCAR, AND THEIR BEARING ON THE EVOLUTION OF MADAGASCAR'S LEMURS

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Was there a mid-Cenozoic extinction event in Madagascar and, if so, what are its implications for the roles of extinction, climate change, and selective context in the evolution of lemurs? The near lack of a Malagasy Cenozoic fossil record has inhibited direct testing of any such hypotheses. To address this problem, we gathered data on the terrestrial vertebrate faunas of continental Africa in the Paleocene and Eocene and Madagascar in the Quaternary. For the former, we evaluated each family's ancient geographic spread, transoceanic dispersal ability, direct fossil evidence of its crossing the Eocene-Oligocene boundary outside Madagascar, direct evidence of its dispersal to Madagascar, and current extinction status. For the latter, we evaluated each colonizing

clade's likely arrival timing and dispersal ability. These data support a major mid-Cenozoic extinction event on Madagascar.
We also modeled changes in diversification rates of Malagasy lemurs using a reconstructed phylogeny of extant and subfossil lemurs, in turn based on 10k trees data for extant lemurs, and Kistler and colleagues' molecular phylogeny of extinct lemurs. We then employed BAMM, TreePar, and RPANDA in modeling lemur diversification rates over time. RPANDA allows environmental variables to explain variation in speciation and extinction rates. When they are not included, multiple speciation and extinction rate models are equally well (or poorly) supported by our data, and our small tree leaves a lot of uncertainty. Our modeling results improve when we include environmental variables. To simulate a test for the presence of a mass extinction and its timing, we constructed a few candidate variables describing the probability of no, one, or several mass extinction event(s) having occurred. We postulated extinctions occurring (or not) at the Eocene-Oligocene, Oligocene-Miocene, and the Miocene-Pliocene boundaries. The model with one mass extinction at 34 MYA (i.e., at the E-O boundary) is best supported, and it shows strong support when compared to the model with no mass extinction.
This provides further support for our inference, derived through our direct comparison of the terrestrial vertebrate faunas of the early Cenozoic on continental Africa and the Quaternary of Madagascar, that there was indeed a major extinction event on Madagascar during the mid-Cenozoic. It provides indirect evidence that the evolution of Madagascar's lemurs was strongly impacted by the climate shift from "greenhouse" to "icehouse" conditions at the E-O boundary.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

SMALL MAMMALS AND A REFINED AGE ESTIMATE OF THE GRAY FOSSIL SITE IN TENNESSEE

SAMUELS, Joshua X., East Tennessee State University, Johnson City, TN, United States of America; ZAKRZEWSKI, Richard J., Fort Hays State University, Hays, KS, United States of America; CROWE, Cheyenne, East Tennessee State University, Johnson City, TN, United States of America; WALLACE, Steven C., East Tennessee State University, Johnson City, TN, United States of America; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States of America

The Gray Fossil Site in Tennessee represents one of only a few late Miocene or earliest Pliocene vertebrate fossil sites in the eastern part of North America. Previously described fauna from the site is unlike other mammal faunas of similar age, with common occurrences of tapir (*Tapirus polkensis*), rhino (*Teleoceras*), ailurid (*Pristinailurus bristoli*), and tremarctine bear (*Plionarctos*). Plant macrofossils from the site are dominated by deciduous trees, particularly oak and hickory, suggesting flora similar to some forests of the southern Appalachian Mountains today.
Screen-washing efforts have yielded thousands of microfossil specimens, including many small mammals. Rodents identified to date include two castorids (*Castor* and *Dipoides*), five cricetids (*Antecalomys*, *Neotoma*, *Postcopemys*, *Repomys*, and *Symmetrodontomys*), a dipodid (*Sicista*), and three sciurids (*Eutamias* or *Neotamias*, *Glaucomys*, and cf. *Sciurus*). Leporids include the archaeolagine *Notolagus* and the leporines *Pronotolagus* and *Alilepus*. Small carnivorans include the mephitid *Buisnictis* and procyonid *Bassariscus*. Presence of several well-known arboreal taxa (cf. *Sciurus*, *Glaucomys*, and *Bassariscus*) and the absence of burrowing rodents suggest that the site was forested; which supports previous environmental interpretations based on fauna, as well as paleobotanical and isotope records.
Stratigraphic ranges of newly recognized taxa are consistent with a latest Miocene to earliest Pliocene age-constraint for the site, but provide a substantially narrower range than previous estimates. Presence of the cricetids *Neotoma* (*Paraneotoma*), *Repomys*, and *Symmetrodontomys*; the leporids *Notolagus*, *Pronotolagus*, and *Alilepus*; and the mephitid *Buisnictis* all help restrict the estimated age range for the Gray Fossil Site. In sum, the site includes a mixture taxa considered characteristic of the Hemphillian and Blancan ages; biostratigraphy suggests the site ranges from 5.8 to 4.7 Ma.
Grant Information:
NSF Grant 0958985. PIs: S.C. Wallace and B.W. Schubert. Systematic Sampling of the Gray Fossil Site Vertebrates: A Unique Mio-Pliocene Fauna from the Southern Appalachians

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

RIVERS AND RECOVERY - MITIGATIVE PALEONTOLOGY AS A RESULT OF FLOODING IN SOUTHERN ALBERTA

SANCHEZ, Joseph, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BORKOVIC, Ben, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; SCOTT, Craig, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada

The flooding of several southern Alberta river systems in 2013 affected hundreds of thousands of Albertans across dozens of communities and caused billions of dollars in damage. A lesser known impact of the floods is that the destructive effect of the water also led to the exposure of many new fossils in the rivers' banks. The discovery of a complete *Leptoceratops* skeleton in the flood-eroded banks of the Oldman River spurred an effort to seek other specimens that might have been exposed by the floodwaters. Over the past three years the Royal Tyrrell Museum of Palaeontology (RTMP), in conjunction with the Government of Alberta, has undertaken a field project to prospect several river systems in southern Alberta in order to find and collect newly exposed fossils and protect them from future flooding events.
At the outset of the project, river flow data were obtained from the Government of Alberta in order to determine which rivers had flooded and merited surveying. Due to the extensiveness of those waterways, intervals that have produced fossils in the past were prioritised. These areas of interest were determined by referencing the RTMP's collections and GIS databases, as well as by interviewing in-house research and technical staff. For those rivers with little to no previously known fossil localities, Alberta Geological Survey maps were used to determine where the largest exposures of potentially fossiliferous bedrock could be found. Finally, all finds reported by the public along rivers were investigated. The river flow data were used to schedule field work around the various rivers' peak volumes to minimize water height and for safety considerations.
Under the context of this project, over 300 km of river bank were prospected in 12 rivers and creeks. In and along these waterways, field work was conducted on foot in waders, by canoe, and by river boat. Specimens were collected by hand, truck, and helicopter, and recorded as latex moulds and digital models. In total, 214 paleontological sites were discovered and documented, resulting in 331 specimens collected and accessioned at the RTMP. Several specimens were determined to have been displaced or damaged directly by the flooding events, and observations of the progressive impact to fossil localities demonstrated the importance of a prompt post-disaster field program.

Technical Session I (Wednesday, August 23, 2017, 8:30 AM)

SYSTEMATIC VALUE OF LONG BONE HISTOLOGY OF MAJOR DINOSAUR CLADES

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The last two decades have seen enormous growth in the study of dinosaur long bone histology and microanatomy, aimed at answering questions of growth, life history, physiology, and evolution. It was generally held that dinosaur bone histology is of little systematic value because of the limited number of amniote bone tissues, which also are prone to convergent evolution. After the initial survey phase with only a few taxa from each major dinosaur clade having been studied histologically, a comprehensive taxon sampling now has accumulated in the published literature. This reveals remarkable histological uniformity of most major clades of dinosaurs, allowing identification of otherwise undiagnostic bone specimens (often small fragments, as in zooarchaeology) and inviting tests of the systematic value of histological data as characters in phylogenetic analyses. We have compiled histologic data for each major dinosaur clade (Theropoda, Sauropodomorpha, Sauropoda, Stegosauria, Ankylosauria, Ornithopoda, and Ceratopsia) and optimized them on a consensus phylogeny of Dinosauria. Basal Dinosauromorpha had highly vascularized fibromellar bone with LAGs. This histology was retained by Theropoda outside of Avialae and by basal Sauropodomorpha. Both retain a large open medullary cavity, limiting Haversian bone development. Basal Sauropodomorpha have thinner laminae in their laminar cortical bone than other dinosaurs. Sauropoda evolved thicker laminae and lost growth mark expression before late ontogeny. Sauropoda possess a small medullary cavity filled by trabecular bone and show extensive Haversian replacement at senescence. Stegosauria either have fibrolamellar bone with longitudinal canals and well developed LAGs (Stegosaurus) or laminar to plexiform fibrolamellar bone (Kentrosaurus). As in Sauropoda, Stegosaur medullary cavities are small, linked to graviportality. Primary cortical bone of Ankylosauria resembles that of Stegosaurus but remains incompletely known because of the early onset of Haversian remodeling. Ankylosaur primary and even secondary tissue is rich in structural fibers. Ornithopods also retained the plesiomorphic histology but have a smaller medullary cavity and accordingly show more remodeling. Ceratopsian histology is least studied among major dinosaur clades, but it probably is most similar to that of ornithopods and theropods. Future work will incorporate histological and microanatomical characters into phylogenetic analyses of Dinosauria to develop an apomorphy-based approach to such data.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DIVERSIFICATION PATTERNS IN THE FAMILY RHINOCEROTIDAE

SANISIDRO, Oscar, Lawrence, KS, United States of America; CANTALAPIEDRA, Juan L., Museum für Naturkunde, Berlin, Germany

Living rhinoceros' species are but a vestige of the great diversity that the Family Rhinocerotidae attained during the Cenozoic. We present an overview of the diversification patterns of the Rhinocerotina (Family Rhinocerotidae), with emphasis on the potential influence of sampling biases. We conducted a taxonomic review of the group, including an updated compilation of observations for each species in order to estimate true richness in the fossil record. Our results show several pulses of taxonomic replacements (late Miocene, Miocene-Pliocene and Plio-Pleistocene) interspersed between intervals of lower turnover rates. We show that the evolutionary history of Rhinocerotina shows disparate diversity and taxonomic dynamics at a continental scale, probably stemming from different paleobiogeographic and ecological backgrounds.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

UTILIZING AUGMENTED REALITY FOR INCLUSIVE EXHIBIT DESIGN

SANTOS, Gabriel-Philip, Raymond M. Alf Museum of Paleontology/ The Webb Schools, Claremont, CA, United States of America; LEPORE, Taormina, Raymond M. Alf Museum of Paleontology/ The Webb Schools, Claremont, CA, United States of America

Due to the growing accessibility and affordability of smartphone and tablet technology, many museums are incorporating cutting-edge technology into their exhibits and educational programs. Augmented reality (AR) is one such way that paleontology museums have incorporated technology to both increase engagement and provide flexible displays within otherwise static exhibits, at a relatively low production cost. In most cases, the information presented via AR is supplementary and designed for the "general audience" of the museum. This type of design can be exclusionary to those within specific subgroups of the "general audience", such as English language learners or non-English speaking visitors, visitors with sensory impairment, or visitors who are neuroatypical. Generally, for these museum visitor subgroups, secondary engagement takes the form of supplementary pamphlets, audio tours, traditional tactile exhibit additions, or tour guides. While these secondary engagement methods are effective, they risk causing guests to feel "removed" from the immersive and technological museum experience. With increasing attention toward developing museums with universal design and accessibility, AR can be utilized as a strong tool to better inclusivity within paleontology museums. Using free platforms to host and share AR-based media, we demonstrate case studies in which exhibits can be "auto-translated" into multiple languages by overlaying translated signage over existing exhibit text. For those with sensory impairments, we demonstrate how media can be set to appear alongside exhibits, including AR sign language, closed caption, or descriptive audio. With AR, exhibit text and signage can be overlaid by graphics and supplemented with touch-screen tactile aids

that better present exhibit information to neuroatypical guests. The multitude of AR media platforms available are free to small institutions are often user-friendly in their design and application for both the designer and user. Additionally, since AR media is digital, designs can easily updated with new information. We provide easily implementable recommendations and files along with our institution case studies to increase inclusivity using AR technology.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A TURONIAN POLYCOTYLID PLESIOSAUR (REPTILIA; SAUROPTERYGIA) FROM HOKKAIDO, JAPAN, AND ITS BIOSTRATIGRAPHIC AND HISTOLOGICAL SIGNIFICANCE

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The Cretaceous Yezo Group in Japan and Sakhalin, Russia, is so far the only place in the northern Pacific where a number of reptilian fossils have been reported from the continuous stratigraphic sequence of mid to uppermost Cretaceous with good stratigraphic controls. Documentation of the taxonomic composition of Yezo reptilian fauna is thus crucial to understand the stratigraphic and geographic distribution of Cretaceous marine reptiles at a global scale. Plesiosaurian fossils are fairly common in Japanese Upper Cretaceous, but elasmosaurid remains dominates the record whereas only a limited number of polycotylid specimens are known so far. HMG-357 of Hobetsu Museum described here is an indeterminate Turonian polycotylid from the Upper Cretaceous Yezo Group in Obira Town, Hokkaido, Japan, and consists of five articulated vertebrae at the base of the neck, eight ribs, a part of the left scapula and a clavicular arch; it is the first reasonably complete polycotylid clavicular arch from the country. The occurrence of this specimen is significant, because its Turonian occurrence demonstrates the survival of Polycotylidae across the Cenomanian-Turonian boundary in northwest Pacific where notable faunal turnover events have been documented among shelled molluscs and microfossils, as well as an excursion of carbon isotope ratio. We also examined its histological features of the rib using computed tomographic scanning and thin-sectioning, and it is the first histological study of a definite polycotylid. It exhibits osteoporotic-like condition, and characterized by the parallel-fibered tissue with avascular bone as known as external fundamental system, and shows extensive remodeling. In addition to the macroscopic osteological features such as the complete closure of the neurocentral suture and partial obliteration of the clavicular sutures, observed histological characteristics also indicate that HMG-357 represent a mostly full-grown individual.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ULTRALIGHT POLYESTER RESIN CASTS FOR MUSEUM EXHIBITS IN SOUTHWEST CHINA

SATO, Tetsuya, Peking University, Beijing, China; XU, Feng-lun, Xingyi National Geopark Museum, Xingyi, China; HU, Bin, Xingyi National Geopark Museum, Xingyi, China; JIANG, Da-yong, Peking University, Beijing, China

Fossil casts are important in paleontology for research and education. Casts are commonly used in museum exhibits especially when the necessary materials do not exist in that particular collection. However for a low-budget local museum, shipping costs are high due to the weight inherent in many large, high quality casts. Moreover handling by inexperienced persons endangers fossil casts during transportation and mounting. Here we present a method to produce lightweight but highly durable, exhibit-quality casts.

The Xingyi National Geopark Museum (XNGM), located in Xingyi City, southwest China's Guizhou Province, recently opened an exhibit that featured local Middle Triassic marine fauna in the context of material from the Early Triassic Chaohu fauna, the Middle Triassic Panxian fauna, and the Late Triassic Guanling biota. In the spring of 2016, Peking University (PKU) donated two dozen exhibit-quality casts from these faunas to promote on-going fieldwork in Guizhou with support from local governments, and therefore, these casts were shipped over 1200 miles from Beijing to Xingyi. The casts comprised two layers when the original fossils were in slabs. The first layer was made of polyester resin, fumed silica, and 1/2-inch chopped glass fibers with the ratio of 15:3:1 by weight in that order. No-brand polyester resin from a local vendor was used for cost and accessibility. The mixture had the viscosity of peanut butter (~250,000 cps) and was applied on RTV silicone molds with China bristle brushes in several sizes. The second layer was 1-1.5 inches of light-density open-cell spray polyurethane foam (ocSPF), which provided thickness and worked as a cushion. Although the ocSPF's longevity is relatively short (up to 20 years) due to ultra-violet light and routine surface damage, this lifespan is acceptable considering the timespan until the exhibit's renewal. The casts reduced approximately 75% of the weight compared to regular polyurethane resin casts previously made in PKU. At present, these lightweight casts are on display in the newly established XNGM exhibit.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

LATEST OLIGOCENE GLYPTOSAURINE LIZARDS FROM THE SHARPS AND MONROE CREEK FORMATIONS, SOUTH DAKOTA, AND PHYLOGENETIC AND BIOCHRONOLOGIC IMPLICATIONS

SCARPETTA, Simon G., University of Texas at Austin, Austin, TX, United States of America

Fossiliferous deposits in the iconic Badlands of South Dakota have yielded a rich record of terrestrial vertebrates for the late Eocene and much of the Oligocene. Early Oligocene deposits are well-documented and contain a wide variety of extinct mammal and reptile taxa. Late Oligocene deposits are less-comprehensively studied, but contain unique and important fossils of extinct taxa that do not appear after the latest Oligocene. Here, I document and describe previously collected but undescribed glyptosaurine lizard fossils from the Oligocene Sharps and Monroe Creek formations. Glyptosaurines are an extinct clade of anguid lizards that appear to have become extinct near the Oligocene-Miocene boundary, and the fossils described here represent one of the latest known appearances of glyptosaurines in the fossil record. I provide taxonomic and phylogenetic descriptions of each specimen, improving upon previously inconclusive descriptions of late Oligocene glyptosaurines from central North America. I refine the known temporal range and phylogenetic relationships of Oligocene glyptosaurines. I discuss challenges with biochronological interpretations of the Arikareean mammal age and discuss options for better temporal constraint of this interval.

Grant Information:
Geological Society of America
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Lundelius Award in Vertebrate Paleontology

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TWO REMARKABLE CARPAL BONE POSITIONS IN *PROSANTORHINUS GERMANICUS* (MAMMALIA: RHINOCEROTIDAE)

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The Miocene rhinoceros *Prosantorhinus germanicus* is one of three rhinoceros taxa from the famous locality of Sandelzhausen (Germany). The remains have an age of around 16 Ma (MN5) and the rhinoceroses are most numerous among the overall findings. The remains of *P. germanicus* are dominating the rhinoceros assemblage. Belonging to the rhinocerotid tribus Teleoceratini, this species is often described with a semi-aquatic mode of life as the whole tribus is. *P. germanicus* is characterized by a relatively small barrel-shaped trunk and short limbs. The second most abundant rhinoceros species is *Plesiaceratherium fahlbuschi*. This rhinoceros is somewhat larger than *P. germanicus* and shows rhinoceros typical proportions of trunk and limbs. *Lartetotherium sansaniense* is the largest and rarest rhinoceros species from Sandelzhausen and seems to be a generalized rhinoceros in feeding habits and locomotory adaptations.

The carpal bones Carpale IV and Intermedium show a high variation in *Prosantorhinus germanicus*. The Intermedium is a bone from the proximal row of carpals and positioned between the medial Radiale and the lateral Ulnare. The Carpale IV is a bone from the distal row of carpals and is laterally positioned to the Carpale III. In the normal rhinocerotid condition Intermedium and Carpale IV are in contact with each other through articulation facets at the dorsal parts of the bones. Among the preserved carpal bones of *P. germanicus* some of these two bones show additional articulation facets which are located on the palmar processes of both bones. These facets are reducing the range of flexion between the proximal and distal row of carpals and therefore stiffening the wrist. While the additional facets are present or absent on the Intermedium, the situation is more confusing in case of the Carpale IV. Either the additional facet is present or, in case of a lack of this facet, a knob-like structure is present. This leads to the question if the knob is the leftover of a reduced facet where the stiffening of the wrist is not necessary or if the knob is the base of a developing facet to stabilize the wrist by stiffening. The latter possibility seems more reasonable. In case of a semi-aquatic mode of life in *P. germanicus*, the additional facets stabilized the wrist on muddy grounds, or as a sexual dimorphism, independent of a semi-aquatic or terrestrial mode of life, it stabilized the wrist in the heavier males for example. Further analyses of the whole postcranial skeleton will follow to clarify if these facets are an adaptation to a semi-aquatic mode of life in *P. germanicus*.

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Podium Symposium (Wednesday, August 23, 2017, 8:15 AM)

APPENDAGE REGENERATION IS AN ANCIENT TRAIT OF OSTEICHTHYES

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Salamanders are the only tetrapods capable of regenerating limbs as adults, however the evolutionary origin of this remarkable ability remains unclear. The only other sarcopterygian capable of regenerating its fin endoskeleton are the lungfishes. Regeneration of dermal fin rays is common among teleost fish, yet fin endoskeleton regeneration has only been reported in living representatives of the non-teleost clade Cladistia, family Polypteridae. Therefore, the explanation for the phylogenetic distribution of vertebrate appendage regeneration as a trait remains elusive. Here, we combine experimental studies in non-teleost actinopterygians and comparative RNA-seq analyses in an effort to resolve the evolutionary origin of limb and fin regeneration. First, we demonstrate that among actinopterygians, fin endoskeleton regeneration is not restricted to living representatives of early diverging clade Cladistia, but is also present in species of the other two non-teleost clades: the paddlefish, *Polyodon spathula* (Chondrostei) and the spotted gar, *Lepisosteus oculatus* (Holostei). Next, we generated transcriptome assemblies of regenerating and non-regenerating appendages for *Polypterus*, lungfish, axolotl, zebrafish and mouse digit tips. Our comparative RNA-seq analysis provides compelling evidence for a shared appendage regeneration program between axolotl limbs and *Polypterus* and lungfish fins. Lastly, we show that the genetic program deployed in regenerating fin rays and digit tips differs significantly from the common program found during regeneration of fin and limb endoskeleton. Altogether, our findings provide strong support for an evolutionary scenario in which an appendage endoskeleton regeneration program first arose in osteichthyes and was subsequently lost in amniotes and teleosts.

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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

NEUTRON COMPUTED TOMOGRAPHY OF CRETACEOUS TYRANNOSAUROID *BISTAHIEVERSOR SEALEYI* AND PALEOCENE PHENACODONTID *TETRACLAENODON PUERCENSIS* SKULLS SHOWS DETAIL NOT EASILY VISIBLE WITH X-RAY CT

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3D visualization of x-ray computed tomography (CT) has revolutionized the study of paleontology over the last decade by allowing paleontologists to gain essential insights into the anatomy, development and preservation of important specimens. Having only been rarely applied to vertebrate fossils, neutron computed tomography (NT) is an exciting new frontier in 3D visualization. Based on the interaction of neutrons and the nuclei of materials, NT is able to penetrate fossils impregnated with dense, iron rich minerals otherwise impervious to traditional CT, and can also be used to distinguish areas of distinct elemental or isotopic composition within fossils. We have applied NT to two specimens, using the unique capabilities of the Los Alamos Neutron Science Center at Los Alamos, New Mexico. The skull of the holotype of the Cretaceous tyrannosauroid *Bistahieversor sealeyi* (NMMNH P-27469) and a nearly complete skull of the Paleocene phenacodontid "condylarth" mammal *Tetraclaenodon puercensis* (NMMNH P-69898) were scanned using high-energy and low-energy (thermal) neutrons. To reduce attenuation due to neutron scattering by hydrogen, a common component of plaster, a special carbon fiber composite support jacket was constructed to hold the *Bistahieversor* skull. To allow detailed comparison of the two scanning techniques, the *Bistahieversor* skull was also scanned using 10MeV microtron CT at 100x100µm resolution, which is to our knowledge the highest resolution CT of an entire tyrannosaur skull ever made, and *Tetraclaenodon* was scanned with 150keV x-ray CT. Preliminary NT results revealed details of the internal bone structure of both specimens not readily visible with CT, with no residual increased radiation level following the cool-off period. High energy NT showed that *Bistahieversor* possesses the extensive tympanic sinuses and elongate, tubular endocast that were once thought to diagnose only the largest-bodied, most derived tyrannosaurids like *T. rex*, whereas thermal NT scans showed *Tetraclaenodon* has an endocast that was not as proportionally large, and overall more primitive, than the brains of modern placentals.

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Technical Session XVII (Saturday, August 26, 2017, 9:00 AM)

UNDERWATER CAVES OF THE YUCATÁN PENINSULA REVEAL UNEXPECTED RECORDS OF LATE PLEISTOCENE FAUNAL INTERCHANGE

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The Great American Biotic Interchange (GABI) refers to the dispersal of organisms from South America to North America, and vice versa. For large mammals this interchange became possible by the late Hemphillian. While these continents are well known for their late Cenozoic faunas, and recorded immigrant taxa, our knowledge of GABI in the Yucatán and Central America is sparse. This has led to a profound gap in our understanding of the origins and development of faunal communities in the Neotropics, between southern Mexico and South America. Further, this sparse record has led researchers to interpret this area as a bridge between the two continents, rather than the complex and diverse ecological region that it is, including its own endemic taxa. Recent exploration of cenotes and underwater caves of the Yucatán is changing this picture, with extraordinary and unexpected records of late Pleistocene mammals. We focus on Outland Cave, near Tulum, Mexico. While Pleistocene skeletal remains have been found throughout this submerged cave system, most attention has centered on Hoyo Negro (HN), a natural trap pit under 55 m of water. Mammals entered Outland Cave through horizontal passages when sea level was lower during the late Pleistocene, and many fell to their deaths in HN. Expeditions to the site require technical diving and innovative technology to document and retrieve specimens. Underwater photogrammetry is used to record fossils *in situ* prior to removal. The fauna includes elephant-like gomphotheres, at least three types of giant ground sloths, tapirs, sabertooth cats, pumas, bears, canids, and a human. The Native American individual is currently the oldest and most complete of the earliest human skeletons in the Americas. Recovery and analysis of sloth, bear, and canid remains over the past year provided biogeographic and evolutionary surprises. A megalonychid sloth is a new genus and species that may be endemic to the region. The bear, *Arctotherium* ("South American" short-faced bear), is the first record of the genus outside South America. The relative abundance of *Arctotherium* individuals in the deposit, and pristine condition of their remains, makes this the most complete and abundant short-faced bear material known from a single locality. Most recently, a canid skull represents another "South American" genus, hitherto unknown outside that continent. While the sloths may be part of earlier stages of GABI, we hypothesize that the bear and canid expanded their distributions northward during the late Pleistocene, just prior to their extinction.

Technical Session XI (Friday, August 25, 2017, 8:45 AM)

***BISON* FROM THE TULE SPRINGS LOCAL FAUNA, SOUTHERN NEVADA: IMPLICATIONS FOR THE DIVERSITY AND BIOGEOGRAPHY OF LATE PLEISTOCENE BISON IN SOUTHWESTERN NORTH AMERICA**

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The genus *Bison* was a common and abundant component of many megafaunal communities in the late Pleistocene of North America. Recent genomic investigations have proposed that *Bison* migrated into North America in two waves, the first between ~195 and ~135 ka, and a second between ~45 and 21 ka. The initial immigration was followed by relatively rapid dispersal and concomitant phenotypic diversification, particularly in horn core size, shape, and orientation. Complementary fossil evidence from the American southwest sheds light on the timing and character of this dispersal.

The chronology of fossils of *Bison* recovered from middle-late Pleistocene groundwater discharge deposits in the northern reaches of the Las Vegas Valley, Nevada, conforms well with the genomically-inferred dispersal pattern. The Las Vegas Formation has produced the Tule Springs local fauna, the largest open-site vertebrate fossil assemblage dating to the late Pleistocene in the Mojave Desert/southern Great Basin. *Bison* is well represented in this fauna throughout the highly resolved stratigraphic sequence of the formation, in multiple units ranging from 100 ka - ~20 ka.

A long-horned morphotype represented by two partial skulls occurs in Member B, Bed B_2 of the Las Vegas Formation, which dates to between ~55 and 45 ka. The size and morphology of the horn cores of both specimens suggest affinity with the long-horned species *Bison latifrons*; however, the horn cores are shorter and more strongly curved than classic examples of that species. Consequently, the skulls have previously been assigned to a variety of other species of debatable validity, or have been interpreted to represent hybrid forms. It is more likely that the skulls represent a regional variant of *B. latifrons*, and that observed differences in horn core length and curvature reflect geographic plasticity consistent with a rapidly-diversifying evolutionary lineage. Similar horn cores from other southwestern localities (Rancho La Brea, Diamond Valley Lake) support this interpretation.

The smaller, shorter-horned species *Bison antiquus* is also present from Bed B_2 of the Las Vegas Formation, and is the sole bison species represented from younger members of the formation. The reduced body size, smaller horn cores, and increased abundance of *B. antiquus* relative to *B. latifrons* and other megafauna likely correspond with the second immigration pulse deduced from genomic data. The dominance of *B. antiquus* in midcontinent North America at the end of the Pleistocene may have resulted from a shift towards herding behavior.

Podium Symposium (Wednesday, August 23, 2017, 8:00 AM)

TIMING THE DEVELOPMENTAL ORIGINS OF MAMMALIAN LIMB DIVERSITY

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Limbs have been models for development, regeneration, and evolution for over 100 years. Some reasons for this are that limbs are diverse, easily experimentally manipulated, and often regenerative. My lab has been using mammalian limbs as a model to investigate limb development, and how development has evolved to generate the limb diversity of the fossil record. One of our primary foci has been the developmental timing of the evolution of mammalian limbs. To investigate this, we first used discrete variables to quantify the morphology of the mammalian limb through the fossil record and among living forms. When reconstructed phylogenetically, we found that, of the 100% of observed changes, 83% were in the autopod, 12% in the zeugopod, and 4% in the stylopod. This suggests that distal limb elements tend to evolve more frequently than proximal elements. Possible reasons for this are numerous, and include developmental biases on variation. As distal limb elements appear later in development than proximal elements, we hypothesized that early limb development is conserved among mammals relative to later limb development. To test this, we quantified the transcriptomes and morphologies of developing bat, mouse, pig and opossum limbs. Our results suggest that the development of the mammalian limb is conserved during initial outgrowth but diverges shortly thereafter, consistent with earliest limb outgrowth being developmentally inflexible. To test the hypothesis that this inflexibility results from gene interactions, and that these interactions limit the generation of variation within and among species, we built and perturbed gene interaction networks for early (EN) and late (LN) limb development in mouse. Our results suggest that the EN is more robust. We then quantified levels of the same genes within populations and among species, and found that they vary less at earlier limb stages. We also found that variation in gene expression levels among individuals and species are correlated. These results suggest that EN robustness buffers population-level variation in gene expression early in limb development, and limits the evolution of early limb development among species.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DENTAL MORPHOLOGY AND DIET OF THE FIRST OCCURRING OLD WORLD HIPPARIONS FROM THE BASAL VALLESIAN OF THE VIENNA BASIN (MN9, 11.4-11.0 MA)

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We evaluated seven maxillary and mandibular cheek tooth morphological characters and upper molar mesowear of three penecontemporaneous Pannonian C (early late Miocene) hipparion assemblages from Gaiselberg, Atzelsdorf and Mariathal in the Vienna Basin, Austria within the context of age, stratigraphy, paleodiet and paleoenvironment. These assemblages represent the oldest reported Old World hipparions and are directly relevant to the "Hipparion Datum" which has long been considered as a key geochronologic marker for early late Miocene Eurasian and African horizons and therefore also relevant to the origin of all Old World Hipparion clades. We tested three hypotheses regarding these first-occurring Central European hipparions: (1) they were high crowned grazers, (2) they possessed primitive cheek tooth traits and (3) they are referable to the genus *Cormohipparion*. Based on the results of our assessment of crown height, protocone morphology, confluence of pre- and postfossettes and the presence of pli caballinids and ectostylids, hipparions from all three localities exhibit primitive cheek tooth traits but those from Mariathal exhibit some advanced characters that anticipate Austrian and German later Vallesian age. Consequently, we refer the Gaiselberg and Atzelsdorf assemblages to *Hippotherium* sp. and the Mariathal assemblage to *Hippotherium* aff. *primigenium* and not to *Cormohipparion*. Mesowear analysis reveals that Pannonian C hipparions from all three localities incorporated a majority of browse in their diets but also some grass and were most likely opportunistic mixed feeders, a condition that sharply contrasts with African early Pliocene forms (such as *Eurygnathohippus woldegabrieli*) that appear to have been dedicated grazers. Hipparion genera from the late Miocene-Pleistocene of Eurasia and Africa enjoyed an extensive evolutionary radiation. Our tooth evaluation of Pannonian C hipparions provides a critical piece of information for future polarization of such characters for unravelling the phylogeny and paleoecology of this important group.

Technical Session XX (Saturday, August 26, 2017, 4:00 PM)

THE CENTRAL ROLE OF FUNCTIONAL MODULARITY IN VERTEBRATE EVOLUTION

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The vertebrate body first evolved as a highly integrated, segmented musculoskeletal unit well designed for transverse undulatory movement in water. The hypothesis tested here is the following: did diversification of this original vertebrate body plan involve the evolution of semi-independent functional modules? Unlike the vast majority of musculoskeletal modifications in vertebrate evolution, functional modularity involves benchmark transformations that can be defined and distinguished on functional criteria, such as the independent movement of structures or body parts or the loss and acquisition of wholly different functions. A limited number of such transformations are identified.

Two kinds of functional modules are here identified, *axial* and *paraxial*, the former involving functional independence in the midline and the latter creating functional independence between bilateral structures. The identified functional modules, when mapped onto vertebrate phylogeny, only rarely evolve in parallel, almost never reverse, and are often associated with major radiations involving diversification of the newly acquired functional modules. As a result of these phylogenetic trends, vertebrate evolution generates an expanding array of life forms with increasing functional modularity.

The neck, an early axial functional module that allows the head to move independent of the trunk, evolved once among basal amniotes and was lost only once in ichthyosaurs, one of many secondarily aquatic amniotes. The tail, the site of another axial functional module, was originally functionally linked to the hind limb as the anchor for major limb retractor musculature. Functional independence of the tail and hind limb evolved twice (in maniraptoran theropods and basal synapsids) and was never reversed. Functional diversification of the tail in avians and mammals is well documented and stands in stark contrast to basal members within each clade.

The mobile should girdle and unilateral jaw function in therian mammals are examples of paraxial functional modularity, the former allowing the shoulder joints to move independently presaging the evolution of a multiplicity of mammalian gaits and the latter allowing the jaws to engage independently presaging an unheralded radiation in dental heterogeneity. These functional modules appear to have evolved once and have never fully reversed (to fixed girdles and isognathus mastication). Functional modularity appears to play a central and still underappreciated role in vertebrate evolution.

Technical Session VII (Thursday, August 24, 2017, 2:30 PM)

FLIGHT PROPERTIES OF THE EARLY ENANTIORNITHINE BIRD *PROTOPTERYX FENGNINGENSIS*

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The Cretaceous Enantiornithes, the most species-rich group of non-neornithine birds, is extremely well represented in the Early Cretaceous Jehol Biota of Northeastern China. While compelling evidence indicates that these birds were accomplished fliers, their aerodynamic properties related to speed, power, energetic efficiency, and maneuverability remain minimally known. We use a multipronged approach that combines morphofunctional analyses with modeling of flight parameters to describe the aerodynamic properties of the Jehol enantiornithine *Protopteryx fengningensis*, one of the earliest (~131 Myr) and most primitive members of the group. Multivariate estimation from anatomical dimensions of three *Protopteryx* specimens produced reliable values for body mass (33–49 g), wing span (317–352 cm), and wing area (189–237 cm^2), which in turn resulted in low values of aspect ratio (*AR* = wing $span^2$/wing area; 5.2-5.4) and wing loading (*WL* = body mass/wing area; 0.172-0.204 g/ cm^2). These estimates are similar to the values of small living birds such as skylarks (*Alauda*). Like in the latter, the small body mass, low *AR* and *WL*, and rounded wingtips of *Protopteryx* indicate that the wings of this bird could have generated high-lift and maximized thrust allowing rapid take-offs and high efficiency while flying at low-to-medium speeds. In addition, a morphofunctional analysis of the humeral deltopectoral crest (i.e., insertion point for flight muscles) reveals consistency with the morphology of birds that use a flap-and-glide type of intermittent flight. Like many small living birds, *Protopteryx* could have used this type of intermittent flight to reduce transport costs (i.e., the high aerodynamic drags generated by its body and wings) as it increased flying speed or duration. Furthermore, the relatively distal position of the alula (located closer to the wingtip than in modern birds of similar size) is reminiscent of the alular placement of larger birds with relatively limited maneuverability (e.g., fowls, loons, grebes, auks, cormorants, pelicans and frigatebirds). This observation suggests that *Protopteryx* could have had a lesser degree of maneuverability and control during slow flight than its similarly-sized living counterparts. In summary, the aerodynamic and mechanical features of *Protopteryx* indicate that this early bird was (1) an efficient flier at low-to-medium speeds, (2) used an intermittent flap-and-glide strategy to reduce flight costs, and (3) had limited maneuverability when compared to modern birds of similar size.

Grant Information:
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Technical Session XIV (Friday, August 25, 2017, 2:45 PM)

THE SABRE CAT *SMILODON FATALIS* FROM TALARA PERU: AGE, SEX, MASS AND SOCIALITY

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In 1958, the Royal Ontario Museum collected more than 28,000 fossil bones of Late Pleistocene age from Talara, Peru. Included in this fauna are 1,949 fossils of the sabre cat *Smilodon fatalis*. All bones of the skeleton are present in this collection, except for the clavicle, xiphisternum and some hyoid elements. A basihyoid bone is described for the first time, and a caudal series of 13+ bones is proposed. Compared to the MNI (minimum number of individuals) of 20 based on postcranial material, there is an MNI of 25 based on the right dentary. This collection thus has the second largest reported number of individuals of *S. fatalis* preserved, after the famous Rancho La Brea (RLB), site in California. The limb and metapodial elements average smaller in length than those of the RLB *S. fatalis*. The dentaries were aged using tooth wear, resulting in a count of one juvenile, six young adults, 16 adults, one old adult and one indeterminate, giving a similar proportion as is present at RLB. Tooth-bearing elements were sexed using published osteometrics of the RLB collection, resulting in two females and one male based on skulls, and eight females and two males based on dentaries. The average carnassial length for these sexed specimens demonstrates sexual dimorphism in this collection. Published regressions were used to estimate body mass of the Talara *S. fatalis.* They yielded an average of 244.1 kg based on three Talara humerus measurements, 198.4 kg based on three femur measures, and 154.1 based on two tibia measures. The body mass range for RLB *S. fatalis* was published as 160 kg to 280 kg so the Talara cat largely falls within this range. Associated limb material could better constrain these estimates. There is a preponderance of limb material with unfused ephiphyses, giving a calculation of 41% juveniles, even though only one dentary preserved the milk dentition. The combination of sexual size dimorphism in the dentition, sexual shape dimorphism in the skulls, a skewing of the sample towards females, and a delayed limb maturation compared to the dentition all suggest some form of sociality in this species.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW MATERIAL OF A SMALL SIZED EOSAUROPTERYGIAN FROM THE MIDDLE TRIASSIC OF LUOPING, YUNAN, CHINA

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Recent years, Dawazi locality in Luoping, Yunan, southwestern China produced many well preserved and very important Triassic fish and reptiles, including four species of small-sized eosauropterygians (adult body length less than 50 cm): *Diandongosaurus acutidentatus*, *Dianopachysaurus dingi, Dianmeisaurus gracilis,* and *Dawazisaurus brevis*.

Here we report a new eosauropterygian material form the Member II of the Guanling Formation from Dawazi locality. Its cranial morphology is quite different from those of *Diandongosaurus* and *Dianmeisaurus*, but similar to those of *Dianopachysaurus* and *Dawazisaurus* in having constricted rostrum, external naris closer to the orbit than to the anterior end of the rostrum, postorbital region longer than preorbital region, supratemporal fenestra elongated elliptic. It is also featured by the mixture of some diagnostic of latter two species. It is similar to *Dianopachysaurus* in having well-developed nasal processes of the premaxillae that form most of the internarial region, and having a posteriorly constricted parietal. It is similar to *Dawazisaurus* in having V-shaped posterior margin of the skull roof, interfenestral septum of the skull roof narrower than the interorbital region, and elongated retroarticular process. Its clavicle has no anterolateral process, also supporting the close relationship with *Dianopachysaurus* and *Dawazisaurus*. It has 17 dorsal vertebrae, while this number is 16 and 19 respectively in *Dawazisaurus* and *Dianopachysaurus*.

The new material is tentatively recognized as a new species. It differs from *Dianopachysaurus* and *Dawazisaurus* in having a long supratemporal fenestra that is little longer than the orbit, weakly pachyostotic dorsal ribs, and without pachyostotic on the anterior caudal ribs.

Dianopachysaurus is only known by the type specimen, which could be a juvenile individual. The size of new material is between the only known specimens of

Dianopachysaurus and *Dawazisaurus*. Moreover, the number of dorsal vertebrae is fallible, new material has mixed features, so the possibility that three specimens could belong to same species needs to be taken into account.
Grant Information**:**
Supported by the National Natural Science foundation of China (#41372028)

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

REVEALING THE SKELETON OF THE POLAR DINOSAUR *LEAELLYNASAURA AMICAGRAPHICA* USING SYNCHROTRON COMPUTED TOMOGRAPHY

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Leaellynasaura amicagraphica was a small, bipedal, herbivorous dinosaur from Australia that lived about 106 million years ago within the Antarctic Circle of that time. Known aspects of the brain of this dinosaur suggest that it had enhanced visual ability enabling it to see under the low light conditions that prevailed during the polar winter. Although several cranial elements of *Leaellynasaura* exist (including the nasals, frontals, prefrontals, parietals, left maxilla with dentition and partial jugal, quadrate and pterygoid) they are too delicate to be removed from the rock in which they are embedded. High resolution synchrotron computed tomography (CT) provides a non-destructive means of creating digital models, allowing the specimens to be virtually removed and rearranged to reveal the skull and brain anatomy. On the inferior surface of the parietal and frontal bones is a mould of the top of the brain, however, the anterior part of the endocast cannot be seen without removing the matrix. The digital reconstruction of these bones reveals a more complete view of the brain including the olfactory bulbs. Reconstruction of the similarly delicate post-cranial elements also allows for further study and display. The partial post-cranial skeleton of *Leaellynasaura* consists of hind limb bones, various vertebrae with ossified tendons, a partial pelvis and the entire tail. It is clear that *Leaellynasaura* had an incredibly long tail, more than twice the length of the body anterior to the pelvis and approximately 13 times the femoral length, and is perhaps one of the longest tails relative to body length of all dinosaurs. An estimate of the body size of this small dinosaur can also be calculated from the skull and post-cranial skeleton by comparison with other known skeletons of the same family. Finally, the synchrotron scans and resulting 3D reconstruction of the skull and post-cranial skeleton provide a unique understanding of the morphology of *Leaellynasaura*, and allow this material to be 3D printed for display.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

VERTEBRATE PALEOPATHOLOGICAL COLLECTIONS FROM RANCHO LA BREA AND A CENTURY OF RESEARCH

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Rancho La Brea has recorded the most complete terrestrial biota from the late Pleistocene of North America. One of the many unique qualities of the fossiliferous asphalt deposits is the preservation of bones that exhibit pathologic conditions. Maladies can be separated into several categories including developmental anomalies, chronic re-injury, arthritic conditions, and traumatic Injury. Developmental conditions range from a relatively benign lack of complete fusion in some bones to potentially fatal (eg., *spina bifida*). Some chronic re-injuries provide provocative evidence of intra- and interspecific conflict and reflect the brutal daily reality of predation. Arthritis comes in many forms which relates to repetitive use and old age. Traumatic injuries (especially those that cripple) may afford rare insight into behavior and social interaction between individuals of an extinct species.

Over the past century, the Rancho La Brea collections have been periodically studied. First to organize and study these materials was the eminent paleopathologist Roy L. Moodie, with 16 publications issued from 1918-1930 which discuss a variety of pathologic conditions found in several extinct species. With reorganization of the collections in the 1980's and after a hiatus of almost 50 years, renewed interest in the pathological materials has produced more publications in the past 30 years. With an estimated 10,000+ specimens in this Rancho La Brea collection subset, there is huge potential for much more paleopathological research.

Technical Session VIII (Thursday, August 24, 2017, 2:00 PM)

'ARCHAIC' PALEOGENE MAMMALS POSSESSED UNIQUE LOCOMOTOR STYLES DISTINCT FROM MODERN FORMS: INSIGHTS FROM MULTIVARIATE ANALYSES

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The diversification of eutherian mammals after the end-Cretaceous mass extinction saw a proliferation of morphologies associated with an array of diets and ecologies. Mammalian faunas of the Paleogene were dominated by 'archaic' taxa, which are characterised by their robust anatomy and tend to lack any obvious extant analogues. Consequently, our comprehension of the early evolution of eutherian ecological diversity and the roles of many 'archaic' mammals remain poorly understood. We use a quantitative approach to investigate the locomotor behaviours of a sample of Paleogene mammals. We compiled a dataset of 20 functionally significant postcranial measurements for ~150 extant mammals and 15 Paleogene taxa which were subjected to a suite of multivariate analyses. Principal Components Analyses arrayed the extant taxa on a multivariate continuum according to locomotor group. The fossil taxa were ordinated in morphospace characterised by short, robust limbs capable of powerful but low-velocity movement and generally fell out of the range of morphospace occupied by extant mammals. The most similar extant mammals to our sample of fossil taxa were slower moving arborealists such as *Arctictis* or fossors such as *Chaetophractus*. Canonical Discriminant Analysis was used to predict the locomotor groups of our fossil taxa and correctly classified 51% of the extant mammals. Misclassifications tended to fit with observed overlap in functional anatomies or locomotor behaviour. Fossil taxa were classified as either semi-fossorial or arboreal, in concordance with their robust morphology. Our results show that extant mammals exhibit a vast repertoire of locomotor behaviours that are inherently difficult to define and classify but which generally conform to predictable functional parameters. 'Archaic' taxa exhibit a distinct and more constrained range of locomotor ability defined by their prevalent robust morphology. However, there are subtle distinctions between 'archaic' taxa indicative of niche partitioning that are not easily comparable to extant mammals. This suggests that, far from being generalized ancestral stock, 'archaic' taxa were experimenting with their own unique locomotor styles. The extinction of many 'archaic' groups at the end of the Paleogene is associated with a trend towards increasingly open habitats, which was less conducive to the survivorship of robust, ambulatory mammals.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW SPECIES AND BODY FORM OF THE LATE CRETACEOUS 'BLUNT-SNOUTED' BONY FISH, *THRYPTODUS* (ACTINOPTERYGII: TSELFATIIFORMES)

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Thryptodus Loomis (Actinopterygii: Tselfatiiformes) is an enigmatic Late Cretaceous bony fish genus characterized by a broad, blunt rostrum formed by generally fused right and left premaxillae, where *T. zitteli* Loomis is currently the only known species of the genus. Whereas the holotype of *T. zitteli*, a nearly complete skull, was destroyed during World War II, all other reported remains are represented by isolated rostra. USNM PAL 22499 and DMNH PAL001108 belonging to the US National Museum of Natural History (USNM), Washington, DC, and the Perot Museum of Nature and Science (DMNH), Dallas, Texas, respectively, are previously undescribed, nearly complete neurocrania of *Thryptodus* from the Britton Formation (Cenomanian – lower Turonian) of the Eagle Ford Shale in Dallas County, Texas. The two skulls exhibit the following characters that are not found in *T. zitteli*: a straight posterodorsal margin of premaxillae incompletely covering the mesethmoid such that the mesethmoid is partially exposed dorsally; an oblong (rather than pyriform) dental plate of parasphenoid; and an anteroposteriorly short sphenotic-prootic-pterotic complex. Thus, the two skulls are interpreted to belong to a new species of *Thryptodus*.

USNM V 21375 is a 4-m-long skeleton of *Xiphactinus audax* (Actinopterygii: Ichthyodectiformes) from the lower Coniacian portion of the Austin Chalk in Fannin County, Texas. It contains a nearly complete skeleton of *Thryptodus* sp. (USNM PAL 606789) as stomach content, offering new information about the post-cranial anatomy of *Thryptodus*. Its standard length, fork length, and total length are ca. 107, 114, and 124 cm, respectively. The pectoral fins are long (ca. 30 cm) and are directed ventrally. The dorsal fin spans nearly 60 cm, about one-half of the total length of the fish, where the longest anterior-most fin rays measures ca. 35 cm. It also preserves the right pelvic fin and anal fin that are also long, measuring ca. 20 cm and 40 cm, respectively. The caudal fin is poorly preserved, but the specimen does indicate that it is forked and measures ca. 23 cm high and 17 cm long. The skeletal anatomy indicates that *Thryptodus* was a sluggish durophagous fish.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

JUVENILE SAUROPOD REMAINS FROM THE LOWER CRETACEOUS OF PHU PENG, KALASIN PROVINCE, THAILAND

SHIMIZU, Ieyoshi, Tsukuba, Ibaraki, Japan; CHANTHASIT, Phornphen, Bangkok, Thailand; SARDSUD, Apsorn, Bangkok, Thailand; KHANSUBHA, Sasidhorn, Bangkok, Thailand; AGEMATSU, Sachiko, Tsukuba, Ibaraki, Japan; SASHIDA, Katsuo, Tsukuba, Ibaraki, Japan

New dinosaur species have been successively reported from terrestrial Mesozoic red-beds of the Khorat Group distributed in northeastern Thailand which is now known as one of the richest dinosaur bearing formation in Asia. Among this dinosaur assemblage, sauropod remains from the Lower Cretaceous Sao Khua Formation are the most abundant. Although most of the sauropod remains were disarticulated, nearly all of them have been assigned to *Phuwiangosaurus sirindhornae* and it has been long believed that the sauropod fauna was dominated by this species. However, recent studies suggested the existence of a different sauropod taxon.

In this study, juvenile sauropod remains from the Sao Khua Formation of the Phu Peng hill (Sahat Sakhan district, Kalasin province) are identified and described. They can be obviously distinguished from *P. sirindhornae* and provisionally named as "Phu Peng Sauropod". This juvenile sauropod, which has been discovered along with few theropod remains and at least three individuals of sauropod including juvenile *P. sirindhornae*, is represented by a left scapula, humerus, and femur. The morphology of the humerus and femur of the "Phu Peng Sauropod" resembles Chinese *Euhelopus zdanskyi*, whereas the scapula is morphologically unique among titanosauriforms from East Asia (the acromial plate expanded weakly; the glenoid faces anteroventrally; the posterior margin of the acromial process gently sloping to face posterodorsally) possibly indicating the "Phu Peng Sauropod" as a new species. On the basis of the scapula and femur morphology (the glenoid faces anteroventrally; the pronounced bulge is present on lateral edge of the proximal one-third of the femoral shaft), the "Phu Peng Sauropod" is presumed to be a member of basal titanosauriformes, less derived than somphospondyli to which most other East Asian sauropods belong, though a precise phylogenetic position is unclear due to the inadequate elements.

In addition to juvenile remains of the "Phu Peng Sauropod", the adult remains are found from other Lower Cretaceous dinosaur sites in Kalasin, which were formerly thought to be *P. sirindhornae*. These facts show that previous attribution of considerable numbers of sauropod remains to *P. sirindhornae* should be reconsidered and the sauropod fauna of this formation is not fully dominated by this species, but rather *P. sirindhornae* and "Phu Peng Sauropod" were coexisted. The ontogenetic variation for appendicular elements is shown to be little in the "Phu Peng Sauropod".

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ANALYSIS OF FOSSIL ENVIRONMENTS REVEALS BIASES IN THE FOSSIL RECORD OF MYSTICETE PRESERVATION

SHIPPS, Brenlee K., George Mason University, Fairfax, VA, United States of America; PEREDO, Carlos M., George Mason University, Fairfax, VA, United States of America; UHEN, Mark D., George Mason University, Fairfax, VA, United States of America

Mysticeti, or baleen whales, are marine mammals that evolved roughly 34 million years ago during the latest Eocene. Modern mysticetes inhabit a wide range of environments, varying annually with seasonal migration patterns, and spanning great distances, temperature gradients, and latitudes. The evolutionary history of mysticete habitats, however, remains poorly understood. While mysticete diversity and abundance is well documented in the fossil record, information on paleoenvironments has proven scarce. Often, this is not due to a lack of information available, but rather because the paleontological literature and lithological literature have not always been examined together. This, in turn, hampers a full understanding of baleen whale evolution.

Here, we remedy these challenges by conducting an exhaustive review of the lithological literature for deposits containing mysticete whale fossils and adding the data into the Paleobiology Database (PBDB). In doing so we consolidate the existing paleontological dataset already present in the PBDB with the novel dataset to generate a complete paleoecological dataset for published collections containing mysticete fossils (approximately 850).

Our results highlight the large number of mysticete fossils known from localities with little or no environmental information. Further analysis suggests a strong association of mysticete fossils with nearshore, coastal environments. Finally, we compare the environmental distribution of extant mysticetes to those in the fossil record across geologic stages, providing commentary on biases and patterns that appear, most notably the tendency towards coastal environments in all but the Serravallian and Piacenzian, which contain significantly more deep water data than other stages. In doing so, we highlight the extent to which near shore environments are overrepresented in the Mysticete fossil record and discuss implications for broad, macroecological studies aiming to utilize this dataset.

Grant Information**:**

Work for this project was funding by the George Mason Undergraduate Research Scholars Program.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

PERISSODACTYLA, NON-RUMINANT ARTIODACTYLA, AND CARNIVORA FROM THE LATE PLEISTOCENE OF TÉRAPA, SONORA, MEXICO

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The paleontological deposit near San Clemente de Térapa represents one of the very few Rancholabrean North American Land Mammal Age sites within northeastern Sonora, Mexico. Fossils are deposited within a shallow basin that formed when basalt from the Moctezuma volcanic field flowed south to Térapa. This basalt flow has been dated to 42.9 ± 3.3 ka and it has been estimated that the basin began to fill with sandy sediment at 40.2 ± 3.2 ka. At that time, grasslands were common in the area while riparian corridors most likely followed local rivers to the Gulf of Mexico. In addition, packrat middens from Sonora suggest that the summers were cooler and drier and the winters were wetter than currently experienced in northern Mexico. Within the Térapa basin, fossils were collected in the early 2000s and more than 60 taxa have been identified, including *Bison, Cuvieronius, Mammuthus, Hydrochoerus, Cynomys, Crocodylus* cf. *C. astutus, Pampatherium* cf. *P. mexicanum*, *Glyptotherium cylindricum* and numerous species of birds. Though many other taxa are present at Térapa, this project focuses on the Perissodactyla, non-ruminant Artiodactyla, and Carnivora that have been previously identified and recorded but not described in detail. Therefore, this research aims to more thoroughly describe the material as well as amend incorrect initial identifications. For example, *Equus* sp. was identified in prior literature, but further examination reveals two distinct morphotypes based on dentition. Discriminant Function Analysis of equid postcrania will determine with which of the morphotypes the elements are associated. Artiodactyls include *Palaeolama* sp., cf. *Camelops*, and *Platygonus* sp., and Carnivorans include *Canis dirus*, *Lynx rufus*, *Procyon lotor*, and the first record of *Smilodon fatalis* from the site. These Térapa mammals provide a more thorough understanding of the Rancholabrean of northern Mexico.

Technical Session XVIII (Saturday, August 26, 2017, 9:30 AM)

BURNETIAMORPHS DID IT FIRST: CRANIAL ADORNMENT AND RATES OF SPECIATION IN A PERMIAN LINEAGE OF THERAPSIDS

SIDOR, Christian A., University of Washington, Seattle, WA, United States of America; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States of America; NESBITT, Sterling J., Virginia Tech, Seattle, WA, United States of America; PEECOOK, Brandon, Field Museum, Seattle, WA, United States of America; SMITH, Roger M. H., Iziko South African Museum, Cape Town, South Africa; TABOR, Neil J., Southern Methodist University, Dallas, TX, United States of America; TOLAN, Stephen, Chipembele Centre, Mfuwe, Zambia; WHITNEY, Megan, University of Washington, Seattle, WA, United States of America

Among therapsids, biarmosuchians are generally regarded as rare members of the Permian assemblages in which they occur. Despite their relative scarcity, with fewer than 30 specimens known worldwide, the biarmosuchian subclade Burnetiamorpha was remarkably diverse, with eleven species currently recognized and at least two additional species awaiting formal description. Moreover, the subclade was broadly distributed, as burnetiamorph fossils are known from at least six sedimentary basins spanning the northern (Russia) to southern regions of Pangea (Malawi, South Africa, Tanzania, and Zambia). Burnetiamorpha was among the first tetrapod clades to develop bony horn-like processes and crests, which in other extinct tetrapod lineages have been considered characteristics enhancing species recognition or mate competition (e.g., ceratopsid dinosaurs). One prediction made by the hypothesis linking diversity and cranial adornment is that a clade with adorned species should be relatively more speciose than a closely-related, but unadorned clade, with similar ecology. We compared the relationship between the taxonomic diversity and abundance of burnetiamorphs to other clades of Permian therapsid carnivores as a preliminary test of the hypothesis that conspicuous cranial adornments are correlated with enhanced rates of speciation. Compared to Permian gorgonopsians and therocephalians from southern Pangean assemblages, Burnetiamorpha has a much higher percentage of species to specimens recovered. This pattern emerges within individual sedimentary basins and as a global aggregate. Burnetiamorpha was thus more speciose than would be expected based on its comparatively small sample size. A more in-depth analysis of cranial adornment and its relationship to speciation needs to address the function of the horns and crests in burnetiamorphs. Preliminary histological thin-sections of the skull roof of a small, presumably juvenile burnetiamorph display anatomy similar to that seen in pachycephalosaurid dinosaurs, with two patterns of bone deposition present. The deepest part of the frontals and parietals is formed by compact bone whereas most of the pachyostotic dome is cancellous and features a pattern of radiating trabeculi. The evolution of numerous, fast-growing cranial adornments may also imply an elevated metabolic status for this group of early therapsids.

Grant Information:

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Romer Prize Session (Thursday, August 24, 2017, 9:30 AM)

THE ORIGIN AND EARLY EVOLUTION OF LEPIDOSAURIAN REPTILES

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Lepidosaurian reptiles comprise one of the most diverse groups of tetrapods with almost 10,000 living species of squamates (lizards and snakes) and sphenodontians (represented by a single living taxon: *Sphenodon*), with both lineages estimated to have originated during the Early Triassic. However, the origins and early radiation of lepidosaurs remain largely enigmatic by several factors, including: the oldest unequivocal fossils currently attributed to the Squamata are from the Middle Jurassic; available studies of broad level/deep-time diapsid reptile relationships provide very limited sampling of either fossil or living lepidosaurs (often, Squamata being represented as a single terminal unit); morphological and molecular evidence of squamate relationships disagree on what is the earliest squamate clade (iguanians vs dibamids and geckoes); among others.

Here, I provide a new phylogenetic dataset with a deep sampling of the major diapsid and lepidosaurian lineages (living and fossil) at the species level in order to identify the composition and early evolution of lepidosaurs. All taxon scorings were based on personal observation of specimens and/or 3D CT scans from 51 collections from around the world, making it the largest species sample ever collected for investigating the origin of lepidosaurs—over 150 species. It also implements rigorous criteria for character construction in order to avoid biological or logical biases in the morphological dataset. I applied multiple methods of phylogenetic investigation: maximum parsimony, maximum likelihood, and Bayesian inference (non-clock and clock based analyses using total evidence dating) with and without molecular data, and testing for performance improvement by the partitioning of morphological data.

The results indicate novel relationships among diapsids and re-shape the lepidosaurian tree of life. Previously proposed early lepidosaurs are found to belong to other lineages of reptiles. Importantly, heretofore unrecognized squamate fossils are found as the earliest squamates, dating back to the Early Triassic, thus filling what was thought to be a fossil gap of at least 50 million years. In most results (morphology only and combined data) geckoes are the earliest squamate crown clade, iguanians are always found as later evolving squamates, and scincomorphs are polyphyletic, thus dramatically differing from previous morphology based studies, but agreeing with the molecular data.

Grant Information:

The Vanier Canada Graduate Scholarship and the Izaak Walton Killam Memorial Scholarship provided PhD scholarships to T. Simões.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A SMALL-BODIED *FUMICOLLIS*-LIKE HESPERORNITHIFORM FROM THE HELL CREEK FORMATION OF MONTANA

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Hesperornithiformes is a clade of flightless diving birds known from localities spanning the Cretaceous of North America, Europe, and Asia. The majority of hesperornithiform specimens are found in marine sediments of the Western Interior Seaway of North America. However, a sparse record of these animals is also present in terrestrial fluvial sediments, indicating that some species inhabited freshwater or brackish estuary systems in addition to marine ecosystems. Here we describe four previously undocumented femora of a non-hesperornithid hesperornithiform from the terrestrial Hell Creek Formation of Montana, two of which are virtually complete. All specimens are approximately the same size, have well-developed muscle scarring, and a smooth outer cortex, suggesting they represent skeletally mature individuals. The femora are characterized by a gracile morphology, with a length to mid-diaphysis width ratio of 7.5. In lateral view, the femur is strongly curved, with the proximal and distal ends offset posteriorly relative to the mid-diaphysis. Proximally, the trochanteric ridge is present, and, as in other hesperornithiforms, the distal lateral condyle is laterally expanded. Morphologically, the Hell Creek femora are most similar to *Fumicollis* from the Niobrara chalk, and are distinguished from *Baptornis* by a flattened distal surface of the lateral condyle, the constrained arc of the femoral trochanter, higher degree of antero-posterior curvature, and narrowing along the distal lateral shaft into the lateral condyle. Preliminary phylogenetic analysis posits that the taxon represented by the new femora is a non-hesperornithid hesperornithiform that is the sister taxon to the least inclusive clade containing Brodavidae and Hesperornithidae. Unfortunately, none of the four hesperornithiforms previously documented for the Hell Creek Formation and equivalent

units (*Potamornis skutchi*, *Brodavis americanus*, Hesperornithiformes A and B) preserve femoral material, making taxonomic referral of the new femora difficult. However, these new specimens provide detailed phylogenetic information that expands knowledge of hesperornithiform diversity in the latest Maastrichtian, just prior to the Cretaceous-Paleogene extinction event.

Preparators' Session (Thursday, August 24, 2017, 10:15 AM)

THE NULLARBOR SWAT TEAM PROJECT: ADDRESSING COLLECTIONS BACKLOGS

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Over the past five years Field Museum's vertebrate paleontology staff has focused on addressing persistent backlogs, particularly in the fossil mammal collection. The most recent effort involves a strategy we call the "Swat Team" approach to work on collections whose specimens we cannot easily identify with in house expertise. This concept was used on a small scale in the extant mammal collections, and we have completed the first large scale application of this method at Field Museum. The tactic has two components; an outside expert to provide identifications, and a short term team of collections staff to process the newly identified fossils. The target of this project was a collection of thousands of small mammals from Quaternary owl pellet deposits in a series of caves of the Nullarbor Plain in southern Australia. In 1955, and 1964-65 Ernie Lundelius and Bill Turnbull made collections in the Nullarbor Plain caves, but published a series of papers only on the Madura Cave. Most specimens from the other caves were still in bulk storage, taking up room, but no use to science in that state. We found our expert in Matt Macdowell of Flinders University who came to Chicago for six months from March to November, 2016 and identified approximately 20,000 rodents and small marsupial specimens including mostly unprocessed specimens. A team of five paid summer interns created 11,098 new catalogue records. This processing included electronic cataloguing, numbering specimens, printing specimen labels, packaging specimens in gelcaps and vials, arranging in drawers, and creating drawer labels. One intern took high resolution photos of all specimens, but this aspect took another three months to finish. These specimens document the pre-European small mammal fauna of the Nullarbor, and are now available for studies including "paleo-conservation" work to restore these faunas to the extent possible.

Grant Information:
This work was supported by an Endeavour Fellowship to Dr. Matthew McDowell, and Bass Scholarship funds, and a Negaunee Grant to William Simpson

Technical Session X (Friday, August 25, 2017, 8:45 AM)

RED IN TOOTH AND JAW: MANDIBULAR MORPHOLOGY REVEALS POSSIBLE INTRINSIC PRESSURES ON ARCHOSAUROMORPH TROPHIC EVOLUTION THROUGH THE EARLY MESOZOIC

SINGH, Suresh, University of Bristol, BRISTOL, United Kingdom; ELSLER, Armin, University of Bristol, Bristol, United Kingdom; STUBBS, Tom, University of Bristol, Bristol, United Kingdom; BENTON, Michael J., University of Bristol, Bristol, United Kingdom

The radiation of the Archosauromorpha in the Triassic helped re-establish stable ecological dynamics following the end-Permian extinction, and established archosauromorph-dominated faunas that fostered the rise of dinosaurs. However few quantitative studies of the radiation exist, and attention has focused instead on dinosaur and pseudosuchian evolution in the later Triassic. Furthermore, previous work has disregarded the connections between the two events.

Here we provide an extensive, eco-morphological study of archosauromorph macroevolution through the Triassic and Early Jurassic. We apply geometric morphometric and multivariate, comparative phylogenetic methods to infer patterns of trophic ecology and evolution from the mandibular morphology of 160 archosauromorph genera.

We identify a novel and recurring trend of archosauromorph morphospace occupation; the expansion accompanying cladogenesis is typically "at the expense" of older clades, with new clades infiltrating the morphospace of pre-existing clade(s), eventually displacing them. We also recover substantial reductions in mandibular disparity and rates of evolution during the end-Triassic extinction event, and find later dinosaur success is based on the loss of pseudosuchian diversity during this extinction. Furthermore, we find considerably high rates of mandibular evolution within pterosaurs, phytosaurs and rhynchosaurs, highlighting their atypical mandibular anatomies as key innovations that assisted their radiations into new eco-space.

Our results reveal a complex picture of archosauromorph trophic evolution involving both biotic and environmental factors. We find evidence for an extrinsic driver for the rise of the dinosaurs, but suggest there were some intrinsic pressures on trophic evolution in the Early-Middle Triassic, indicating that intrinsic factors may have played a greater role in driving archosauromorph macroevolution than previously thought.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

ONTOGENETIC CHANGES IN BONE TISSUE OF *SAUROLOPHUS ANGUSTIROSTRIS* (DINOSAURIA: ORNITHISCHIA) FROM THE LATE CRETACEOUS OF MONGOLIA

SLOWIAK, Justyna, Institute of Paleobiology Polish Academy of Sciences, Warsaw, Poland; FOSTOWICZ-FRELIK, Lucja, Institute of Paleobiology Polish Academy of Sciences, Warsaw, Poland; GINTER, Michal S., University of Warsaw, Warsaw, Poland

Late Cretaceous *Saurolophus angustirostris*, frequent in the Nemegt Formation of Mongolia, was one of the largest hadrosaurs. Several skeletal elements (the scapula, humerus, ulna, radius, metacarpal, femur, tibia, fibula, and rib) of eight individuals at various ontogenetic stages were sectioned for this study, and examined under light and scanning electron microscopes. The long bone compacta of young individuals (less than 50% of adult size) is composed of the fibrolamellar complex. This highly vascularized tissue expresses growth cycles marked by changes in vascularization pattern; lines of arrested growth (LAGs) occur only in the fibula. The secondary remodeling in young individuals is poorly developed, especially in larger skeletal elements (the scapula or humerus), whereas it becomes denser in smaller bones such as the radius, which shows a great abundance of overlapping secondary osteons. The compacted coarse cancellous bone, with the large content of the endosteal lamellar bone was formed in all bones in the perimedullar region. In older individuals (80% of adult size) the secondary remodeling is also most extensive in smaller elements, where LAGs are sparse but well discernible. Larger bones, such as the humerus or femur, show large erosion cavities in the deep cortex; secondary osteons are abundant but not as densely packed as in smaller bones (e.g., the radius or fibula). LAGs have not been preserved in the large bones sampled by us. The most external cortex of an adult femur displays the lamellar bone matrix; however, the tissue is sparsely longitudinally vascularized and external fundamental system (EFS) was not formed. The presence of fibrolamellar complex indicates a rapid growth typical of large dinosaurs (including hadrosaurs). However, the long bones of *Saurolophus* are much more vascularized than those of *Maiasaura* and show the periodical changes in this condition, similar to those recognized in young *Apatosaurus*, a diplodocid. The scarcity of LAGs and a weaker remodeling in large bones resemble *Edmontosaurus*, a genus matching *Saurolophus* in size (while *Maiasaura* was only half-size of either of them). Our observations suggest that the growth rate and intensity of bone remodeling in hadrosaurs is strongly related to the definite size of an animal. The largest taxa maintained rapid bone growth longer in ontogeny, and the remodeling intensified after individuals reached ca. 50% of an adult size.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE FIRST VERTEBRATE BODY FOSSILS FROM THE CARBONIFEROUS-PERMIAN MAROON FORMATION, COLORADO, USA

SMALL, Bryan J., Texas Tech University, Lubbock, TX, United States of America; PARDO, Jason D., University of Calgary, Calgary, AB, Canada; LUNGMUS, Jacqueline K., University of Chicago, Chicago, IL, United States of America; DOUGLASS, Robert J., Natural History Museum of Utah, Sandy, UT, United States of America; SCHLOTTERBECK, Tyler, South Dakota School of Mines, Rapid City, SD, United States of America; HUTTENLOCKER, Adam K., University of Southern California, Los Angeles, CA, United States of America

The Carboniferous-Permian record of southwest USA has been crucial to understanding the terrestrialization of western Pangean ecosystems following the collapse of coal swamp forests. The Maroon Formation of Eagle Basin, Colorado, is a thick sequence (up to 4,500 m) of nonmarine redbeds deposited in a subsiding cratonic basin bounded by the ancestral Front Range and Uncompaghre Highlands. The formation is dominated by fluvial, arenaceous eolian, and loessite deposits. Radiometric dates of zircons from the loessite from the depocenter suggest an Early Permian source, so that deposition of the Maroon Formation was likely concurrent with some classic vertebrate sites of the Cutler Group elsewhere in the southwest USA. Finer-grained units contain footprints of amphibians, diadectomorph stem-amniotes, and synapsids, resembling coeval Permian ichnoassemblages of the Cutler Group and Tambach Formation, Germany.

Here, we report a new, predominantly aquatic vertebrate assemblage from two limestones near the base of the Maroon Formation on the Colorado River near Derby Junction. The limestones, each approximately 30-60 cm thick, contained extensive algal mats that entrapped and preserved tiny invertebrate (spirorbid worms and myalinid bivalves) and vertebrate remains, most likely in a brackish lagoonal or backwater lacustrine setting. Vertebrates contrast with the ichnofauna, comparing more closely to those of aquatic Carboniferous sites that are stratigraphically lower than the Cutler. Vertebrates include teeth and fin spines of xenacanthid and hybodont sharks; platysomid toothplates; an associated skeleton of cf. *Progyrolepis*; toothplates of sagenodontid lungfish; an amphibamid temnospondyl with affinities to *Amphibamus* and *Doleserpeton*; and isolated vertebrae and limb bones of likely amniote affinity. The fish assemblage preserves similarities with the Kinney Brick Quarry assemblage (Carboniferous Atrasado Formation, New Mexico), including cf. *Progyrolepis* and a lungfish that resembles *Sagenodus hlavini*.

The limestone units in the lower Maroon may represent widespread semipermanent wetland ecosystems during periodic wet intervals or interglacial highstands. In combination with the associated dryland redbed ichnoassemblage, the preservation of a persistent but rare aquatic wetland in a predominantly terrestrial sequence shows the potential of revealing undersampled aquatic relicts in an early Permian continental ecosystem.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW MARINE VERTEBRATE ASSEMBLAGE FROM THE WILSON GROVE FORMATION AT BLOOMFIELD QUARRY (LATE MIOCENE), SONOMA COUNTY, CALIFORNIA

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A relatively diverse assemblage of at least 17 vertebrates (three species of sharks, three genera of teleost fishes, nine marine mammals, and at least two species of bird) is reported from the basal Wilson Grove Formation in a small quarry just north of the town of Bloomfield in Sonoma County, California. The vertebrate, as well as associated invertebrate, assemblages suggest intertidal to shallow subtidal water depths and water temperatures interpreted from the fauna are consistent with the latitude of the fossil locality (37°N) during the late Miocene. A single Sr isotope age determination of 7.92 Ma is consistent with other age determinations bounding the deposits and with interpretations based on vertebrate and invertebrate biostratigraphic data. The age of these vertebrate remains facilitates comparisons with better-known Miocene vertebrate assemblages from other parts of western coastal North America. The ichthyofauna is indicative of the relatively recent northeastern Pacific assemblages that originated in the late Miocene, and each of the species of sharks (*Hexanchus griseus, Cetorhinus maximus, Isurus oxyrhynchus*) and genera of bony fishes (*Sardinops, Merluccius, Sarda*) collected at this site, are still found in California coastal waters. The marine mammals from this location include the most diverse walrus assemblage yet reported in the world, including

Dusignathus santacruzensis, *Gomphotaria pugnax*, *Imagotaria* sp., cf. *Pontolis*, and Odobeninae indet. Indeterminate odontocetes, balaenopterid and herpetocetine mysticetes, and an indeterminate hydrodamaline sea cow are also reported. The marine mammal assemblage has affinities with those from the Capistrano, Purisima, and San Mateo formations of California. Bird remains are reported from the Wilson Grove Formation herein for the first time. There are at least two species of bird represented by five specimens from the Bloomfield Quarry location. These specimens have been referred to Aves indet., Pan-Alcidae indet., Mancallinae indet., and cf. *Uria brodkorbi.* The combination of precise chronological age and detailed knowledge of both vertebrate and invertebrate assemblages from Bloomfield Quarry provide a rare snapshot of the shallow marine ecosystem of northern California during the late Miocene.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MANGANESE OXIDE PERMINERALIZATION IN DINOSAUR BONE AT THE JURASSIC-CRETACEOUS BOUNDARY OF CENTRAL UTAH

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Manganese oxides are rare in terrestrial deposits, but more commonly occur as nodules that form under specific conditions of temperature, pressure, pH, and dissolved oxygen associated with abyssal plain deposits of ocean basins. Thus, manganese oxides are rarely associated with fossilization of vertebrate remains.

Micro-scale mineral mapping (QEMSCAN) of dinosaur bone from the lag gravel deposits at the unconformable contact between the Upper Jurassic Morrison and the Lower Cretaceous Cedar Mountain formations contain pyrolusite (MnO_2) in vascular canals and lamellae. Reflected light microscopy reveals that the mineral has weak coloration, weak pleochroism, strong anisotropy, a moderate polishing hardness, and lacks internal reflections. Reflected light microscopy confirms that the mineral species is pyrolusite, an orthorhombic manganese oxide. This locality was even evaluated as a potential source for manganese ore during World War II, illustrating the extensive manganese oxide constituent in these deposits locally at the Jurassic-Cretaceous boundary.

These results provide geochemical evidence for the depositional conditions of the terrestrial Jurassic-Cretaceous boundary in central Utah. Aqueous solution equilibria indicate that the mineral species in the vascular canals and lamellae formed at surface and temperature conditions. The same mineral phase equlibiria indicate the precipitation of pyrolusite in vascular canals and lamellae of the bone occurred at a high pH (+8) and under low dissolved oxygen level. These conditions are consistent with deposition in highly evaporative environments like paleosols and hypersaline alkaline playa lakes, often involving anaerobic respiration by communities of bacteria and archeans.

Grant Information:
Office of Undergraduate Research, University of Utah
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

TUSK MORPHOLOGY IN THE VALLEY OF THE MASTODONS (CALIFORNIA, USA): ARE WESTERN MASTODON TUSKS DISTINCTIVE LIKE WESTERN MASTODON MOLARS?

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American mastodons (*Mammut americanum*) represent ~20% of the large mammals from the Diamond Valley Lake Local Fauna (DVLLF), the largest non-asphaltic, Late Pleistocene terrestrial vertebrate assemblage in southern California. Recent research has shown that mastodons from western states (CA and ID) exhibit relatively narrow molar crowns. In these individuals, including almost all DVLLF specimens, crown length regularly exceeds crown width by a factor of two for third lower molars. DVLLF proboscidean material includes at least 15 mastodon tusks, 6 Columbian mammoth (*Mammuthus columbi*) tusks, and 17 tusks of uncertain affinity. The goal of this study is to conduct a morphological description of the DVLLF mastodon tusks in order to continue exploring skeletal proportions that may be unique to western mastodons. Documenting regional differences among mastodon populations may facilitate understanding of how these megafauna responded to changing conditions at the end of the Pleistocene.

Measurements of length, circumference, and pulp cavity depth were collected from each DVLLF tusk, when possible, then compared to values in the literature. Maximum tusk circumference (MTC), either directly measured or calculated from diameter, is currently the most informative measurement for DVLLF mastodons because it could be collected on the majority of tusks and can be used to discriminate between sexes. In addition, larger tusks belong to older mastodons, so MTC can be used to broadly estimate the ontogenetic stage of an individual. Preliminary results indicate that all 15 mastodon tusks belong to adult males. Of the 17 tusks of uncertain affinity, 4 are likely adult females, 12 are likely adult males, and one falls between the MTC ranges for each sex, indicating that it is either a juvenile male or a female of advanced age. Tusk morphology could not be used to discriminate between proboscidean species, but efforts to identify species based on tusk microstructure are underway.

Maximum tusk circumference values for DVLLF mastodons are not unusual, but there are some indications that DVLLF mastodons have relatively short tusks. For example, Diamond Valley Lake specimen WSC 18743, one of the largest mastodons from California, has a complete right tusk that does not appear to be unusually worn at the tip, yet is substantially shorter than tusks of mastodons of roughly equivalent age.

Technical Session XIX (Saturday, August 26, 2017, 2:15 PM)

NEW INFORMATION ON THE THEROPOD DINOSAUR *CRYOLOPHOSAURUS ELLIOTI* FROM THE EARLY JURASSIC HANSON FORMATION OF THE CENTRAL TRANSANTARCTIC MOUNTAINS

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The crested theropod, *Cryolophosaurus ellioti*, was discovered in the Early Jurassic Hanson Formation (~194 Ma) of the Central Transantarctic Mountains. Excavations in 1991 recovered the skull, numerous vertebrae, and appendicular elements. Originally described as an allosauroid, recent phylogenetic analyses recovered *Cryolophosaurus* as either a basal member of Tetanurae, or outside a Ceratosauria + Tetanurae clade, often allied with several Early Jurassic coelophysoids. These three hypotheses posit markedly different patterns of theropod evolution, with the former two implying more ghost lineages and rapid diversification in the Early Jurassic. We describe new material of *Cryolophosaurus* collected in 2010-11, newly prepared specimens, and CT scans of the skull. This includes a second *Cryolophosaurus* braincase and two left fibulae, demonstrating the presence of at least two individuals in the quarry. The new specimens and insights reveal a mosaic of character data, with traits of the braincase (e.g., leaf-shaped parasphenoid, grooved along dorsal and ventral edges; pneumatic occipital condyle) present in basal tetanurans (e.g., *Allosaurus*, *Dubreuillosaurus*); whereas two vertebral traits (posterior cervical neural spine tables expanded into a distinct bowtie-shape; mid-caudals with low lateral ridges extending between the transverse processes and prezygapophyses) are shared with *Dilophosaurus*. Pectoral girdle features (e.g., short scapular acromion process set at oblique angle to blade; short, rounded ventral process of coracoid; swollen coracoid tubercle extending as oblique ridge) are similar to *Dilophosaurus* and coelophysoids; whereas hindlimb traits (e.g., thick fibular crest of tibia, which extends as low ridge to proximal end; oblique crest on lateral face of cnemial process; broad, shallow medial fossa of fibula; elongate, obliquely oriented iliofibularis tubercle of fibula) are shared with *Dilophosaurus* and several basal members of Ceratosauria and Tetanurae. These anatomical data argue against allosauroid affinities of *Cryolophosaurus*, but also introduce character conflict both supporting and contradicting the two alternate hypotheses of relationships. New phylogenetic datasets that sample taxa comprehensively from early dinosaurs and theropods, as well as basal members of Ceratosauria and Tetanurae, will be required to resolve the phylogenetic relationships of *Cryolophosaurus* with more confidence, and thus provide insight into patterns of theropod diversification during the Early Jurassic.

Grant Information:
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Technical Session XVII (Saturday, August 26, 2017, 10:15 AM)

EARLY MAMMALIAN FAUNAL RECOVERY FOLLOWING THE CRETACEOUS-PALEOGENE MASS EXTINCTION EVENT IN MCGUIRE CREEK, MONTANA, USA

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The changes in mammalian faunal composition and structure following the Cretaceous-Paleogene (K-Pg) mass extinction are central to understanding not only how terrestrial communities recovered from this large-scale ecological perturbation, but also the early evolution of archaic groups leading to extant mammalian clades. Previous studies of mammalian faunas following the K-Pg mass extinction have investigated recovery on continent-wide scales over millions of years, or focused on faunas right after the mass extinction and ca. 300 Ka later, potentially missing processes occurring during the earliest part of the recovery. Here, we tracked and analyzed changes in mammalian local faunas during the earliest phase, on a restricted spatiotemporal scale. We compiled a sample of 229 mammalian specimens from four localities spanning 45 meters of the Tullock Formation in the McGuire Creek area of McCone County, Montana, and placed these localities into a high-precision chronostratigraphic framework using $^{40}Ar/^{39}Ar$ tephra ages and magnetostratigraphic data. The sample consists of three local faunas: Z-Line, which comprises two localities from between 66.04 Ma (K-Pg boundary) and 66.01 Ma, and Luck O Hutch and Coke's Clemmys, each of which comprises a single locality from between 66.01 and 65.75 Ma. We used faunal composition, dominance, heterogeneity, shareholder quorum subsampling, and rarefaction to assess ecological structure in each local fauna and quantitatively compare local faunas through time.

Our results indicate that between the earliest post-K-Pg Z-Line local fauna and the two younger local faunas, at least four new mammalian genera appeared, including the multituberculate *Cimexomys* and a likely member of the plesiadapiform genus *Purgatorius*; raw species richness nearly doubled, from 6 species in Z-Line to 11 species in Luck O Hutch and 10 species in Coke's Clemmys; and metatherians fell from 10% to 0% of specimens. Interestingly, at least three metatherian specimens from Z-Line may represent taxa usually only found in the Cretaceous. These results show that within the first 250 Ka of the biotic recovery, mammalian local faunas were undergoing rapid changes and moving towards pre-K-Pg-extinction levels of taxonomic richness and heterogeneity, but there also may have been some low level of holdover of latest Cretaceous taxa into earliest post-K-Pg-extinction faunas. Our results further underline the merits of examining biological processes in the fossil record at ecologically relevant scales whenever possible.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A PECULIAR FISH JAW WITH MOLARIFORM TEETH FROM THE EARLY EOCENE OF TADKESHWAR MINE, INDIA HIGHLIGHTS DIVERSITY AND EVOLUTION OF EARLY GYMNODONT TETRAODONTIFORMS

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Excavations during 2015 at a channel deposit in the early Eocene Cambay Shale Formation of the Tadkeshwar open cast lignite mine near Vastan in Gujarat Province, western India, have yielded terrestrial mammals, lizards, snakes, frogs, and birds as well as a few marine/brackish-water animals, predominantly teeth of the shark *Physogaleus* and *Myliobatis* rays. Among these is a jaw of an unusual teleost.

This lower jaw of a gymnodont has fused dentaries, lacks a beak, and shows a remarkable series of teeth that are unique among all known fossil and living Tetraodontiformes. The teeth are molariform with raised "spokes" radiating inward from the emarginated peripheral edge of the crown. Tooth development is intraosseous, with new teeth developing in spongy bone before they erupt and attach to the dentary by pedicels. Although many of the 110 tooth loci in the fossil specimen have lost their teeth, in life the teeth would have grown to fit tightly together to form a broad and continuous crushing surface.

The estimated age of the early Eocene Cambay Shale vertebrate fauna is ca. 54.5 Ma, making the jaw the second oldest confirmed gymnodont fossil. Comparisons to extant taxa of gymnodonts with fused dentaries (e.g., *Diodon*, *Chilomycterus*, and *Mola*) offer few clues about evolutionary relationships of the new fossil. Although the fused dentaries suggest affinities to diodontids and molids among living tetraodontiforms, it remains challenging to interpret phylogenetic relationships of the new Indian gymnodont because no living or fossil tetraodontoid has similar tooth morphology. We describe it as a new genus and species, and place it in its own new family of Gymnodontes.

Grant Information:
National Geographic Society, Leakey Foundation, Belgian Science Policy Office, Tontogany Creek Fund, National Science Foundation, Wadia Institute of Himalayan Geology.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

EMBRYONIC DEVELOPMENT AND EVOLUTION OF THE AVIAN SKULL

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In the lineage of dinosaurs leading to modern birds, the skull underwent notable transformations, changing in shape, size and number of separate recognizible elements. Traditionally, two elements surrounding the orbit are seen as lost during this evolutionary transition. The prefrontal bone, limiting the anterodorsal margin of the orbit, is assumed to be lost within Maniraptora accompanied by the acquisition of a T-shaped lacrimal. The postorbital, limiting the posterodorsal edge of the orbit and separating the temporal fenestrae, is seen as disappearing within Euornithes, making the temporal fenestrae and the orbit confluent.

By studying the embryological development of the skull in different groups of modern archosaurs, we found the persistence of these lost elements as individual ossification centers, that nevertheless fuse to other bones. A prefrontal ossification develops in the Chilean tinamou but in no Neognath, and fuses to the nasal, while a postorbital center was found in three neognaths fusing to the frontal bone.

We revisited the fossil record and found that cases of reappearing elements support the notion of persistent ossification centers in the embryological period. Particularly, we see the presence of a separate prefrontal element in specimens of Deinonychus, Archaeopteryx and a juvenile enantiornithine as convincing evidence of the persistence of those so-called lost elements, revealing the evolutionary history of the theropod skull, and the developmental malleability of the bones conforming it.

Grant Information:
Fondecyt 1150906

Technical Session XIII (Friday, August 25, 2017, 1:45 PM)

COUNTERSHADING AND STRIPES IN *SINOSAUROPTERYX* REVEAL HETEROGENEOUS HABITATS IN THE JEHOL BIOTA

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Countershading is one of the most ubiquitous camouflage strategies in modern animals. Masking the three-dimensional shape of the body by reducing self-shadowing decreases conspicuousness in most habitats, helping to avoid detection by predators and prey. The optimal pattern of the transition from a dark dorsum to light ventrum is dictated by the lighting environment, which is in turn dependent upon habitat. Applying these principles, we describe the pattern of countershading in the theropod dinosaur *Sinosauropteryx* from the Early Cretaceous Jehol Biota of Liaoning, China. From reconstructions based on exceptional fossils, the colour pattern is compared to predicted optimal countershading transitions based on 3D reconstructions of the animal's abdomen imaged in different lighting environments. Reconstructed patterns match well with those predicted for animals living in open habitats. Jehol is presumed to have been a predominantly closed forested environment which is also evident from countershading gradients in the ornithischian, *Psittacosaurus*, however our results indicate a heterogeneous range of habitats explored by dinosaurs the vicinity of the Jehol lakes. In addition to a striped tail we also note that *Sinosauropteryx* exhibits a 'bandit mask', which is a common pattern in many living vertebrates.

Grant Information:
Natural Environment Research Council (Ph.D grant NE/L002434/1).

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DEVELOPMENTAL AND PHYLOGENETIC ORIGINS OF THE LATEROSPHENOID IN CROCODYLIANS

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The anterolateral region of the brain is protected by a structure that has received different names in various groups of tetrapods due to the uncertainty of its homology. The bone in this region of the braincase was named laterosphenoid in crocodylians, and it was used later to designate the same structure in all extinct archosaurs. Developmentally, this bone is said to represent the ossification of the pila metoptica, with some contribution of the pila antotica. Analysis of the laterosphenoid of the archosauriform *Euparkeria* indicates that more embryonic cartilages may be present in the formation of the laterosphenoid, namely the taenia medialis and part of the planum supraseptale. The latter is known to remain cartilaginous in living crocodylians, but nothing is known about the participation of the taenia medialis. This led to the formulation of the hypothesis that the laterosphenoid of pseudosuchians degenerated at some point in the evolutionary history of the group, resulting in the comparatively reduced bone of extant crocodylians. Preliminary tests were made in three embryos of *Caiman yacare* of selected stages, in order to identify which cartilages form the laterosphenoid. They were stained with a 2% iodine solution for six weeks and subjected to micro-computed tomography scanning. Results show the embryonic membranes enclosing the anterolateral region of the braincase, but there were no signs of ossification by the age of 33 days. A small centre of ossification was found anterior to the gasserian ganglion of the trigeminal nerve in the embryo with 42 days, and was identified as corresponding to the pila antotica. By 53 days, the centre is significantly more developed, extending dorsally up to the trochlear nerve as a thin sheet. There were no signs of ossification of the pila metoptica ventrally, nor of the taenia medialis dorsally. A survey of the fossil record for comparison with preserved laterosphenoids was not immediately successful, as most of the braincases are incomplete in this region. All known laterosphenoids seem to be generally similar to the one of *Euparkeria*, although the presence of the taenia medialis could not be yet discarded. The exception is the notosuchian *Simosuchus*, whose laterosphenoid is markedly shorter. Next steps of this project include refinement of the embryonic series, focusing in older embryos as the taenia medialis could be a late ontogenic acquisition. Also, selected fossils will be scanned to confirm the anatomy of this structure.

Grant Information:
CNPq - Conselho Nacional de Desenvolvimento Científico e Tecnológico (PDJ 152087/2016-8)

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

REASSESSING THE BIOCHRONOLOGY OF KENNEWICK ROADCUT (WASHINGTON, USA) USING ARVICOLINE RODENTS

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Kennewick Roadcut (KRC) is located in the southeastern portion of Washington state. This locality holds an exceptional collection of Pleistocene-aged fossil remains, KRC potentially represents a chronological sample of nearly continuous deposition over the last two million years. If this is the case, then KRC has the potential to serve as an important geographic comparison to other western North American Pleistocene localities. While the site has approximately 15,000 small mammal bones it has been impossible to provide absolute dates to the sedimentary layers as well as the specimens. Previous researchers used the extensive collection of arvicoline rodents to provide a biochronology for the locality. Unfortunately, the initial biochronology was based on the presence of *Lemmiscus curtatus*, at the bottom of the stratigraphic section. Since this original study, *L. curtatus* has been found in multiple fossil localities that date much older than originally thought. This calls into question the dates associated with the biochronology. Here, we evaluate specimens identified as belonging to the genus *Microtus*. *Microtus* specimens are the most abundant group in the base of KRC, and are not seen again past these first few beds of sediment.

Specimens have a variable number of enamel triangles, predominantly seven enamel triangles (24 of 25 specimens). Triangles three and four are confluent with one another across (96% of specimens). Triangles six and seven are confluent with one another (96% of specimens). These characters compare favorably with previously described fossil arvicoline rodents, from North America. This sample and study allows continued investigation and comparison with named fossil arvicoline rodents to further refine the biochronology of Kennewick Roadcut.

Technical Session VIII (Thursday, August 24, 2017, 2:15 PM)

NEW FOSSILS OF PAROXYCLAENIDS (PLACENTALIA, MAMMALIA) FROM THE EARLY EOCENE OF FRANCE SHED LIGHT ON THE ORIGIN AND EVOLUTION OF THESE ENDEMIC EUROPEAN MAMMALS

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Paroxyclaenidae is an enigmatic archaic group of middle size placental mammals. They are known only from Europe, and are recorded from the early Eocene (Ypresian) to the middle Eocene (Bartonian). Paroxyclaenids are divided into two distinct subfamilies: Paroxyclaeninae and Merialinae. They have been variously placed by different authors in Carnivora, Creodonta, 'Condylarthra', and Insectivora, but are considered since 1970's as members of Pantolesta.

The dentition of paroxyclaenids is complete (4 premolars, 3 molars); it is highly specialized, with relatively enlarged posterior premolars, spaced out cheek teeth, but

primitive, for instance, in the absence of hypocone on upper molars. The molars decrease in size from M1/m1 to M3/m3; the M3 and m3 are sometimes well reduced. A particularity of the dentition of some paroxyclaenids is the tendency to enlargement and molarisation of the third and fourth upper and lower premolars, generally exceeding the succeeding molars in size.
We recently studied unpublished fossils from the first half of the Ypresian: these fossils originate from the French localities of Le Lien (Hérault), Pourcy, Mutigny, Avenay (Marne), and Condé-en-Brie (Aisne). They allow to describe new specimens of *Merialus martinae* (the oldest paroxyclaenid) and three new species – the oldest paroxyclaenine and two merialines. Their study is the opportunity to review the evolution of this family – the last extensive and comprehensive review of the paroxyclaenids has been published in 1988. The two paroxyclaenid subfamilies – Paroxyclaeninae and Merialinae – are rarely recorded together: this case only occurs in the Paris Basin during the early Eocene (Mutigny, Avenay, Condé-en-Brie). Half of the merialines are present in the Southern European Province, while the paroxyclaenines are only recorded in Northern European Province. The two subfamilies reach their maximum size (≈ 3-4 kg) (e.g., *Spaniella*, *Kopidodon*) around the early/middle Eocene boundary (47.8 Myr). However, some smaller paroxyclaenids (body mass around 1 kg) have co-existed together with the larger ones. The small middle Eocene paroxyclaenids, which are as small as the taxa found in the early Eocene, have been the last representatives of the group (Bartonian). The maximum of diversity of the Paroxyclaenids occurred during the Lutetian (middle Eocene).
Finally, because the new fossils provide information on the morphology of the earliest paroxyclaenids, their study is the opportunity to question the origin of this group and its relationships among Placentalia.
Grant Information:
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Technical Session XV (Friday, August 25, 2017, 2:00 PM)

THE RECONSTRUCTED BRAINCASE OF *ADELOBASILEUS* AND IMPLICATIONS FOR EARLY MAMMALIAFORM DIVERSITY

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Discoveries in China over the past few decades have demonstrated that Mesozoic mammaliaforms exhibited a wide range of small-bodied vertebrate ecomorphs. These discoveries have largely been restricted to the Jurassic and Cretaceous Periods of China. However, far less is known about mammaliaform ecomorphological diversity elsewhere in the world, or in the Triassic Period when mammaliaforms first appeared. North America is especially lacking in data on early Mesozoic mammaliaforms. Using microscopic computed tomography, we reconstructed the braincase of *Adelobasileus cromptoni*, a Carnian-stage Triassic mammaliaform from western Texas. The reconstruction showed that the braincase of *Adelobasileus* is extremely dorso-ventrally flattened and antero-posteriorly elongated, and is more reminiscent of extant crevice-dwelling lizards than any mammalian relative. Using geometric morphometric and traditional morphometric analyses, we found evidence for extensive remodeling of the cranial vault and lateral braincase wall and comparative conservation of the basicranium, relative to other mammaliaforms. This unique morphology suggests adaptation to an ecological role not filled by known extant or extinct mammals or non-mammalian cynodonts. We hypothesize that additional brain expansion seen in crown mammals and later mammaliaforms restricted similar remodeling of the braincase in these taxa. Consistent with this hypothesis, the endocast of *Adelobasileus* is similar in shape to that of *Morganucodon* but lacks the extensive lateral expansion of *Hadrocodium* and crown mammals. A reanalysis of the phylogenetic position of *Adelobasileus* using updated character states from the reconstruction shows, in concurrence with earlier studies, that *Adelobasileus* falls just outside the clade that includes *Morganucodon* and crown mammals. Our analysis demonstrates that mammaliaforms' experimentation with novel ecomorphs in the Mesozoic may have started tens of millions of years earlier than previously thought and may have occurred throughout the world. It also suggests that early mammaliaforms were not necessarily restricted to niches occupied by extant mammals.

Technical Session I (Wednesday, August 23, 2017, 9:45 AM)

VERTEBRAL MORPHOLOGIES ASSOCIATED WITH INCREASES IN BODY SIZE IN EXTINCT ARCHOSAURS BUT LOST IN LIVING ARCHOSAURS

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Many extinct archosaurs reached body sizes greater than any other terrestrial vertebrate (e.g. 80 ton titanosaurs, 20 ton theropods). While the major body size transitions in this clade are well documented, less is known about the skeletal morphologies that are correlated with increases in body sizes. We hypothesize that modifications of their intervertebral articulation structures allowed for larger bodies in several archosaur lineages, in particular the addition of an accessory structure, the hyposphene-hypantrum, in the trunk region. To investigate how [illegible] articular surface area-to-volume ratios across Archosauria, we measured [illegible] articular surfaces in extinct and extant archosaurs. Results show that hyposphene-hypantrum bearing taxa have increased articular surface area, normalized to vertebral centrum volume, compared with taxa that lack these structures. Normalized articular surface area (proxy = femoral length) in crocodylians and birds. Extinct archosaurs, however, did not follow that trend and plotted closer to extinct birds than to extant crocodylians, even though they are larger than extant taxa. We hypothesized that the addition of the hyposphene-hypantrum in vertebrae fits them together in a novel way that uses less, metabolically expensive bone, and that it adds an additional angle of articulation. Because of this morphological change in their vertebrae, dinosaurs and pseudosuchians could have a stronger connection between consecutive vertebrae without linearly increasing the mass of their skeleton with body size, allowing them to grow larger. The hyposphene-hypantrum appears to have evolved convergently in several extinct archosaurian lineages (e.g. paracrocodylomorphs, saurischian dinosaurs), and the structure is not present in any living archosaurs. These crown groups (i.e. crocodylians and birds) are generally much smaller (max size ostrich: 0.22 ton; max size crocodile: 1.1 ton) and occupy ecological morphospace that is widely disparate from each other and their extinct relatives. The loss of the hyposphene-hypantrum further supports the hypothesis that it was structurally important for body size evolution because it is lost in the phylogeny when taxa reduce to ~1 meter (e.g. *Sphenosuchus*, *Hesperosuchus*). Additionally, it is not regained in large crocodylian taxa (e.g. *Deinosuchus*) that have become fully or semi-aquatic, potentially because of reduced effects of gravity in water, similar to how whales reduced their articulations.
Grant Information:
Welles Fund (UC Berkeley)

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

HISTOLOGY AND GROWTH OF IGUANODON BERNISSARTENSIS

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The genus *Iguanodon* comprises some of the earliest discovered dinosaur taxa. It acquired an iconic status when a large number of more or less complete skeletons was exhumed from a coal mine near Bernissart, Belgium. The skeletons represent the largest find of its kind in Europe, and their morphology has been studied extensively. Recently, a study on morphological variation in *I. bernissartensis* was published, but no histological data on the ontogenetic status of the individuals was included. These natural treasures are notably threatened by decay of the pyrite which is ubiquitously present in the skeletons, therefore continued action is needed to preserve them. Here we present the first results on the histology and preservation of *I. bernissartensis* from Bernissart (Belgium) and the contemporary bonebed locality of Nehden (Germany), from which hundreds of mostly disarticulated bones of *I. bernissartensis* of similar preservation were uncovered. We sampled cores, and cut small sections of 16 individuals from Bernissart but also made full cross sections of eight specimens from Nehden.
Our analytical approach (polarized light microscopy, µXRF, FTIR spectroscopy, carbon and oxygen stable isotope analysis) demonstrates the morphological preservation of the bony tissues, and presence of metal sulfides and silicates in the medullary cavity. The pyrite has thus not penetrated the bony tissues themselves, which allowed assessment of the growth of this iconic taxon. In addition, the pyrite also protected the bone periphery from erosion, so that the highly porous outermost rim of freshly grown bone tissue is still preserved in some specimens. The long bone tissues generally show a fast growing woven-parallel fibered complex with numerous longitudinal to circumferential primary osteons arranged in a laminar to plexiform pattern, similar to other iguanodontians and hadrosaurs. We also found very few growth marks (3 to 4 in the ribs of large specimen RBINS I52, and up to 5 in femur WMN P61446 (80/436) from Nehden), which occur as vascularization shifts, annuli, and/or LAGs. At the time of writing, growth model work is being performed, despite this irregular occurrence of growth marks. The abundance of erosion rooms is less pronounced than in hadrosaurs, but *I. bernissartensis* likely grew similarly fast to the more derived hadrosaurs.
Grant Information:
KS acknowledges the FWO (Research Foundation Flandres) for funding
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Preparators' Session (Thursday, August 24, 2017, 11:30 AM)

THE IMPORTANCE OF BEING UNCERTAIN: PROBABILISTIC COMPUTATION OF TRACKMAKER SIZE, GAIT, AND GAUGE

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The incorporation of uncertainty measurements in computations (an infrequent practice in paleontology) proves its value in the analysis of a dataset of over 6,600 sauropod tracks from the Late Jurassic (Kimmeridgian) of the Jura Mountains (NW Switzerland). The tracks were measured and mapped in the field, then assigned global coordinates (each with spatial uncertainty) based on sitemaps and orthophotographs. The track measurements were not normally distributed, invalidating the use of conventional statistical methods, so probabilistic methods were used with uncertainty weighting and error propagation.
Conventional trackway gauge measurements (e.g., the width of the angulation pattern and the trackway ratio) are quite sensitive to measurement uncertainty. Without uncertainty weighting, gauge may vary erratically along a given trackway, and using conventional arbitrary fixed thresholds to distinguish 'wider' versus 'narrower' gauge segments is unstable, improbably suggesting large shifts in gauge every few strides along a 120 m long trackway for example, while uncertainty weighting resolves two statistically-distinct gauges (1.6 ± 02 for 59% of the trackway and 1.9 ± 0.2 for 39%), each with longer contiguous segments.
Trackmaker size estimation also benefits from uncertainty weighting. Gleno-acetabular distance D_{GA}, a proxy for quadrupedal trackmaker size, is either computed as proportional to hip height (which in turn is assumed proportional to track size, requiring two assumed proportionality factors) or alternatively, based on the distance from the midpoint of a manus track pair to that of the corresponding pes pair, times a constant that depends on the assumed gait. We generalize the latter approach, but rather than assuming some gait, we solve for D_{GA} at successive (uncertainty-weighted) track locations along a quasi-regular trackway for combinations of the two unknown gait parameters limb phase and duty factor, thus creating a space of possible D_{GA} solutions. Those with less variation along the trackway are preferred, using a fitness function that quantifies persistent variation in D_{GA}. A high-fitness solution, if found, indicates that the trackway could have been created by a fairly constant gait. In a representative sauropod trackway, a solution is found for a narrow range of walking gaits (limb phases ~0.3) and D_{GA} = 1.6 ± 0.07 m. This size estimate is not statistically different from that based on inferred hip height (D_{GA}

= 1.9 ± 0.4 m) but offers much higher precision (4-5% compared to 23%), as well as insight into how it walked.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MAMMALIAN FAUNAL COMPOSITION ACROSS LOCALITIES IN THE LATE OLIGOCENE NSUNGWE FORMATION, RUKWA RIFT BASIN, TANZANIA

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The Nsungwe Formation, located in the Rukwa Rift Basin of Tanzania, is a depositional unit (over 200 m in thickness) characterized by a myriad of micro-depositional environments. This shallow wetland system developed in a semi-arid climate approximately 25 Ma, providing a rare window into the early development of the modern East African Rift System. Although sedimentological data indicate periodic/seasonal climatic fluctuations, the presence of fish, frogs, crustaceans and aquatic molluscs in many localities suggests perennial availability of water. Mammalian fossils are differentially preserved across nine main localities, raising a number of intriguing taphonomic and paleoecological questions. Geological data suggest that mammal-bearing localities represent a range of depositional environments, each represented by different taphonomic modes of preservation. This study compares mammalian faunal composition and size sorting among Nsungwe Formation localities. An analysis of 5537 identified invertebrate and vertebrate specimens from nine localities indicates the following taxonomic breakdown: mammals comprise approximately ~15% of the sample, with rodents accounting for just over half of identified mammal specimens. Anthracotheres are represented by the next highest number of specimens, followed by macroscelideans and primates. Fascinatingly, hyracoids, a group that dominates the Paleogene faunas of northern Africa, comprise less than 1% of Nsungwe Formation fauna, and hyaenodonts are even more sparse. Mammalian faunal composition is highly variable across localities, with mammals ranging from 6% of the recovered specimens at one site to over 20% from a different but nearby locality. Maximum length was recorded for prepared specimens (n=787; min < 1 mm, max 133 mm), with the vast majority of specimens recovered from well-sampled localities measuring between 2 and 6 mm in length. Close examination of localities at the base of the Songwe Member indicate that these wetland/low energy fluvial environments preserve a greater size diversity of mammals than the localities higher in section, from massive megaherbivores to minute micromammals.
Grant Information:
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Technical Session III (Wednesday, August 23, 2017, 3:30 PM)

A LATE MIOCENE OSTRICH (STRUTHIONIDAE) POPULATION FROM HEZHENG, CHINA AND IMPLICATIONS FOR THE PALEOBIOLOGY, TAXONOMY, EVOLUTION, AND BIOGEOGRAPHY OF EURASIAN OSTRICHES

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The late Miocene (Hipparion) component of the Hezheng Biota (Linxia Basin) comprises a diversity of terrestrial vertebrates including birds, mammals, and turtles from Gansu Province, China, adjacent to the Tibetan Plateau. Fossils of a minimum of six individuals of early ostriches from Hezheng (~8 Ma) represent some of the best-known fossil records of Struthionidae, recording several anatomical regions for the first time and providing a window into intraspecific variation. The fossils include several synsacra/pelvises, a tarsometatarsus, a skull with a partial sequence of cervical vertebrae, and a partial skeleton which preserves much of the trachea. This collection includes the first fossil of an ostrich skull (possibly a subadult as indicated by the absence of a jaw symphysis) that exhibits a palate overall similar to the living species, but differing in proportions of the different elements with the palatine shifted rostrally and having a more robust pterygoid. The tarsometatarsus is didactylous and has a very low intercondylar eminence. The pelvis and synsacrum differ from the living species in being slightly larger, having extensive grooving/ridges on the ventral aspect of the synsacral vertebrae, a large foramen in the transverse process of the second synsacral vertebra, and differences in the position and proportions of other anatomical features (such as a more caudally positioned supratrochanteric process).

Overall, the sizes of the ostrich specimens from Hezheng are close to that of living individuals, but they tend to be on the larger or more robust end of the spectrum. The measures of the pelvic region specimens are very similar to one another, suggesting the absence of significant sexual size dimorphism. That absence in a population of an early ostrich indicates that the extreme size variation (up to 50%) present among Neogene fossil ostriches could reflect actual species differences. Some features of the Hezheng specimens (including the large muscular tubercle on the cranial end of the ilium) may help to provide outgroup or primitive character states for examining the evolution within the extant lineages of *Struthio*.

The new material supports the idea that *Struthio linxiaensis* (from Gansu) and *S. wimani* (from Shanxi) are synonyms. Furthermore, it is possible that some European and East Asian late Miocene specimens represent a single species, and several mammals from Hezheng also are known in Eastern Europe, indicating the broad Eurasian distribution of some large-bodied taxa in the late Miocene.
Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

UNITING THE UPPER TRIASSIC DEPOSITS OF CENTRAL AND NORTH PANGEA: THE FIRST RECORD OF *PARASUCHUS* FROM THE NEWARK SUPERGROUP AND ITS IMPLICATIONS FOR BIOCHRONOLOGY

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The Newark Supergroup of eastern North America has been instrumental in establishing a near continuous chronology of Late Triassic tectonic events, biological changes, and climatic changes. Though vertebrate fossils have been known from throughout the well-dated Newark Supergroup for over 150 years, tying the extensive stratigraphic record of the Newark Supergroup to other much more fossiliferous localities in northern Pangea (e.g., Chinle Formation, Germanic basin) has been difficult. One of the most commonly identified tetrapods from the Newark Supergroup is *Rutiodon*, a phytosaurian archosauriform and a taxon that had previously been used to correlate sediments from the Newark Supergroup with those of the Chinle Formation and Dockum Group of the southwestern USA. Here we reassess a specimen previously assigned to *Rutiodon* from the Zions View tetrapod assemblage of the New Oxford Formation of the Newark Supergroup, Gettysburg basin, Pennsylvania. This specimen had been identified based on a slender and uncrested rostrum. However, the lack of a rostral crest is plesiomorphic for all Late Triassic phytosaurs, and unlike *Rutiodon*, the Zions View skull preserves a row of jugal nodes, dorsally-oriented supratemporal fenestrae, and short squamosal with a dorsal groove. Instead, we identify this specimen as the first confirmed occurrence of *Parasuchus* in the Newark Supergroup. Thus, not all phytosaurs from the Newark Supergroup are referable to the endemic *Rutiodon*. Recent work established a monophyletic *Parasuchus* known from the Popo Agie Formation of Wyoming, the Colorado City Member of the Dockum Group of Texas, the Blasensandstein (Hassberge Formation) of Germany, the Drawno Beds of Poland, and the Maleri Formation of India, indicating a widespread clade of early-branching parasuchids. Recognition of *Parasuchus* from the Newark Supergroup provides a geographic connection between these northern occurrences in Europe and the central portion of Pangea in the southwestern USA. This reinterpretation serves as a check on the ages of the assemblages within the Newark Supergroup, showing that the New Oxford Formation may either be older than previously hypothesized or *Parasuchus* may have had a longer range than previously hypothesized, and that those earliest Late Triassic faunas are not restricted to the southern Newark basins.

Technical Session I (Wednesday, August 23, 2017, 10:30 AM)

HISTOLOGIC ANALYSIS OF MOSASAUR TOOTH CROWN FEATURES AND THEIR DEVELOPMENTAL SIGNIFICANCE

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The development, histology, and evolution of mosasaurid tooth crowns remain essentially undocumented despite abundant research on attachment and implantation. Moreover, phylogenetic analyses of mosasaurids often contain characters detailing the external morphology of the marginal teeth, and the current study seeks to determine whether the homology of several of these characters can be assessed using histology. To address this objective, we examined mosasaurid teeth exhibiting flutes (narrowly-spaced ridges with concave enamel between adjacent ridges), facets (widely-spaced ridges with flat enamel between adjacent ridges), serrations, and enamel wrinkles (coarse texture around the apex). These structures are either formed only by the enamel or contain contributions from the underlying dentine; the difference between these two conditions may vary across Mosasauridae. Isolated mosasaur teeth (from genera including *Globidens, Mosasaurus, Platecarpus,* and *Prognathodon*) exhibiting various external structures were embedded in resin, and thin-sections were prepared for histologic analysis. These thin-sections revealed that flutes and facets are not solely enamel structures but must be formed during the initial proliferation of the inner dental epithelium because the dentine mirrors the ornamentation of the enamel. Therefore, flutes and facets are developmentally homologous and represent opposite ends of a spectrum of slight epithelial folds that develop during tooth crown formation. Histologic evidence that flutes and facets form a morphological continuum supports previous observations of some species of *Mosasaurus*, in which teeth of smaller individuals exhibit flutes whereas teeth from larger individuals exhibit facets. In addition, we found that the carinae in mosasaurids are composed of both tissue types, but that serrations are formed only by enamel. The wrinkled or pebbled enamel texture characteristic of *Globidens* and some species of *Prognathodon* is also restricted to the enamel layer. We conclude that the diversity of mosasaurid tooth crown structures is dictated by two processes that occur during different stages of tooth development: flutes and facets are products of a change in the morphology of the inner dental epithelium prior to enamel and dentine production, whereas serrations and surficial wrinkles are products of differential rates and extents of enamel deposition. A better understanding of the nature of these structures will aid in revising these tooth characters in future mosasaur character matrices.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

CHANGES IN RHINOCEROTOID BODY MASS DIVERSITY ACROSS THE EOCENE OF NORTH AMERICA

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During the Eocene, North American rhinocerotoids experienced an adaptive radiation, resulting in an increase in both body mass diversity and associated occupied ecological niches. It is unclear if this pattern of body mass diversity is the result of competition with

terrestrial, browsing, large-bodied ungulates, climatic change over the course of the Eocene, or corresponding changes in the patterns of body mass of presumed rhinocerotoid predators. Using m1 area as a proxy for body mass for all known Eocene ungulate genera including rhinocerotoids, this study examined the temporal pattern of changes in m1 area across the epoch (Wasatachian-Chadronian North American Land Mammal Ages).
If shifts in rhinocerotoid body mass diversity were consistent with competition among ungulates, then a temporal pattern indicating divergence (i.e., non-significant overlap) of m1 area ranges between rhinocerotoids and other ungulates would be expected. If body mass changes resulted from climatic change or predator evolution, then shifts in m1 area would be temporally correlated with measures of climate (in this case, mean annual temperature (MAT) estimated from isotopic ^{18}O) or predator estimated body mass.
Results indicated that the temporal pattern of rhinocerotoid m1 area across the Eocene was not correlated with MAT or predator body mass. Statistically significant changes ($P<0.05$) in rhinocerotoid m1 area were inversely correlated with changes in m1 area of other perissodactyls. Our results thus suggest that competition within Perissodactyla was an important factor in shaping the early diversity of this group.

Technical Session III (Wednesday, August 23, 2017, 2:15 PM)

BIOMECHANICAL STRESSES OF PEDAL GRASPING BEHAVIOR WITHIN MODERN AVES: MORPHOLOGICAL ADAPTATIONS AND MESOZOIC IMPLICATIONS

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Flight in modern birds required a unique reformatting of the arms and hands which rendered the forelimbs essentially useless for the support which limbs typically offer tetrapods. As a result of this adaptation, birds are obligate bipeds and the large range of niches which modern birds fill submit their feet to an equally large variation of biomechanical stresses. Increased grasping capabilities in bird feet typically results in relative shortening of proximal phalanges. This is especially notable in birds of prey which display immense gripping strength and similar foot morphologies through convergent evolution. However, the presence or degree of proximal shortening is dependent on toe and phalangeal number. To analyze the effect such biomechanical stress has on pedal morphology, we binned all modern birds into either terrestrial/aquatic, arboreal, clinging, or raptorial classifications to represent the frequency and intensity in which grasping behavior is utilized within a particular species. Using the most up to date Avian phylogenic trees available, we tested ANOVA and ANCOVA models through Baysian methods by regressing the lengths of penultimate phalanges for each toe for each sampled species with its respective proximal phalanges. Here we present our analysis documenting morphological variation within and between each of these ecological bins. In most but not all proximal phalanges, we found statistically significant evidence for a divergence between the pedal anatomy of perching and raptorial birds and the anatomy of ground dwelling or aquatic birds. We found mixed results for clinging birds, including swifts and woodpeckers, which likely requires further investigation. Our results offer insight into the differences in stresses between anisodactyl and zygodactyl foot forms within similar niches, propose a timeline for the acquisition of perching and raptorial behavior, and suggest perching niches provide several preadaptations for clinging and raptorial behavior. In addition to our analysis of modern Aves, we apply the relationships which we discerned for modern birds onto extinct groups. These models have implications for the ecology of Mesozoic birds such as Enantiornithines and possibly non-avian dinosaurs. Diet of extinct species is currently analyzed with methods such as dental anatomy, stable isotope analysis, and occasional stomach contents. With the addition of information gathered from pedal morphology, we can add depth and detail to our understanding the ecology and predator-prey relationships of the Mesozoic.

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

DISPARITY AND RATES OF EVOLUTION IN HADROSAURID DINOSAURS

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Hadrosaurid dinosaurs were an important component of the Late Cretaceous ecosystems of Antarctica, Eurasia and the Americas. They evolved extensive dental batteries and hypertrophied nasal passages with highly modified surrounding elements often associated with cranial crests. Here, we document the evolutionary dynamics of these animals regarding their unique suite of cranial and postcranial attributes.
We find that accelerated rates of evolution concentrate in the skull, particularly in the facial complex. Slower rates are found in more basal hadrosauroids, whereas accelerated rates appear in lineages closer to Hadrosauridae. Specifically, facial accelerated rates occur in brachylophosaurin and saurolophin saurolophines, and at the base of the more inclusive lambeosaurine clades. The premaxilla and nasal bones show accelerated rates in the tribes Saurolophini and Lambeosaurini. Feeding-related characters only display accelerated rates ancestrally in Saurolophidae. In the postcranium, the pectoral girdle and forelimb show accelerated rates at the origin of saurolophids, whereas southern kritosaurins display accelerated rates in the pelvic girdle and hindlimb.
The entire hadrosaurid skeleton increased in disparity during the Late Cretaceous, with the postcranium and feeding-related attributes peaking in disparity during the lower Campanian, and the facial elements being most disparate in the late Campanian. Both the postcranium and feeding-related traits are more disparate in basal hadrosauroids, suggesting variation constraints for hadrosaurids in these areas. Within hadrosaurids, saurolophines possess a more disparate dental, facial and postcranial morphology than lambeosaurines. However, the premaxilla and nasal bones show similar, and at the same time greater, disparity in saurolophines and lambeosaurines relative to basal hadrosauroids, as expected from the development of highly derived ornamental structures.

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Technical Session VII (Thursday, August 24, 2017, 1:45 PM)

EXPANDED STERNAL RIBS INDICATE AN UNUSUAL ACCESSORY RESPIRATORY MECHANISM IN THE LONG BONY-TAILED CRETACEOUS BIRD *JEHOLORNIS*

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In the long bony-tailed basal bird genus *Jeholornis* from the Early Cretaceous Jehol Biota of northeast China, a distinctive pair of ossifications are associated with the sternum. These structures are roughly P-shaped, with a convex, usually fenestrated expansion near one end of the shaft. They have generally been identified as lateral trabeculae, paired processes that extend from the caudolateral corners of the sternum in most ornithothoracine birds. However, the putative lateral trabeculae of *Jeholornis* differ from those of adult ornithothoracines in not being fused with the body of the sternum, and in fact are preserved in a wide variety of positions and orientations relative to the sternal body. Furthermore, lateral trabeculae are otherwise unknown in birds outside Ornithothoraces, so their reported occurrence in *Jeholornis* is surprising.
However, *Jeholornis* skeletons housed in the Shandong Tianyu Museum of Nature in Pingyi, China reveal that the putative lateral trabeculae of *Jeholornis* in fact represent a pair of curiously expanded sternal ribs. In one specimen exposed in lateral view, the expanded sternal ribs are preserved in articulation with the vertebral ribs of a mid-dorsal vertebra, with the convex expansion directed ventrally and located near the end of the sternal rib that contacts the vertebral rib. In a second specimen, the anterior half of the left sternal plate is exposed in dorsal view, and the expanded sternal rib is caudalmost in a series of four that remain in articulation with the costal margin of the sternum.
Reidentification of the 'lateral trabeculae' of *Jeholornis* as sternal ribs is consistent with the positional variability of these structures across specimens, given that displacement of sternal ribs is common in Jehol bird skeletons, and removes the only evidence for lateral trabeculae or accessory sternal ossifications in non-ornithothoracine birds. Expansion of the caudalmost pair of sternal ribs in *Jeholornis* is a highly unusual, presumably autapomorphic feature with uncertain functional implications. However, the expansions may be broadly analogous to the multiple small flanges, called sternocostapophyses, that occur on the sternal ribs of some pterosaurs and are thought to have improved the ability of the intercostal muscles to contribute to ventilatory movements by altering their moment arms. The expanded sternal ribs would then represent the key component of an accessory respiratory mechanism unique among birds.

Podium Symposium (Wednesday, August 23, 2017, 9:30 AM)

STRUCTURE OF THE PECTORAL LIMB OF THE EARLY PERMIAN BOLOSAURID REPTILE *EUDIBAMUS CURSORIS*: FURTHER EVIDENCE SUPPORTING IT AS THE EARLIEST KNOWN FACULTATIVE BIPED

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Eudibamus cursoris, a bolosaurid parareptile, from the Early Permian Tambach Formation (approximately 290 mybp), Thüringer Wald (Thuringian Forest), of central Germany, has been interpreted as the earliest known facultative biped. This was initially proposed based on the postcranial limb proportions in the type specimen (MNG [Museum der Natur, Gotha, Germany] 8852), but the forelimb itself has never been formally described. A nearly complete left, and partial right forelimb are preserved in the type specimen. The forelimb is less than 60% the length of the hindlimb. Only a thin, blade-like scapula is visible. Brachial, antebrachial, and manual elements are slender and elongate compared to those of other basal amniotes. The humerus has two well-developed distal condyles with terminally facing articular facets. Delto-pectoral attachments were along a narrow ridge. The radius and ulna are nearly subequal in length. Conspicuously, the ulna lacks a well developed olecranon process. Carpals are proximo-distally elongate compared to other basal amniotes. The intermedium and lateral centrale and the radiale and medial centrale articulate end-to-end, and their combined lengths equal that of the ulnare; the intermedium and radiale, and the medial and lateral centralia are equal in length. Four distal carpals are visible, it is unclear whether whether the fifth is truly absent or simply unossified. The distal carpal associated with digit two is reduced to a tiny pebble of bone, whereas that associated with digit four is largest and somewhat wedge shaped. Four metacarpals, likely equivalent to digits two-five, are present. The proximal portion of metacarpal two is present but length of the entire element cannot be determined. No elements of digit one can be seen, though its absence could be an artifact of preservation; however, the presence of only four distal carpals suggests *Eudibamus* may have had only four manual digits. Three phalanges are preserved in digits three and four. Both come to blunt tips and neither exhibits a significantly elongate penultimate element. The overall limb proportions seen in *Eudibamus* could suggest facultative bipedality or vertical clinging and leaping. However, vertical clingers and leapers normally have at least one disproportionately elongate manual digit and well-developed manual claws. Neither phalangeal proportions, nor the two well-developed terminal phalanges show such adaptations in *Eudibamus* and its interpretation as a facultative biped remains the most plausible interpretation of its postcranial anatomy.

Grant Information:

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

MIOCENE MAMMALIAN FAUNAS FROM THE WUSHAN, CHINA, AND THEIR SIGNIFICANCE FOR EVOLUTION, BIOCHRONOLOGY, AND BIOGEOGRAPHY

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Recently we have found a new section which yielded plenty of mammalian fossils in Wushan Subbasin, Gansu, China. This section encompasses the entire middle Miocene and the late early Miocene. From the middle Miocene strata, two fossiliferous horizons had been found and mammalian fossil including proboscideans, suids, bovids, and a new species of rhinoceros were excavated. They show important morphological modifications within these groups, and therefore indicate the evolutionary trends in various aspects and are important for stratigraphic correlation of the middle Miocene. In the early Miocene strata, an important discovery is a very primitive proboscidean. It is the earliest fossil proboscidean record in China and indicates the "proboscidean datum event". Moreover, the Palaeozoographical differentiation in the middle Miocene has been discussed based on a study of species distribution of the caprine bovids and listriodont suids. Their distribution basically affirms the east-west boundary of mammalian in middle Miocene. However, a large transitional area seems to exist in Inner Mongolia in middle Miocene. Therefore, this study is not only a report of new fossil localities and taxa, but also an important progress on biostratigraphy and biozoography in the middle Miocene of East Asia.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW ONTOGENETIC AND BIOMETRIC DATA FOR ICHTHYODECTIDAE: SMALLEST RECORDED INSTANCE OF *XIPHACTINUS AUDAX* (TELEOSTEI: ICHTHYODECTIFORMES)

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Xiphactinus audax (Teleostei: Ichthyodectiformes) was originally described from a partial pectoral fin and has since become famous for its size and its common occurrence; however, very little is known about the early life cycle of *Xiphactinus* due to a paucity of sub-adult fossils available for study. Here, we report the first instance of a small, potentially juvenile, *X. audax* (FHSM VP-19020) from the Smoky Hill Member of the Niobrara Chalk Formation in Gove County, Kansas. The specimen consists of an associated pair of dentaries, a right preoperculum, and an isolated vertebra but only the dentaries were diagnostic to a genus-level within Ichthyodectidae. An exaggerated anterior tooth, irregular tooth size along the entirety of the alveolar margin, a conical tooth cross-section, and six ventrolateral sensory pits were indicative of *X. audax*. Based on previous studies, VP-19020 is up to 91.2% shorter than the mean *Xiphactinus* dentary length and 89.8% smaller than the mean width. VP-19020's maximum mandibular length is 2.59 cm while the mean *Xiphactinus* dentary length is 29.5 cm long. Ecologically, this is important because biometric data has not been recorded for any *Xiphactinus* specimen less than three meters long. Modern game fish with voracious adult diets, such as *Thunnus orientalis* and *Megalops atlanticus*, that reach similar comparable lengths have accelerated growth rates during their juvenile stages. *X. audax*, based on growth data gathered from *T. orientalis* and *M. atlanticus*, would have likely shared their growth rates and reached adult size in a relatively short amount of time. Additionally, the tooth morphology and gut contents of complete adult specimens indicate that the diets of small *Xiphactinus* specimens did not drastically change between juvenile and adult stages. Presently, nothing can be said about *X. audax* ontogenetic stages younger than juvenile with any certainty since larval or fry stages have not been found within the fossil record and all ichthyodectids, *Xiphactinus* included, went extinct during the K/Pg mass extinction. The exact age of VP-19020 cannot currently be determined since the otoliths and scales were not preserved; however, the use of exploratory osteohistological methods on the dentaries could identify the specific ontogenetic stage of the specimen at death.

Technical Session IV (Wednesday, August 23, 2017, 4:00 PM)

PALEOECOLOGICAL AND PALEOCLIMATIC RECONSTRUCTIONS OF THE PLEISTOCENE KHOK SUNG VERTEBRATE FAUNA (NAKHON RATCHASIMA PROVINCE, NORTHEASTERN THAILAND): STABLE CARBON AND OXYGEN ISOTOPE INVESTIGATIONS OF UNGULATE TOOTH ENAMEL

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In mainland Southeast Asia, Khok Sung constitutes one of the richest Pleistocene vertebrate fauna, 15 different mammalian taxa, with especially complete and diversified fossil remains. The age of the Khok Sung fauna has been tentatively attributed to the late Middle Pleistocene, either 213 ka or 188 ka, based on the occurrence of paleomagnetic short reversal and on the presence of *Crocuta crocuta ultima* that represents an accurately calibrated biochronological index. To investigate paleodiets and habitats of the Khok Sung ancient mammals and to understand the corresponding regional climate, we performed an analysis of stable carbon and oxygen isotopes extracted from tooth enamel carbonate of various ungulate taxa, coupled with the cenogram method.

The enamel $\delta^{13}C$ values of Khok Sung ungulates indicate a variety of diets, ranging from pure C3 to pure C4 plants, suggesting that C4 grasses were a major component of the local Thai ecosystems during the late Middle Pleistocene. The stable isotopic distinction between C3 and C4 plants exhibits the Pleistocene wildlife habitats ranging from closed forests to open grasslands for the Khok Sung area. Moreover, differences within sympatric Pleistocene mega-herbivores, rhinoceroses (between locally extinct *Rhinoceros unicornis* and today surviving *Rhinoceros sondaicus*) and proboscideans (between *Stegodon* cf. *orientalis* and *Elephas*), and within cervids (between *Panolia eldii* and other taxa) characterize niche partitioning that would minimize either intergeneric or -specific competition. Paleoclimatic interpretations based on the serial sampling of tooth enamel of large mammals combined with the cenogram analysis reflect significant seasonal variation in precipitations and temperature for the Khok Sung locality.

Our analysis suggests a humid glacial condition for Khok Sung, similar to that observed for the late Middle Pleistocene cave deposits of Thum Wiman Nakin. Compared to modern environments in northern Thailand, it is obvious that C4-dominated grasslands were more widespread at that time when anthropic impacts on the ecosystems were absent.

Grant Information:
1) Grants for Development of New Faculty Staff (Chulalongkorn University)
2) Grants for attending conference and presenting academic work (Chulalongkorn University)

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TAPHONOMY OF DINOSAUR COPROLITES FROM THE UPPER CRETACEOUS (CAMPANIAN) TWO MEDICINE FORMATION, NORTHWESTERN MONTANA

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The Upper Cretaceous (Campanian) Two Medicine Formation near Choteau, Montana, yields coprolites of large herbivorous dinosaurs, presumably Maiasaura. In order to recover data on depositional context and taphonomic history, we made new collections in the summer of 2016 and analyzed existing collections. In an effort to document specimens in sedimentary context, we systematically prospected exposures of the formation throughout the Egg Mountain field area and measured stratigraphic sections at coprolite sites. Only four coprolites had been previously found in situ, and after a week of focused searching by eight people, no new specimens were discovered that were definitively in place. However, we did collect two coprolites with adhering matrix. One of these specimens was serially sectioned, and thin sections were made of this and several other specimens to evaluate mineral content and chemical composition (using SEM-EDS). We described the basal contact of this large (28.3 cm long, 17.1 cm thick), oblong coprolite in an effort to characterize biological activity at the coprolite-sediment interface. Randomly oriented black plant material dominates the coprolite, while the underlying lithology is predominantly massive white carbonate mudstone to wackestone. The boundary is characterized by a zone of flattened plant material along with localized bioturbation, which marks the sediment-coprolite interface. The coprolite is heavily bioturbated by sinuous burrows ranging from 3 mm to 1 cm in diameter. Some burrows exhibit meniscate backfill. Despite striking differences in coprofabric within the original sample set, all samples (n=16) consist primarily of calcium carbonate with rare detrital inclusions of quartz and feldspar. The general rarity of the coprolites in outcrop, and the fact that they do not occur in tabular deposits or stratified plant-rich beds is consistent with a fecal origin. This is further corroborated by the random orientation of plant material in thin section and hand sample. This study contributes to our understanding of the depositional setting and ichnology of dinosaur coprolites in the Two Medicine Formation.

Grant Information**:**
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Technical Session II (Wednesday, August 23, 2017, 10:45 AM)

LIVING BY THE EROMANGA SEA: EVIDENCE OF BRACKISH-WATER TOLERANT CROCODYLIFORMS AND OSTEICHTHYANS FROM THE LOWER CRETACEOUS WINTON FORMATION AT ISISFORD, QLD.

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The late Early Cretaceous Winton Formation at Isisford has previously been thought to be a terrestrial or fluvial-lacustrine deposit, with fossils of the crocodyliform *Isisfordia duncani* and the osteichthyan *Cladocyclus geddesi* found within representing freshwater tolerant taxa. The interpretation of *C. geddesi* as a fresh water taxon is unique amongst all other *Cladocyclus* sp. found worldwide. However, a new study suggests that the Winton Formation at Isisford is basal and closer to the contact with underlying conformable marine Mackunda Formation, deposited during the regression of the intracontinental Eromanga Sea. A detailed analysis was needed to clarify whether any marine signature could be detected in the Winton Formation at Isisford, and even so, if the vertebrate fossils from Isisford were autochthonous or allochthonous.

The vertebrate fossils at Isisford are found in calcite-cemented feldspathic litharenite concretions. Petrographic analysis of the concretions revealed no signs of compaction, with the majority of framework grains (65%) floating in the calcite cement, and x-ray diffraction analysis showed one generation of cement formation luminescing at ~585–650 nm wavelengths. Along with minimal vertebrate fossil distortion, this suggested the cement precipitated once during shallow burial. The stable isotopic $d^{18}O_{VPDB}$ (-12.25 to -4%) and $d^{13}C_{VPDB}$ (-5.3 to 4.1%) values for the calcite cement represent a brackish water signature along with sulfate reduction and methanogenesis. Coupled with the presence of interbedded sand and silt packages with mud rip-up clasts in cores samples taken nearby, this suggests that the Winton Formation at Isisford represents a deltaic or estuarine setting proximal to the Eromanga Sea.

Patterns of articulation and completeness in the *I. duncani* and *C. geddesi* fossils were compared to actualistic taphonomic observations. Given the paucity of crocodyliform decay studies, it was also necessary to conduct a decay experiment using juvenile *Crocodylus porosus* carcasses as a proxy for *I. duncani*. This data showed that prolonged subaqueous decay in a low-energy environment resulted in poor skeletal articulation. As

the *I. duncani* and *C. geddesi* specimens instead show moderate to high degrees of articulation and completeness, they were buried prior to, or with limited, 'bloat and float' and are therefore autochthonous, or at most parautochthonous. The holotype of *C. geddesi* also does not show signs of tetany or stress-related death, and was likely tolerant of brackish water conditions.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

RELATIONSHIPS OF DIET AND GASTROLITH SHAPE, USING LAYER CHICKS: IMPLICATION FOR *DEINOCHEIRUS* DIET

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Gastroliths (geo-gastroliths) are stones stored in digestive organs of animals and have been reported in some non-avian dinosaurs. Our previous study suggested that shape of gastroliths be categorized based on diet in archosaurs including crocodyles, non-avian dinosaurs, and birds (rounded in herbivory and angular in carnivory and piscivory). Although the ornithomimosaur *Deinocheirus* possess numerous well-rounded gastroliths, its diet was suggested as omnivory based on fish bone remains as its stomach contents. Because the shape of gastroliths changes in gizzards through abrasion, gizzard muscularity is expected as another factor that may influence gastroliths shape. In this study, layer chicks are used to verify whether gizzard muscularity contributes to gastroliths shape difference and if it could explain well-rounded nature of *Deinocheirus* gastroliths.

A total of 76 layer chicks, which had no access to stones prior to the experiments, were employed for the experiments. These individuals were bred under the same conditions except for diet and gizzard muscularity. Gizzard muscularity was controlled by feeding rice hull. Four experimental groups were set: (1) grass fed on muscular gizzard group, (2) dried-fish fed on muscular gizzard group, (3) grass fed on less muscular gizzard group, and (4) dried-fish fed on less muscular gizzard group. All individuals had free access to food, water, and stones. Stone shapes are evaluated using software ImageJ and employed circularity, roundness, and solidity as indicators.

The experiments revealed that the grass fed groups have significantly more rounded stones (higher values of circularity and solidity) than the dried-fish fed groups ($p < 0.01$). Within the same dietary groups, the groups with higher gizzard muscularity had more rounded stones than the groups with lower gizzard muscularity ($p < 0.01$), suggesting contribution of gizzard muscularity in the degree of grit modification. Although whether *Deinocheirus* had "gizzard" that is homologous to extant birds cannot be certain at this point, the well-rounded gastroliths of *Deinocheirus* may indicate that *Deinocheirus* had a highly muscular "gizzard". Then, the high gizzard muscularity of *Deinocheirus* may reflect mainly herbivorous diet instead of strong omnivory, since avian gizzard muscularity increase as amount of insoluble plant fiber consumed increase.

Technical Session VIII (Thursday, August 24, 2017, 4:00 PM)

THE PALEOENVIRONMENT OF LOPEROT, AN EARLY MIOCENE CATARRHINE LOCALITY IN WEST TURKANA, KENYA: EVIDENCE FROM STRATIGRAPHY, SEDIMENTOLOGY, AND GEOCHEMISTRY

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Loperot, a fossil-rich Early Miocene site in west Turkana (Kenya), preserves fauna that includes small (e.g. *Paraphiomys* sp., *Diamantomys leuderitzi*) to large (e.g *Platybelodon* sp., *Chilotheridium pattersoni*, *Canthumeryx syrtensis*) mammals. Several aquatic animals such as crocodiles, turtles, fish and a whale have been found at this locality, which indicates that a large river was present at Loperot, and was at one point connected to the ocean. Our recent excavations at the site identified new hominoid materials making Loperot one of the oldest sites to preserve both hominoid and cercopithecoid fossils. Hominoids are often associated with closed-canopy forests, while early monkeys are more often associated with open environments. Was Loperot a humid, closed-canopy forest, a more open environment, or some combination of both during the Early Miocene?

We identified two main facies within the 30-meter stratigraphic section exposed at Loperot: 1) crossbedded sandstones (fluvial) that fine upward into 2) red/green silty claystones (paleosols) that exhibit peds and contain rhizoliths. In the sandstone units, quartz content increases and feldspar abundance decreases up-section. We interpret this as a shift in sediment source over time. The direction of river flow indicated by crossbeds changes from East-West to North up-section and is most likely due to regional tectonics. The overlying red/green claystones are smectitic, exhibit slickensides on granular peds, and contain rhizoliths. The high smectite clay content and slickensides suggest they are Vertisols that formed on the river's floodplain. Our stratigraphic analysis reveals that the ape and monkey fossils found in 2012 came from different stratigraphic units. Stable isotope values of rhizoliths from paleosol units containing ape fossils record $d^{13}C$ values averaging -10.6‰, indicating a pure C_3 (forest) environment; rhizoliths found with monkey fossils have higher average $d^{13}C$ values (-8.2‰) and suggest a mixed C_3/C_4 habitat (open shrubland).

Therefore, we infer that Loperot was a riparian forest during the Early Miocene, and that when the river was present, trees were abundant, making the habitat suitable for apes. When the river meandered away, the trees followed suit, leaving Loperot as a more open habitat utilized by monkeys.

Grant Information:
Geological Society of America - Southeastern Section, Appalachia Cookie Company, the Office of Student Research and the Department of Geology at Appalachian State University.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MORPHOLOGICAL CHANGES OF THE MOLAR OCCLUSAL SURFACE THROUGH DENTAL WEAR IN *NAKALIMYS LAVOCATI* (RHIZOMYIDAE, RODENTIA) FROM THE NAKALI FORMATION (EARLY LATE MIOCENE) OF NORTHERN KENYA

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We report on morphological change of the molar occlusal surface through dental wear in *Nakalimys lavocati* (Rhizomyidae, Rodentia) from the Nakali formation (early Late Miocene) of northern Kenya. Nakali is located at the eastern shoulder of the central Kenyan Rift. We have carried out paleontological field-works in this area since 2002, and collected a number of mammal fossils including a very rich rodent fauna comprised of 6 families and 10 taxa. Among them, the most dominant species is *Nakalimys lavocati*, which accounts for more than 500 dental specimens or > 80% of the total rodent assemblage. The rodent fauna from the Late Miocene of Africa is quite limited. This sample provides us a rare opportunity to investigate the senescence change of the molar occlusal surface through dental wear in this species.

The characters of dental morphology for *Nakalimys lavocati* have the following features. 1) Unilateral hypsodonty in the lower molars with the crown height of the labial side higher than the lingual side. On the other hand, the upper molar crowns have the lingual side higher than the labial side. 2) Lophodonty in upper and lower molars, with 3-5 lophs (anteroloph, protoloph, mesoloph, metaloph, posteroloph) or lophids (anterolophid, metalophid, protolophid, mesolophid, posterolophid). 3) Short mesoloph/ -id than other lophs.

These features sequentially change as dental wear proceeds. By late wear, occlusal surfaces become completely flat, with the enamel height on the labial and lingual sides becoming equal in both upper molars, and lower molars. As wear advances, adjacent lophs unite (for example on the first and the second upper molar, the metaloph unites with the posteroloph). In later wear, the third upper and lower molars develop isolated, central enamel lakes. However, these are reduced and disappear in the latest wear.

Our report provides detailed description of the dental morphology and dental wear pattern in *Nakalimys lavocati* and supplies comparative information for identifying this species and closely related species. Alpha taxonomy and secure identification must take into account variation in dental morphology due to wear.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A RE-ANALYSIS OF ~350 KA HOMININ-LIKE FOOTPRINTS FROM VÉRTESSZOLOS, HUNGARY, EMPLOYING PHOTOGRAMMETRY AND 3D ANALYSIS

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The Vértesszolos quarry is located in North West Hungary, where the Paleolithic 'Samu' hominin fossil remains (*Homo heidlebergensis*) were found. The site is dated between the Early and Middle Pleistocene (ca. 500-350ka). In 1967, a surface of calcareous mud was excavated a short distance from where the 'Samu' hominin remains were found, exposing numerous fossil tracks made by a range of mammals and birds. Of particular interest were three elongate impressions - two successive and one isolated. These tracks have previously been referred to in the literature as both hominin in origin, and as being produced by a small bear (*Ursus stehlini*). Since bear pes prints can resemble human footprints, we attempted to discern the 3D morphology of the traces quantitatively, using digital photogrammetry. Our analysis shows that one of the prints (the isolated impression) is most likely the product of two superimposed hoof prints from an ungulate. However, the two successive prints are more problematic. The highly weathered surface (first exposed in the 1960's) has made interpretation of these impressions particularly difficult. Both impressions seem to possess a narrow, rounded end similar to the heel of a human footprint. The impressions are broader on the opposite end, and bounded by smaller impressions that could be interpreted as toe marks. However, the imprints vary considerably in their length/width ratios, and are too widely spaced to form part of a single biped trackway. It is conceivable that one or both of these impressions are highly weathered hominin tracks. However, given the highly weathered nature of the exposed surface, and the lack of clarity in the prints, we cannot at this time confidently attribute the prints to any specific track maker. Our digital models of the prints provide a means of analysis without prior assumptions. That we are unable to attribute the prints to any track maker with certainty, highlights the importance of analyzing tracks quantitatively, and with objective methods.

Grant Information:
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Technical Session XIX (Saturday, August 26, 2017, 4:00 PM)

DINOSAUR NESTING AT HIGH-LATITUDE: IMPLICATIONS FROM NEST MATERIAL, NEST STRUCTURES, AND INCUBATION HEAT SOURCES

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Dinosaur eggshells have been found worldwide, with their highest latitude occurrence in Arctic Siberia (paleolatitude 75°N). This global distribution raises intriguing questions about dinosaur nesting behaviors in various environments/regions, particularly at high-latitudes. Although fossil evidence suggests that some dinosaurs, such as hadrosaurs and sauropods, covered their eggs with nest material/substrate during incubation, little is known about the nest structures and heat sources used by covered nesters. In order to elucidate incubation methods used by dinosaurs at high latitudes, we statistically

analyzed the relationships between nest material, nest structure, and type of heat source used for incubation in 41 species of extant covered nesters (i.e., crocodylians and megapode birds). We found correlations between nest substrate and heat source/nest structure; species that use plant/soil material build mound nests and rely mainly on heat from microbial respiration (via plant decay) to incubate eggs, whereas species that use sand/gravel build buried hole nests and rely on heat from solar radiation or geothermal activity. Furthermore, covered nesters relying on solar radiation cannot nest in cool environments, whereas those relying on microbial respiration are able to nest at low ambient temperature (~15 °C). These correlations thus permit prediction of incubation heat sources and nest structures in extinct covered nesters based on the nature of the sediments in which fossil eggs are preserved. Investigation of 191 dinosaur egg clutches/nesting horizons reveals that hadrosaur (spheroolithid) eggs and some sauropod (megaloolithid) eggs are predominantly associated with fine-grained paleosols, whereas other sauropod (faveoloolithid) eggs are associated with non-pedogenic, coarse-grained sediments. These results indicate that hadrosaurs and "megaloolithid sauropods" primarily incubated their eggs in mounds using heat from microbial respiration, whereas "faveoloolithid sauropods" incubated their eggs in sandy, buried holes using solar or geothermal heat. Thus, hadrosaurs and "megaloolithid sauropods" were probably more adaptable and capable of nesting at cool high-latitudes since they favored mound nesting, which is consistent with the reported occurrence of hadrosaur eggshell in Siberia. In contrast, "faveoloolithid sauropods" would have been more restricted in their nesting habits due to their reliance on external heat sources, consistent with their observed distribution at lower paleolatitudes.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

EVOLUTION OF BODY MASS IN THE HESPERORNITHIFORMES

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Body mass has strong relationships with several factors (e.g. physiology, biomechanical constraints, and geographic range), which could influence the evolution of animals. In diving animals, a strong correlation between body mass and diving depth/duration has been reported. Hesperornithiformes is one of the most dominant Mesozoic birds in Northern Hemisphere during the Late Cretaceous. This group is known as foot-propelled flightless divers and has wide range of body size. Here we demonstrate a multivariate regression analysis to estimate body masses of hesperornithiforms, which may infer the evolution of hesperornithiform diving ability.

In order to estimate the body mass of hesperonithiforms, an empirical equation is calculated based on measurements of transverse and sagittal diameters of the proximal end of the tarsometatarsus from 74 extant foot-propelled diving birds (cormorants, grebes, and loons), which have a similar locomotion and morphology to hesperornithiforms. Furthermore, a maximum likelihood based ancestral state reconstruction of the body mass in the phylogenetic framework is conducted to reveal the distribution of body mass in the tree of Hesperornithiformes.

Results in this analysis show that hesperornithiforms have a body mass, ranged from 0.70kg of *Pasquiaornis hardiei* to 41.13kg of *Hesperornis rossicus*, which is nearly 60 folds. Ancestral body mass reconstruction indicates a small body mass in basal hesperonithiforms and a greater diversity in body mass within the clade of Hespeornithidae, similar to the trend in Pan-Alcidae (auks). It differs from Sphenisciformes (penguins), which evolved extremely large body mass early in their evolutionary history and reduced their mass in derived members. It suggests that hesperornithiforms may have achieved extended and deeper underwater dive later in the late evolutionary history, differing from the pattern in sphenisciforms.

Grant Information:
Sasakawa Scientific Research Grant (The Japan Science Society)

Technical Session IV (Wednesday, August 23, 2017, 2:30 PM)

LINKING MICROWEAR ACROSS THE DENTAL ARCADE: ARE CANID DIETARY SIGNALS FROM THE M1 TALONID COMPARABLE TO THE M2?

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Quantification of carnivoran dietary habits via dental microwear texture analysis (DMTA) is instrumental for inferring dietary and hunting behavior in the fossil record. Currently, use of this technique among canids has been limited to the hypoconulid facet of lower second molars (m2), where bone processing occurs (compared to the carnassial sheering facet which serves to slice, not crush, food). Use of the m2 restricts the number of available specimens; however, caniform carnivorans typically have increased occlusal area on the talonid basin of the lower carnassial (m1). This region is thought to be biomechanically analogous to the m2, which would increase sample sizes from fossil localities, as carnassials are more frequently recovered and more identifiable. We tested the hypothesis that dental microwear textures were similar between the m2 hypoconulid surface and m1 talonid basin in two canids, the coyote (*Canis latrans*) and gray wolf (*Canis lupus*). Paired casts were sampled from museum collections, focusing on three microwear indices indicative of diet within carnivorans: anisotropy, complexity, and textural fill volume. Anisotropy, wear feature alignment, is indicative of flesh consumption and did not differ between the m1 and m2 of coyotes ($p=0.49$) or wolves ($p=0.13$). Complexity, differences in wear feature relief across scales - indicative of durophagy, did not differ between the m1 and m2 for coyotes ($p=0.52$) or wolves ($p=0.29$). Textural fill volume, which corresponds to the size of all wear features but is less informative about diet composition, differed between the m1 and m2 for coyotes ($p<0.001$), but not for wolves ($p=0.11$), which could reflect differences in bite force along the tooth row. Our results suggest that the m1 talonid can be substituted as a comparable facet for the m2 when using dental microwear to reconstruct diets of caniform carnivorans. To highlight the potential for increased sample sizes of fossil specimens, we applied this approach to diet reconstructions for three basal Borophaginae canids from the John Day National Monument: *Cynarctoides lemur*, *Phlaocyon latidens*, and *Rhizocyon oregonensis*. Results suggest the species differed in wear feature complexity ($p=0.045$) but not in anisotropy ($p=0.23$) or textural fill volume ($p=0.40$), with *C. lemur* and *P. latidens* eating harder foods than *R. oregonensis*. ~75% of canid specimens at the John Day National Monument for which DMTA is applicable consist of m1s, thus our results dramatically increase the full extent of available specimens for future dietary reconstruction.

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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DISTRIBUTION OF KERATIONOUS BEAKS IN BASAL CERATOPSIANS FROM THE LOWER CRETACEOUS IN CHINA

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Some fossil vertebrates have been known to have both keratinous beaks (rhamphothecae) and teeth in their feeding apparatus. Among them is the Ceratopsia, which was one of the dominant herbivorous dinosaur clades in the Cretaceous terrestrial ecosystems of Asia and western North America. Reconstruction of their keratinous beaks has been based on the grooves and pits on the lateral surface of preorbital region rostral to the tooth row. However, in extant beaked vertebrates, keratinous sheath also covers regions in which such grooves and pits are absent in their rostra. Fine linear striations are preserved in the rostral regions of skulls and mandibles of some well-preserved basal ceratopsians from the Lower Cretaceous of China including *Psittacosaurus*, *Auroraceratops* and *Archaeoceratops*. The density of the striations is four to seven per millimeter. They are distributed on the external surfaces of the caudal portions of rostral and predentary, and rostral portions of premaxilla, nasal and dentary. Although most of them which develop in rostrocaudal or rostroventral-caudodorsal direction are parallel to each other, some diverge or converge rostrally. The striations extend caudal to the regions with grooves and pits. The striations are present in the rostra of extant beaked vertebrates where the keratinous sheaths cover. We interpret the striated regions as those sheathed by keratin and the directions of the striations as growth orientations of keratinous sheath. In the mandible of *Archaeoceratops*, the caudal border of the striated region is lateral to the first dentary tooth, which indicates slight overlap of the keratinous beak and the tooth row. This study makes possible more accurate reconstruction of the caudal distribution of keratinous beaks in fossil vertebrates.

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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

OCEANIC DISPERSAL RATES WITHIN CROCODYLIA AND THEIR SIGNIFICANCE TO THE DEVELOPMENT OF SALT TOLERANCE IN CROCODYLOIDS

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Among extant crocodylians, alligatoroids (caimans and alligators) are generally regarded as being less salt tolerant than their crocodyloid counterparts (crocodiles and tomistomines). Alligatoroids lack the sophisticated osmoregulatory mechanisms for dealing with prolonged immersion in saltwater seen in crocodyloids, and no alligatoroids have the ocean spanning ranges and more oceanic lifestyles seen in some crocodyloid species. This physiological disparity has led to speculation that salt tolerance may have played a major role in shaping the biogeographical distribution of these two clades, and in particular that it may have served as a strong impediment to alligatoroids dispersing over major oceanic boundaries. Here we employ quantitative phylogenetic methods and a modern taxonomy in order to test this hypothesis.

Two different crocodylian phylogenetic topologies were used, one based on morphological data and the other based on a combination of morphological and molecular data. We incorporated the results of multiple published phylogenetic analyses in order to maximize sampling of fossil taxa. Taxa were binned together into geographical regions that were isolated from other regions by oceanic barriers during the times in which the taxa lived. These regions were then treated as character states in a multistate unordered character that was optimized onto each tree using maximum parsimony. Dispersal frequency was quantified at multiple phylogenetic scales using several standardization techniques. We have consistently found that crocodyloids showed greater capacity for ocean dispersal than alligatoroids, and all major clades within crocodyloidea (crocodylids, tomistomines, and potentially gavialines) independently dispersed across oceanic barriers two to three times more frequently than either of the major clades of alligatoroid (alligatorines and caimanines). These results confirm that saltwater tolerance has played an important role in the biogeographical history of crocodylians, and that this physiological disparity between alligatoroids and crocodyloids is a very ancient one, likely dating to near the split of these two sister groups.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

NEW EARLIEST PALEOCENE (PUERCAN) MULTITUBERCULATES FROM THE CHINA BUTTE MEMBER OF THE FORT UNION FORMATION, GREAT DIVIDE BASIN, WYOMING

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Strata containing earliest Paleocene (Puercan) multituberculates are important for understanding which lineages survived the Cretaceous-Paleogene boundary mass extinction and in what ways they diversified afterwards. A new early Puercan mammalian fauna from the China Butte Member (CBM) of the Fort Union Formation in Wyoming's Great Divide Basin is only beginning to be described. Here we report on the multituberculates in the assemblage that come from a productive quarry (UCM loc. 2011035) that has yielded over 400 vertebrate specimens, including 350 mammalian fossils. UCM loc. 2011035 is approximately 46 meters stratigraphically above the contact between the China Butte Member and the underlying Upper Cretaceous (Lancian) Red Rim Member of the Lance Formation. The locality has produced over 140 multituberculate fossils, comprising mostly isolated teeth but also including several exceptionally well preserved dentaries. Preliminary results show that the fauna includes a new genus within the subfamily Eucosmodontinae, in addition to *Mesodma thompsoni*, *Mesodma formosa, Neoplagiaulax* sp., and *?Kimbetohia mziae.* The three dentaries referred to the new genus of Eucosmodontinae include the diagnostic (for eucosmodontines) laterally compressed lower incisor but a p4 that is roughly half the size of the p4 in known species of *Eucosmodon*. While similar in size to p4s of *Stygimys*, that of the new CBM eucosmodontine has a noticeably higher profile than known species of that genus. The 16 specimens (including seven partial dentaries) referred to *?Kimbetohia mziae* preserve the entire lower dentition (i – m2), though not on a single specimen, and are morphologically very similar to ?*Kimbetohia mziae* from the early Puercan Littleton fauna in Colorado's Denver Basin. The new CBM material further draws into question whether this species is morphologically similar enough to the type species, *Kimbetohia campi*, to be included in the same genus. The multituberculates from UCM loc. 2011035, like the eutherians, indicate that early Puercan recovery faunas had greater diversity than initially inferred from other areas in the Western Interior.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

THE SMALL MAMMALS OF PAISLEY CAVES: DETECTING ENVIRONMENTAL CHANGE AND COMPOSITIONAL TURNOVER AT THE YOUNGER DRYAS-HOLOCENE TRANSITION

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Paisley Caves is a world-famous pre-Clovis archaeological site located in the Summer Lake basin of central Oregon. The caves contain rich and well-studied cultural and faunal assemblages, including the oldest directly-dated human remains in the Americas and a diverse Rancholabrean megafaunal assemblage. Here we examine the extensive record of small mammal remains at Paisley Caves to evaluate the site's faunal diversity dynamics and paleoecology in the context of a prehistoric ecosystem that has been shaped by both natural and cultural influences over the millennia. We identified 1,620 specimens representing 32 species (24 genera, primarily rodents, lagomorphs, and insectivores) across a temporal window spanning from ca. 15,000 to 7,800 cal years BP within Cave 5 of the Paisley Caves complex. We placed the small mammal assemblages within a geochronologic framework using a 3D model of the stratigraphic column combined with 87 published AMS ^{14}C dates. While sample-size standardized richness and evenness remained relatively constant over time, we documented a major turnover in the underlying structure and composition of the small mammal community around 11,500 cal years BP, with the system shifting from a community dominated by Murid and Heteromyid mice (esp. *Peromyscines* and *Perognathines*) to one dominated by Lagomorphs (specifically *Lepus sp.*). The shift was also associated with a turnover within the Lagomorphs, with early communities containing *Ochotona princeps* and *Brachylagus idahoensis*, and later communities characterized by *Sylvilagus sp.*, and finally dominated by *Lepus sp.*. The proportion of woodrats (*Neotoma*), voles (Arvicolinae), squirrels (Scuridae), and pocket gophers (*Thomomys*) remained relatively constant over time relative to all other groups, but were also characterized by underlying turnover in the dominant species over time. Particularly noteworthy was the high occurrence of *Marmota flaviventris* between 11,200-11,800 cal years BP. Taken together, these compositional shifts within the small mammal community are consistent with a relatively cool and mesic terminal Pleistocene with expanded woodland and forest habitats followed by warming and drying in the transition from the Younger Dryas to the Early Holocene. Future analyses will assess the influence of humans and megafaunal herbivores on small mammal biodiversity dynamics against this backdrop of climate-driven environmental change.

Technical Session V (Wednesday, August 23, 2017, 2:45 PM)

THE END OF AN ERA: FAUNAL, PALEOENVIRONMENTAL, AND PALEOCLIMATIC CHANGES IN THE UPPERMOST CAMPANIAN-LOWERMOST PALEOCENE EDMONTON GROUP OF ALBERTA, CANADA

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The end of the Cretaceous is a period of major changes in Earth history, culminating with the extinction of dinosaurs and other organisms at the Cretaceous-Paleogene (K-Pg) boundary 66 Ma. While a large bolide impact and its aftermath are broadly recognized as a major, if not the main, factor responsible for the K-Pg mass extinction, climatic fluctuations that occurred during the Maastrichtian have been invoked as a contributing factor. However, the impact of these climatic fluctuations on terrestrial faunas remains poorly understood and their contribution to dinosaur extinction hotly debated due to the scarcity of end Cretaceous terrestrial deposits worldwide and the focus of most detailed studies on the 2 myr-long Hell Creek Formation of the northern Great Plains of the USA. The Edmonton Group of Alberta, Canada, is a fossiliferous terrestrial unit that preserves a record of the last 7 myrs of the Cretaceous and spans the K-Pg boundary, thus offering an opportunity to test the correlation between climatic fluctuations, paleoenvironmental changes, and terrestrial fauna composition at the end of the Cretaceous. In this study, the stratigraphic range of dinosaur, fish, crocodile, and turtle taxa, inferred from the stratigraphic distribution of macro- and microvertebrate specimens collected over the past 100 years, was compared to paleotemperature and paleoprecipitation estimates and paleodrainage indicators derived from the geochemical composition and pedogenic features of paleosol profiles found throughout the Edmonton Group. Results reveal significant and rapid cooling and decrease in rainfall around 71 Ma followed by a slow warming trend and increase in rainfall, subject to fluctuations, over the next 2.5 myrs. Although shifts between wetlands and well-drained habitats occurred during that time interval, they appear to be decoupled from climate changes. The last 700,000 years of the Cretaceous are characterized by well-drained habitats, warm temperatures, and low rainfall, culminating with a sudden drop in temperature and shift to wetlands just prior to the K-Pg boundary. Surprisingly, the taxonomic composition of dinosaur faunas is undisturbed by episodes of climate change, whereas fish, turtle, and crocodile diversity fluctuates, with some groups even disappearing. This pattern indicates that end Cretaceous dinosaur faunas were stable and capable of withstanding climatic fluctuations whereas ectothermic aquatic vertebrates were climate sensitive and more prone to local turnover and extinction.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

HADROSAUR FAUNAL DIVERSITY DURING THE CLAGGETT MARINE REGRESSION OF CAMPANIAN NORTHERN LARAMIDIA

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The evolution of the hadrosaur-dominated dinosaur faunas in northern Laramidia during the Campanian is recorded within the Belly River Group of Alberta and the contemporaneous Judith River and Two Medicine formations of Montana, and related regions, with these strata being deposited during the regressive portion of the Claggett marine cycle through to the transgressive portion of the Bearpaw cycle. Although hadrosaur material is known from the older Santonian formations of Alberta and Montana, it is not diagnosable. To date, the earliest Campanian hadrosaurs in these regions are all brachylophosaurin saurolophines, the oldest (~81-80 Ma) being *Acristavus* from the Two Medicine Formation of Montana (and the Wahweap Formation of Utah of southern Laramidia, which also produces the oldest lambeosaurine, *Adelolophus*, from North America). The crested lambeosaurines are absent from the early Campanian of northern Laramidia, only becoming common in the youngest Belly River Group (Dinosaur Park Formation) and equivalent strata. No diagnostic hadrosaur material has yet been described from the stratigraphically lowest member of the Belly River Group, the Foremost Formation, or from equivalent strata in Montana. *Probrachylophosaurus* from the lower Judith River Formation and an undescribed, time equivalent, *Gryposaurus*-like taxon occur in the overlying lower unit of the Oldman Formation, while *Brachylophosaurus* is known from both Alberta and Montana from the middle unit (and equivalent) of the Oldman Formation.

We report here on several historical hadrosaur partial postcrania from the lowest horizon of the upper terrestrial portion of the Foremost Formation (~80.5-78 Ma), which are stratigraphically intermediate between *Acristavus* and *Probrachylophosaurus*. We describe multiple 'kritosaurin' saurolophine individuals that are recovered in a phylogenetic analysis as the sister taxon to the South American *Secernosaurus-Willinigake* clade. Another specimen is recovered as a basal hadrosauroid most closely allied with *Lophorhothon* from the Santonian of Alabama. Although the specimens are incomplete, precluding higher level taxonomic referral, we believe that our results support the hypothesis of a possible greater hadrosaur (and possible hadrosauroid) diversity than previously recognized during the early Claggett marine regression in Laramidia, with implications for the occurrences and dispersal of hadrosaurs in South America.

Technical Session XII (Friday, August 25, 2017, 11:00 AM)

PHYLOGENY OF THE *EGERNIA* GROUP SKINKS: COMBINING MORPHOLOGICAL AND MOLECULAR DATA TO DECIPHER THE ORIGINS OF AUSTRALIA'S BLUETONGUED LIZARDS

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The *Egernia* Group is a morphologically diverse clade of skinks comprising 51 extant species from seven genera, spread across Australia, New Guinea and the Solomon Islands. Larger body size has led a number of the more iconic members of this group such as the Bluetongue (*Tiliqua scincoides*) and Shingleback skinks (*Tiliqua rugosa*) to become model species for physiological, ecological, and behavioural studies. Morphological analyses retain an important role in phylogenetics, as a means of testing the accuracy of molecular trees, and for building a framework to place fossils (and thus timescales) on these trees. To date no morphological phylogenetic analysis has been performed for the *Egernia* Group, but with a new molecular study inclusive of all the extant species soon to be published, the time is ripe for an integrated analysis of morphology, molecules and fossils. The Group's physical robustness has meant that they fossilize more easily than other Australian skinks, size also dictating that they are more likely to be recorded from palaeontological excavations. The Riversleigh World Heritage Area of northeastern Australia has so far yielded multiple fossil *Egernia* Group species; preliminary studies have resulted in one new species *Tiliqua pusilla*, and reports of undescribed *Bellatorias* and *Egernia*. Associated *Egernia* Group material recently recovered from the mid-Miocene AL90 site at Riversleigh represents the first opportunity to describe the morphology of a significant portion of a single individual, enough to place it with a higher level of accuracy into a morphological phylogeny of the *Egernia* Group as a calibration node. This morphological data set paired with a preliminary molecular

data set provided the first total evidence assessment of this important Australian reptile clade. The phylogenetic analyses place the AL90 fossil basal to the divergence of the clade inclusive of *Tiliqua* and *Cyclodomorphus* from the rest of the *Egernia*. The AL90 specimen is helping elucidate the evolutionary history of the *Egernia* Group, shedding new light on the origins of Australia's bluetongue lizards.

Technical Session III (Wednesday, August 23, 2017, 1:45 PM)

ANIMATING PALEOGNATHOUS AND NEOGNATHOUS PALATAL FUNCTION TO PREDICT CRANIAL KINESIS IN THE UNKNOWN COMMON NEORNITHINE ANCESTOR

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The split between the Palaeognathae and Neognathae, classifications based on palatal morphologies that bear directly on cranial kinesis, is recognized as the earliest within Neornithes. Morphology of the palate expected in the unknown common neornithine ancestor, however, remains ambiguous. Prokinesis—a function of neognathous palates and beaks—has at times been attributed to fossils and used to infer a primitive state within Neornithes. It seems misguided to seek a prokinetic common neornithine ancestor given the Palaeognathae are often deemed primitive within Neornithes.

We produced animations to demonstrate probable palate and pterygoid function, as evident on high-speed cineradiographic films of live birds, and explained by musculoskeletal morphology. Prokinesis in a neognathous galliform, *Meleagris*, requires a mobile pterygoid, which is absent in the Palaeognathae. So-called "ratite rhynchokinesis" was not detected in the African Ostrich, *Struthio*, the South American Greater Rhea, *Rhea*, and the Australian Emu, *Dromaius*, and each ratite species is kinetically distinct.

The rhea's upper beak is inflexible, and kinetic expression in the other ratites can be attributed to unique morphological aspects of the basic paleognathous palate. Morphology of the pterygoid-quadrate articulation is unique in the emu, and seems incapable of pushing the palate forward, as proposed in rhynchokinesis, while allowing passive upper beak retraction; whereas in the ostrich, a sliding suture between premaxilla and nasals permits the unique, parallel pterygo-palatine bars to move the palate and premaxilla slightly rostrad in response to quadrate protraction.

Preliminary analysis suggests that functional differences accompanied morphological modifications to the basic paleognathous palate, which occurred over long periods of isolation manifest in these flightless species' present distributions, and are consistent with retention with modification of a primitive palatal plan, as opposed to a derived state common to all Palaeognathae. This conclusion is congruent with works that regard the role of prominent basipterygoid processes to absorb backward palatal forces, as in forceful pecking. We propose that this condition, and early pecking behaviors associated with tooth loss, preceded the prokinetic neognathous-type palate, and that the unknown common neornithine ancestor is likely to possess an inflexible upper beak and a pterygoid similar to that of the rhea, in particular with regard to bony articulations that preclude prokinesis.

Technical Session XIII (Friday, August 25, 2017, 3:15 PM)

MICROWEAR AND FINITE ELEMENT ANALYSES OF THEROPOD DENTICLES HIGHLIGHT SHARED FEEDING STRATEGIES AMONG THEROPOD DINOSAURS, BUT DIVERGENT PREY SELECTION BETWEEN DROMAEOSAURIDS AND TROODONTIDS

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The teeth of theropod dinosaurs are easily differentiated based on the morphology and density of the denticles. These features, along with general tooth morphometric data, have been used to discriminate between different genera and species. A tearing function has been proposed for theropod denticles in general. However, the functional significance of phenotypic variation in theropod denticles has not been explored. In particular, the unusual hooked denticles found in troodontids suggest a different feeding strategy or diet. We undertook a two-pronged approach to investigating the function of denticle shape variation, using microwear analysis and finite element analysis.

We investigated teeth from the Upper Cretaceous of Spain and Canada belonging to dromaeosaurines, *Gorgosaurus*, *Richardoestesia*, *Saurornitholestes*, and *Troodon*. *Gorgosaurus*, *Dromaeosaurus*, and *Richardoestesia* have rectangular denticles, velociraptorines have pointed denticles, and hooked denticles are only found in troodontids. Using scanning electron microscopy of the lingual and labial tooth surfaces, we found two main families of scratches: one family of subparallel scratches to the longitudinal axis of the tooth, and another family of oblique scratches. The consistency of this pattern across clades and tooth morphologies indicates that most coelurosaurian theropods employed 'grip and rip' feeding movements, in which the parallel scratches form while biting down into prey, and the oblique scratches form as the head is pulled backwards with the jaws closed.

Using the information provided by our microwear analyses, we used finite element analyses to model the biomechanical response of different denticle morphologies during downward biting and oblique pulling. Our finite element analyses showed that the rectangular denticles of *Dromaeosaurus* had the lowest stresses resulting from our estimated bite forces, and the hooked denticles of *Troodon* had the highest stresses. *Troodon* denticles would have been particularly vulnerable to failure under high bite forces.

Together, our microwear and finite element analysis results show that most predatory coelurosaurs probably employed a 'grip and rip' biting strategy, but that different denticle morphologies were better adapted to high bite forces than others. Despite similar overall bauplans, troodontids and dromaeosaurids may have preferred different prey, with troodontids favouring either softer prey such as invertebrates, or smaller prey that required lower bite forces compared to dromaeosaurids.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

NEW FOSSILS FROM THE LA MESETA FORMATION OF SEYMOUR ISLAND, ANTARCTICA EXPAND OUR UNDERSTANDING OF MIDDLE-LATE EOCENE ANTARCTIC FAUNA

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The Middle-Late Eocene of Antarctica was marked by dramatic change as the continent became isolated from the other southern landmasses and the Antarctic Circumpolar Current formed. These events were crucial to the formation of the permanent Antarctic ice cap and both regional and global climate change. Seymour Island is located near the eastern coast of the Antarctic Peninsula and possesses an Eocene fossil record that provides one of our best glimpses at how life in the high latitudes responded to this climatic shift. This record is famously dominated by giant stem penguins, including the tallest penguins that ever lived. By contrast, non-penguin birds and especially non-avian tetrapods are poorly known from this time. Here, we report new fossils from Seymour Island collected by the Antarctic Peninsula Paleontology Project in 2016 that expand our view of Antarctic vertebrate diversity during the Eocene and refine our understanding of stem penguin diversity. Notably, these include a partial mammalian tooth referred to the sparnotheriodontid litoptern Notiolofos and a juvenile mammalian metapodial of uncertain phylogenetic affinity. New avian material from Seymour Island includes a distal tarsometatarsus from a gruoid (Gruiformes; cranes and trumpeters), the first report of a member of this clade from Antarctica. Remarkable penguin fossils are also present, such as: a nearly complete medium-sized tarsometatarsus with similarities to larger taxa of the stem penguin clade Anthropornis, likely representing a new taxon; a small partial tarsometatarsus similar to members of the genus Delphinornis; and the distal end of a large penguin mandible including the symphysis, only the fourth reported from Seymour.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

STABLE ISOTOPES IN NEOTHEROPOD TEETH FROM THE KEM KEM BEDS, NORTH AFRICA: INSIGHTS IN THE PALAEOENVIRONMENT AND PALAEOBIOLOGY OF LARGE PREDATORY DINOSAURS

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Stable isotopes in biominerals are an important proxy in palaeontology. In terrestrial vertebrates like dinosaurs, information on physiology, diet, and climate can be deducted from stable isotopes in bone, dentine, or enamel. The dense crystalline structure of enamel makes it resistant to post-depositional alteration, and therefore stable isotope ratios in enamel can be preserved throughout geological time. In this study, stable oxygen isotope analysis is used to yield information on the palaeoenvironment and palaeobiology of large predatory dinosaurs. Eight theropod teeth, four of *Carcharodontosaurus* and four of *Spinosaurus*, originating from the Cenomanian Kem Kem beds of North Africa, were selected for enamel sampling. Serial sampling of the larger teeth and bulk sampling of the smaller teeth provided enamel powder that was prepared for stable oxygen isotope analysis. Fluctuations in $\delta^{18}O$ along the growth axis of the larger teeth are detected, suggesting seasonal climatic variation. The majority of the $\delta^{18}O$ values of the tooth enamel from *Spinosaurus* is lower than of *Carcharodontosaurus*, which is interpreted as a more aquatic lifestyle for *Spinosaurus*.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

THE OVERLAP INDEX, A TOOL TO QUANTIFY THE AMOUNT OF ANATOMICAL OVERLAP AMONG GROUPS OF INCOMPLETE TERMINAL TAXA IN PHYLOGENETIC ANALYSES

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One of the biggest challenges in phylogenetic analyses of morphological data is missing data due to incomplete operational taxonomic units, as often occurs in fossils. This incomplete knowledge derives from various reasons, including – in the case of fossils – the numerous filters an organism has to pass through during taphonomy, fossilization, weathering, and collecting. Whereas several methods have been proposed to address issues raised by the inclusion of incomplete terminal taxa, until recently no tool existed to easily quantify the amount of anatomical overlap within a particular clade. The recently proposed Overlap Indexes provide such a value, and might prove useful for comparative cladistics. Two indexes were developed: the All Characters Overlap Index, and the Comparable Characters Overlap Index. The first quantifies the number of characters available for analysis within a clade, whereas the second quantifies the number of anatomical overlaps occurring among the characters for which at least two operational taxonomic units of a specific clade could be scored. Thus, whereas the All Characters Overlap Index includes a measure for completeness of the terminal taxa, the Comparable Characters Overlap Index does not. As such, the former is useful for the detection of underrepresented skeletal regions in particular datasets, and the latter can serve to identify operational taxonomic units providing additional anatomical information in otherwise poorly sampled morphological characters.

The indexes allow to explore and quantify, which one of a number of conflicting tree topologies is supported by more anatomical traits. Both indices serve as tools and as precursors of more elaborate analyses of comparative cladistics concerning for instance character state scoring similarity.

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

UNUSUAL DENTIN DEPOSITION IN THE TUSK OF *LYSTROSAURUS* (SYNAPSIDA: ANOMODONTIA) FROM THE EARLY TRIASSIC OF SOUTHERN PANGEA

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Among Permo-Triassic dicynodonts, *Lystrosaurus* is an iconic form well known for its bearing on the theory of plate tectonics as well as for playing a key role in the recovery of tetrapods from the end-Permian mass extinction. Previous histological research on *Lystrosaurus* has focused on postcranial elements and the evaluation of some cranial sutures. Here we report on a peculiar morphology in the root of a *Lystrosaurus* tusk and describe its histology. We sectioned eight tusks from the lower Fremouw Formation (Antarctica) and *Lystrosaurus* Assemblage Zone (South Africa) with only a single specimen displaying this unusual dental structure.

The most cervical end of the root (i.e. closer to the occlusal end of tusk) appears normal, with a circular cross-section embedded within alveolar bone. More apically (i.e. away from the occlusal end), the root has a slightly wavy border in cross-section, mostly along its lateral edge. Towards the apical end of the root, the waviness becomes increasingly exaggerated and forms a lobed morphology in cross-section. The irregularity of the root is especially dramatic in the apical-most cross-section where more extreme folds and lobing occur on the lateral side of the root. Histological analysis suggests that the folding and lobed morphology is the product of original dentine deposition. Sections of the tusk that are infolded have tubules that curve into the folds instead of the radiating pattern typically associated with centripetal growth. Furthermore, the depositional lines of von Ebner are correspondingly arched. Both of these features relate to the path taken by dentine secreting cells (i.e. odontoblasts). Plicidentine (folded dentin) has been reported for a broad range of Permo-Triassic amniotes, including early synapsids. Although the mechanism of plicidentine formation is likely similar to what produced the unusual morphology seen here, we suggest that the extreme infolding seen in this *Lystrosaurus* was related to a developmental anomaly or pathology. Given that the folding occurs prominently only on one side of the root, functional stresses from feeding may have been involved in producing this morphology. The ever-growing tusks of *Lystrosaurus* are an under-utilized window into the biology of *Lystrosaurus* and their histological study can help to shed light on this important therapsid.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

DENTAL ANOMALIES FOUND IN LIVING RACCOON DOG (*NYCTEREUTES PROCYONOIDES*) AND THEIR IMPLICATION TO DENTAL MORPHOLOGY OF EOCENE MAMMALS

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In living mammalian dentition, anomalous morphologies, which exceed a normal (or common) morphological variation within a species, have occasionally been observed. Such anomalous morphologies should have existed in fossil mammals. A diagnostic morphology in a fossil species based on a single specimen occasionally has a possibility that its characteristic is actually an anomalous morphology of its closely related species. However, it is often difficult to identify such a characteristic morphology as an anomalous morphology due to the scarcity of fossil material.

Here, I report two rare anomalous dental morphologies found in living raccoon dog (*Nyctereutes procyonoides*) and point out similar 'anomalous' dental morphologies in Eocene fossil mammals. One specimen has an extra third root on P3; and the other specimen has mesiodistally-shortened, buccally-swelled, and occlusally-triangular P4. The analogous morphologies of these teeth were found in two Eocene mammalian species, *Brachyhyops viensis* (Artiodactyla; Entelodontidae) from the Southfork Local Fauna (early Chadronian) of Saskatchewan, Canada and *Brachyhyops trofimovi* from the Ergilin Dzo Formation of southeastern Mongolia, respectively. *B. viensis* has a third root on P3; and *B. trofimovi* has mesiodistally-shortened, buccally-swelled, and occlusally-triangular p4. These morphologies are ones of the diagnoses of these two species. The anomalous dental morphologies found in raccoon dog imply a possibility that a part of the species diagnoses of *B. viensis* and *B. trofimovi* may be not diagnostic characters but anomalous morphologies.

Grant Information:
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Technical Session XI (Friday, August 25, 2017, 10:15 AM)

LATITUDINAL EFFECTS ON THE DISTRIBUTION AND DIVERSITY OF FOSSIL MARINE MAMMALS

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Currently, marine mammals (Cetacea, Sirenia, Pinnipedia) are found in all of the world's oceans and at all latitudes, but the diversity of modern marine mammals varies greatly with latitude, peaking in the mid latitudes, and decreasing in the tropics and towards the poles. Previous studies have shown that the fossil record of marine mammals is excellent, and that diversity of all three marine mammals groups has varied over time, independent of the map area of rocks in which the fossils are found. Diversity of fossil cetaceans has been associated with climate and ocean productivity, and these factors produce a peak in cetacean diversity in the middle Miocene. Here, diversity of marine mammals is analyzed in paleolatitudinal bands to determine when the modern patterns of latitudinal diversity were established, and if those patterns can be attributed to particular biological or physical factors. Data for this study was extracted from the globally comprehensive data set of marine mammal fossil occurrences in the Paleobiology Database (PBDB). Paleo positions of fossil occurrences were primarily derived from GPlates using the PBDB data service. These data show that there is a Northern Hemisphere bias in the number of occurrences and diversity of fossil all three groups. This may simply be due to the presence of more continental land mass in the Northern Hemisphere throughout the Cenozoic, yielding more coastal area associated with those land masses. These data also show an antitropical distribution from the Oligocene to the Holocene for Cetacea and Pinnipedia, with a tropical to subtropical distribution for Sirenia from the Eocene to Piocene. Sirenians expand into high North Pacific latitudes in the Pliocene, possibly occupying ecological space formerly occupied by the by then extinct Desmostylia. Fossil cetaceans and pinnipeds are more prevalent in the mid-latitudes when compared to equatorial latitudes or the poles. In the Eocene, both occurrences, diversity, and overall geographic range are relatively low at least in part due to the origin of Cetacea and Sirenia in the late early Eocene and the origin of Pinnipedia in the late Oligocene.

Technical Session XVI (Saturday, August 26, 2017, 9:15 AM)

APPENDICULAR OSTEOLOGY OF *DREADNOUGHTUS SCHRANI*, A GIANT TITANOSAURIAN (SAUROPODA, TITANOSAURIA) FROM THE LATE CRETACEOUS OF PATAGONIA, ARGENTINA

ULLMANN, Paul V., Rowan University, Glassboro, NJ, United States of America; LACOVARA, Kenneth J., Rowan University, Glassboro, NJ, United States of America

The postcranial anatomy of giant titanosaurians remains poorly known because of a combination of preservational and collection biases. This has hindered our understanding of whether specializations of wide-gauge posture may have evolved among the largest titanosauriforms in support of or as a consequence of extreme body size. *Dreadnoughtus schrani*, a recently described, large titanosaur from the Campanian–Maastrichtian Cerro Fortaleza Formation of Santa Cruz Province, Argentina, offers the first opportunity for detailed study of appendicular anatomy of a truly giant titanosaurian. The entire appendicular skeleton is represented except the manus and portions of the pes. Comparisons with related titanosauriforms reveal that the holotype skeleton (MPM-PV 1156) exhibits three appendicular autapomorphies: (1) a cranioventrally-caudodorsally oriented ridge across the medial surface of the cranial end of the scapular blade; (2) a distinct concavity on the caudomedial surface of the proximal radius; and (3) the distal end of the radius is subrectangular with subequal craniocaudal and mediolateral dimensions. Appendicular features shared between *Dreadnoughtus* and other titanosauriforms encompass a wide range of body sizes, from the giant *Argentinosaurus* to the dwarf *Magyarosaurus*. This suggests that distribution of appendicular similarities among titanosauriforms is controlled by phylogeny, not body size. Further, that gigantism arises independently in multiple titanosaurian lineages suggests wide-gauge posture may have been an exaptation for gigantism. By performing a meta-analysis of phylogenetic character matrices, we found that only a single feature occurs exclusively among the appendicular skeletons of the largest titanosauriform taxa: an accessory ventrolateral process on the preacetabular lobe of the ilium is present in *Dreadnoughtus*, *Alamosaurus*, and *Giraffatitan*. This process appears to have arisen in response to greater stress applied by hind limb adductor musculature in these giant terrestrial vertebrates. Continued investigation of titanosaurian anatomy, myology, and biomechanics is needed to gain greater understanding of the functional nature of wide-gauge posture and how it may or may not have varied among titanosaurs of differing body sizes.

Grant Information**:**
National Science Foundation Graduate Research Fellowship (DGE Award 1002809)

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

CONSIDERING FEASIBILITY OF U-PB DATING APPLIED TO CENOZOIC ISOLATED TOOTH FOSSIL

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Uranium-lead (U-Pb) dating is one of most common radiometric dating methods. It is based on comparing abundances of radioactive element (U) and its decay product (Pb). The method has the advantage of two different decay processes of U-series. Thus, the U-Pb dating has been often applied to a closed-system mineral in determining the depositional age.

The U-Pb dating has been recently applied to tooth and bone fossils and succeeded in achieving expected dates. These materials were, however, almost limited to Mesozoic or older materials. Biological apatite (bioapatite) and Cenozoic materials endogenously have profound problems for U-Pb dating; (1) bioapatite does not always act as a closed system. Abundance of elements related to the dating is easily affected by its uptake and loss, (2) radiogenic elements are often too small in Cenozoic materials because decay Pb does not yet accumulate sufficiently in young materials.

For verifying feasibility of U-Pb dating applied to Cenozoic bioapatite, we used a fragmental molar of *Desmostylus*, a Miocene marine mammal. Morphology is well preserved in appearance. It was collected from the Tonokita Formation, Akan, Hokkaido, Japan, which was estimated at 14.9-15.9 Ma by biostratigraphy. We created a mirror surface by polishing the longitudinal section. A two dimensional isotopic mapping was made by LA-ICP-MS. U/Pb and Pb/Pb were calibrated based on the standard reference material in glass (NIST SRM612).

Based on the mapping, thorium (Th), a parent nuclide of Th-Pb decay process, was little measured in the whole analyzed area, revealing contained ^{208}Pb was not a radiogenic Pb. In the dentine area, concentration of U was approximately two orders of magnitude higher than in enamel, but it was probably concentrated due to diagenesis because the microstructure of dentine was not preserved. Assuming that the diagenetic process was occurred within a short time period, the isochron dating was conducted in the U-concentrated area. The estimated age was 7 Ma, which was extremely different from the expected one.

There are potentially two possibilities for explanation the result; one is systematic error in Pb/U calibration caused by using non-matrix matching calibration standard, the other is that the ages of the forming dentine and diagenetic alteration were occurred in different time. If the latter possibility was true, when radiometric U-Pb dating was applied to

young bioapatite such as Cenozoic materials, it might be necessary to pay attention that tooth formation and related element contamination are not same time.

Podium Symposium (Wednesday, August 23, 2017, 8:30 AM)

EVOLUTION AND DEVELOPMENT OF BAT WINGS

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Comprising 20% of living mammals, bats (Order Chiroptera) are the only mammals capable of powered flight. Bats achieve powered flight through specializations in their forelimbs, including longer digits and novel wing membranes. The earliest known fossil bats date to ~50mya. These bats appear to possess the typical bat hallmarks of elongated digits and wing membranes, and appear to have been capable of powered flight. In fact, our morphometric analyses suggest that their limb morphology was already very similar to that of modern bats. Thus, understanding how bats modified their limbs to achieve powered flight requires studies that reach beyond the fossil record. We have been using development as a tool to gain insights into the morphological evolution of hallmarks of the bat limb. Our studies suggest that the elongated digits of bat forelimbs arise through multiple mechanisms. During earliest outgrowth, the bat forelimb is similar in size to that of mouse. However, during subsequent patterning, bat forelimbs display a larger ZPA and AER, and associated fields of *Shh* and Fgf8 expression, respectively. Shh expression also turns back on later in development, driven by novel *Fgf8* expression, to create a self-sustaining feedback loop with *Bmp2*. We have experimentally demonstrated that upregulation of the *Bmp* pathway leads to increased cell proliferation and digit elongation. In regard to wing membranes, studies suggest that novel Fgf8 expression in the bat interdigital tissue represses *Bmp* signaling, prevents regression of the tissue, and thereby forms the dactylopatagium. We are currently investigating the origination of the novel wing membranes (plagiopatagium, uropatagium) in the bat forelimb. These novel membranes begin to form at Stage 14-15 of development, and we are currently studying when and how these novel wing membranes initially form and eventually diverge among species.

Grant Information:
NSF

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

BUILD-A-BONE SKELETON JIGSAW

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Bones are an excellent resource for engaging youth in learning about science and the natural world. We utilize bones in numerous outreach activities to illustrate both the diversity and similarities across vertebrate species. We bring a variety of articulated and disarticulated skeletons to outreach events (including cats, rodents, rabbits, opossums, bats and birds). Students from K-8 are invited to use the articulated skeletons as guides to help them reassemble the disarticulated skeletons, much like a jigsaw puzzle. In the process, they notice that despite differences in size and shape between the various vertebrate species present, there remains a general similarity in the type and number of key bone structures. Additionally, students are able to examine skeletal elements in cleared and stained embryos at various developmental stages. This allows them to witness the similar structures in early development that then begin to diverge as the embryo matures. It also displays how most of the bones begin as cartilaginous structures, then ossify later in development. Lastly, we display whole mount in situs of several embryos that have been stained to highlight the expression of bone morphogenetic proteins (BMPs). This is intended to show participants that the same genetic toolkit can lead to many diverse phenotypes. The same genes that form bones in the specimens they see before them are the the same genes that form their own bones as well. Seeing the whole process, from gene expression, to the cartilage precursor, all the way to the fully developed and ossified structures, gives students a better appreciation for the importance of bones.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ENVIRONMENTAL DRIVERS OF LAMNIFORM SHARK EVOLUTION FROM THE LATE CRETACEOUS TO EARLY PALEOGENE

VAN DIJK, Jeroen, Uppsala University, Uppsala, Sweden; BAZZI, Mohamad, Uppsala University, Uppsala, Sweden; ŽIGAITE, Živilė, Uppsala University, Uppsala, Sweden; CAMPIONE, Nicolas E., Uppsala University, Uppsala, Sweden

Abiotic conditions, such as ocean temperatures and sea level, play the role of the Court Jester by incurring extrinsic selective pressures on organisms and ecosystems. In comparison, the Red Queen hypothesis implies that biotic interactions are more important selection drivers of evolution. Although the debate remains unresolved, abiotic factors are often considered to be more important drivers of macroevolutionary change (i.e., over long periods of geologic time), including morphological, speciation, and, above all, extinction dynamics.

This study explores dental-shape variation in lamniform sharks and tests for a correlation between dental morphology and climate change (Court Jester Hypothesis). Teeth of lamniform sharks are morphologically diverse and are common throughout the fossil record, making them a model system for investigating macroevolutionary patterns. Our study focuses on Late Cretaceous to Eocene disparity patterns, a period of time that environmentally spans 1) high sea levels and sea-surface temperatures during the Cenomanian, which may have played a critical role in the diversification of marine macropredators (e.g., lamniform sharks), 2) the K–Pg extinction event, which may have incurred notable drops in lamniforms diversity, followed by 3) purported recovery in the Paleogene, possibly associated with the expansion of modern coral reef ecosystems.

A two-dimensional geometric morphometric data set of 311 lamniform teeth forms the basis for measuring disparity across the Late Cretaceous–Eocene. Time-series generalized least squares models applied to test for a relationship between disparity and previously published estimates of temperature ($\delta^{18}O$) and sea level (New Jersey Sea Level Record), tested either independently or in association, found that only temperature has a significant relationship. Temperature received greater AIC support than a null model of random disparity shifts over time, though the latter could not be rejected outright. These results were robust to autoregressive corrections, and were independent of the mass extinction event. It is possible that the temperature-dependent relationship can be attributed to a common cause mechanism (i.e., temperature affected lamniform food sources). Nevertheless, our results support previous assertions suggesting a link between temperature and elasmobranch diversity during the Cenozoic, and also hint at temperature playing a major role, whether direct or indirect, in the K–Pg extinction of lamniforms.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A TIME TO BROOD: INCUBATION PERIOD IN THE THEROPOD DINOSAUR *TROODON FORMOSUS*

VARRICCHIO, David J., Montana State University, Bozeman, MT, United States of America; KUNDRÁT, Martin, Pavol Jozef Safarik University, Kosice, Slovakia; HOGAN, Jason, Montana State University, Bozeman, MT, United States of America

Maniraptoran dinosaurs such as oviraptors and troodontids share several important reproductive characters with modern birds, including eggshell microstructure and iterative egg production. Nevertheless, debate exists concerning their incubation strategies and how it relates to that of modern birds. Parental care and brooding with active heat transfer to eggs have been inferred for these dinosaurs based on clutch-associated adults and clutch-nest configuration. However, limited contact between adult and eggs and the inefficiency of transferring body heat to largely buried eggs may favor incubation from soil burial and reptile-like nest guarding. Here we estimate incubation period for the troodontid, *Troodon formosus*, based on growth-line counts in embryonic teeth.

We examined an embryonic *Troodon* tooth, Museum of the Rockies (MOR) #246-11, measuring 0.36 by 1.9 mm and similarly sized to erupted, in situ teeth for this near-term embryo. Scanning, performed at the beamline ID19 of European Synchrotron Radiation Facility in Grenoble (France), used propagation phase contrast synchrotron microtomography with a monochromatic energy beam of 30 keV. We counted daily growth lines, lines of von Ebner, off a longitudinal section adding lines to compensate for the missing tooth tip. Modern crocodillians begin to establish their functional dentition at 42-52% of the total incubation period, values used here for *Troodon*. Regressions of egg mass versus incubation period from modern vertebrates provide estimates of expected values for avian and reptilian incubation endpoints.

MOR 246-11 preserves 31 intact growth lines with an average spacing of 3.1 µm. Adding 8 additional for the missing crown tip, gives an age of 39 days for the tooth and an incubation period of between 67 and 81 days, or an average of 74 days. Based on an egg mass of 314 g, the *Troodon* incubation period falls nearly midway between predicted avian (44.4 days) and reptilian (107.3 days) values. A shortened incubation period relative to modern reptiles supports brooding whereby adult troodontids elevated clutch temperatures sufficiently over environmental conditions. This concurs with a suite of features in both oviraptors and troodontids, sequential laying, large complex clutches, precocial young, and presumed synchronous hatching, that appear dependent upon both adult body and incubation temperatures elevated over ambient conditions. However, brooding of largely buried *Troodon* eggs would appear to have been too inefficient to operate within an avian-like incubation period.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 8:45 AM)

UNEXPECTED DENTITIONS DISCOVERED IN THREE GENERA OF EARLY DEVONIAN ACANTHOTHORACID PLACODERMS FROM THE PRAGUE BASIN (CZECH REPUBLIC)

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Acanthothoracid placoderms are stem gnathostomes with a distinctive cranial morphology, featuring a long trabecular region that protrudes in front of the nasal capsules, which suggests that they are among the most primitive jawed vertebrates. They could thus be informative about the origin of jaws and teeth. Only two supposed acanthothoracid dental elements have been described: one may not belong to an acanthothoracid and the other, an isolated element, is probably a dermal tessera. In the course of investigating acanthothoracid material from the Lower Devonian of the Prague Basin by synchrotron microtomography, we have discovered well-preserved dentitions in the genera *Kosoraspis*, *Radotina* and *Tlamaspis* that differ fundamentally from the published examples. The teeth of *Kosoraspis* grow on long, narrow bones with transversely concave basal surfaces. At least six elements can be attributed to one individual. The teeth are arranged in transverse files, gradually enlarging towards the lingual side. The bones have no distinct facial laminae, but appear to have been located immediately adjcent to the jaw margin. In *Radotina*, a posterior supragnathal is preserved in articulation on the palatoquadrate complex. It is a long, slender bone, carried by the suborbital rather than the palatoquadrate and located immediately inside the jaw margin. The teeth are blade-like, resembling the odontodes on the edges of the dermal tesserae of *Radotina*, and are arranged in alternating tooth files. The tooth-bearing bones of *Tlamaspis* (a new genus, previously included in *Radotina*) are marginal elements with a deep facial lamina; this lamina carries 3-4 rows of odontodes near the jaw margin, the most marginal row taking the form of large, well-spaced conical teeth. These dentitions bear no resemblance to those of arthrodire placoderms, but share characteristics with those of primitive osteichthyans and chondrichthyans. They will have a major impact on our understanding of dental evolution.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

CONTINENTAL BREAKUP AND THE EVOLUTION OF BODY SIZE IN DINOSAURS

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The evolution of dinosaur body size through the Mesozoic has received considerable attention, particularly as this group contains by far the largest terrestrial animals to have ever existed. While a large amount of attention has been directed at intrinsic drivers of body size in dinosaurs, there has been relatively less work focused on extrinsic factors that may have created constraints in body size, such as the size and distribution of terrestrial regions. Research into the effect of continental area and maximal body size in Cenozoic mammals has previously shown a possible relationship between the two, however until recently there was neither adequate body mass nor spatial datasets available to test this hypothesis for Mesozoic dinosaurs.

Initial results from this study have recovered land area as a potential driver of maximal body size in dinosaurs. In particular, continental area appears to be correlated with body mass changes in Cretaceous environments, with larger land areas generally able to support larger taxa. As well, the reduction in sauropod diversity through the Cretaceous, and the absence of the taxon in northern continents during certain intervals of extreme continental fragmentation, may be related to evolutionary constraints within the group, although support for this correlation is presently weak. Regardless, changes in terrestrial area and the degree of continental fragmentation are important factors that should be considered in large, globally synthetic dinosaur studies, as extrinsic factors such as geography may play an important role in the mode and tempo of dinosaur evolution.

Technical Session XIV (Friday, August 25, 2017, 2:00 PM)

LIFE HISTORY EVOLUTION IN CAVE BEARS – ELUCIDATING THE BIOLOGY OF AN EXTINCT MEGAFAUNAL ELEMENT

VEITSCHEGGER, Kristof, Zurich, Switzerland

During the Pleistocene, Eurasia was home to one of the biggest bear species in history, the cave bear. Tthe biology of this animal was subject of much interest due to their abundance in the fossil record. It was discovered that cave bears were herbivorous with a diet dominated by foliage. In recent years, studies have proven the potential of paleoneurology and paleohistology to elucidate the biology of cave bears. The study of relative brain size or encephalization provides insights into life history strategies such as litter size or gestation time. I collected and investigated a dataset of 412 brain and body size estimates based on the skulls of 10 extant and extinct bear species. The encephalization quotient (EQ) of cave bears is significantly lower than that of most other species. Cave bears exhibit an EQ of 0.60, which is considerably lower than the one of brown bears (0.83) or the one of sun bears (1.31). Using ancestral stage reconstruction, it is evident that a decoupled body/brain size evolution affected the encephalization of cave bears. Additionally, the change to a less energetic diet source and hibernating behaviour showed an influence on the degree of encephalization. Based on relative brain size, I hypothesize that cave bears had a small birth and weaning weight but produced many cubs and had a prolonged gestation time. Bone histology can be used to reconstruct the speed of growth of animals as well as the age of skeletal maturity. For this, the midshaft of 83 femora of seven extant and extinct bear species, including samples from24 different cave bear localities in Europe, were sampled and investigated. Bears possess a fibrolamellar bone and differ mostly in the amount of lamellar bone and of secondary remodelling. To study growth, the distance between lines of arrested growth (LAGs) was measured. These lines are deposited yearly and are correlated with age in bears. After the 11^{th} – 13^{th} LAG the outer circumferential layer (OCL) is produced; the latter is a marker for skeletal maturity. In brown bears, the OCL is produced after LAG 6 or 7 and in the polar bear after LAG 10. The sun bear and sloth bear, both tropical bear species, reach skeletal maturity early after LAG 5 and 6 respectively. The distance between LAGs showed that cave bears grew at a considerable speed and that they reached skeletal maturity later in life compared to other bear species. Longevity estimates based on cementum analysis of 95 cave bear teeth from 21 localities provided a minimum age of 29 years for cave bears.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 11:00 AM)

PHYLOGENETIC REASSESSMENT OF *ARMIGATUS ALTICORPUS* (TELEOSTEI, CLUPEOMORPHA, ELLIMMICHTHYIFORMES) AND NEW CLUPEOMORPH MATERIAL FROM THE LATE CRETACEOUS (CENOMANIAN) OF HAKEL, LEBANON

VERNYGORA, Oksana V., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

The extinct genus *Armigatus* (Teleostei, Clupeomorpha, Ellimmichthyiformes) comprises five species of small marine fishes described from the Late Cretaceous Tethys Sea. Members of the genus *Armigatus* are distinguished from the other ellimmichthyiform clupeomorphs, by the presence of incomplete predorsal series of heart-shaped or oval scutes. The oldest fossil record of the group is described from the Cenomanian deposits of Lebanon that yielded three out of five species of *Armigatus*, the type species *A. brevissimus* from Hakel and Hajula, and two species, *A. namourensis* and *A. alticorpus*, described from Namoura. The other two species are known from Cenomanian – Turonian deposits of Morocco, *A. oligodentatus,* and Campanian deposits of Croatia, *A. dalmaticus*. With the new species being described, the phylogenetic relationships within the genus remain an unresolved issue. The most recent and extensive cladistic analyses of the group exclude *A. alticorpus* due to the lack of sufficient information for the taxon.

We report new *Armigatus* material from Hakel, Lebanon collected in 1998 and housed in the Royal Tyrrell Museum (Alberta, Canada). Two large slabs, TMP 1998.65.11 and TMP 1998.65.12, preserve multiple clupeomorph fishes including two species of *Armigatus*, *A. namourensis* and *A. alticorpus*, which have previously been known only from Namoura, Lebanon. Preservation of the skull elements and caudal skeleton of the *A. alticorpus* specimens provides necessary information for addition of the species in a phylogenetic analysis. Results of the phylogenetic reassessment of *A. alticorpus* indicate that the species had close affinities to the two younger species, *A. oligodentatus* and *A. dalmaticus*. The three species together (*A. alticorpus* (*A. oligodentatus* + *A. dalmaticus*)) belong to a separate lineage diverging from their sister-clade, (*A. brevissimus* + *A. namourensis*).

The new *Armigatus* material further indicates faunal similarity between Cenomanian localities in Lebanon, Hakel and Namoura. The relatively high species diversity and older age of the fossils suggests that the eastern part of the central Tethys is a potential centre of origin of the group. This hypothesis is congruent with the results of our phylogenetic analysis and the ancestral range reconstruction which indicate origin of *Armigatus* in the eastern central Tethys and successive dispersal north (*A. dalmaticus* from Croatia) and west (*A. oligodentatus* from Morocco).

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THE TITANOSAUR TAILS FROM LO HUECO (CUENCA, SPAIN): FOUR DIFFERENT WAYS TO SHAKE?

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Lo Hueco is an Upper Cretaceous (Campanian-Maastrichtian) macro-vertebrate fossil site, where more than fourteen partially articulated and/or associated titanosaur sauropod specimens have been found. So far, only *Lohuecotitan pandafilandi* and a braincase tentatively referred to cf. *Ampelosaurus sp.,* have been identified. The presence of several articulated titanosaur caudal series and the usage of 3D modelling is a unique opportunity for morphofunctional and biomechanical analyses.

The preliminary description of six proximal-middle caudal series (with totally fused neurocentral sutures) suggests the presence of four different morphotypes. Morphotype I has short, anteriorly curved neural spines, high pedicels, and dorsally inclined prezygapophyses. Morphotype II has longer and posteriorly inclined neural spines; short pedicels; slender, long and horizontal prezygapophyses and postero-distally curved anterior chevrons. Morphotype III has short, anteroposteriorly expanded distal end of the neural spines, high pedicels, horizontal and short prezygapophyses and straight chevrons. Finally, the tail of *Lohuecotitan* does not belong to the abovementioned morphotypes, as it has straight and perpendicular anterior neural spines, anteroposteriorly short pedicels, horizontal prezygapophyses and straight chevrons.

Considering the neural spines orientation, which corresponds to the resultant force of the individual forces exerted by muscles and ligaments, Morphotype I would have had a stronger posterior force acting upon the spine, Morphotype II would have had a stronger anterior force acting upon the spine and Morphotypes III and *Lohuecotitan* would have had the anterior and posterior forces at balance. The further the pre-postzygapophyseal contact gets from the articulation of centra, the smaller the range of motion is, so Morphotypes I and III would have had more restricted ventriflexion than morphotypes II and *Lohuecotitan*. The distally curved chevrons of Morphotype II imply a smaller relative attachment area for the caudofemoral musculature compared with the straight chevrons of Morphotype III and *Lohuecotitan*.

This preliminar analysis suggests the titanosaurs from Lo Hueco had very different forces acting upon their caudal vertebrae, ranges of motion and muscular surface insertions. Future analyses will help to evaluate the relation among different type of motions and body plans, as well as their taxonomical significance.

Grant Information:
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Romer Prize Session (Thursday, August 24, 2017, 10:45 AM)

INTEGRATING CLIMATE, VEGETATION, AND MAMMAL COMMUNITY DIVERSITY IN PLIOCENE EAST AFRICA: IMPLICATIONS FOR EARLY HOMININ EVOLUTION

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The ecology of the mid-Pliocene has recently gained attention because of its importance in both our past and future. As a relatively warm period before the glacial and interglacial periods of the Quaternary, the middle Pliocene is an analogue for future climates. More recently, the discovery of evidence for human tool use and behavioral shifts, shows that this period was also a dynamic period of hominin evolution. Though many large-scale correlations between climate and human evolution have been postulated, few have made explicit connections between climate, habitat, and the mammalian community. The heterogeneity-diversity hypothesis makes an explicit ecological connection between vegetation structure and mammalian diversity, positing that as habitat heterogeneity increases, mammalian diversity also increases as a result of increased niche space. Vegetation structure, in turn, is found to be most strongly related to rainfall in extant systems. This study thus connects mammalian community structure to both vegetation structure and abiotic factors across 400 thousand years in the Turkana Basin (3.6-3.2Ma). To measure vegetation structure in the fossil record, stable carbon isotopes from soil carbonates were collected from over 77 km in East Turkana, Kenya (n=128) and were transformed into a point estimate of woody cover. Paleoclimatic data are estimated from previously published global temperature data and stable oxygen isotopes from soil carbonates that act as a rough measure of local hydrology (n=128). Mammalian fossils were strategically collected from the same sites as the soil samples (n=172). Vegetation structure was significantly correlated with both local and global climatic variables in the older period analyzed (3.6-3.4Ma) and becomes uncoupled in younger sediments (3.4-3.2Ma). Vegetation structure was found to be both autocorrelated and more variable in older sediments. As predicted, mammalian community diversity is significantly lower when vegetation diversity decreases in younger sediments. During the younger period in the Turkana Basin (3.4-3.2Ma), tool use has recently been described at 3.3Ma, which couples with a global warming peak. Thus, this study demonstrates that regional and

temporal variation of multiple proxies provide missing ecological connections between climate, habitat and mammalian community structure.
Grant Information:
Thanks to the Leakey Foundation and the National Science Foundation (DGE-1246908)

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

3D CAMOUFLAGE IN A LARGE-BODIED, HEAVILY ARMORED ANKYLOSAUR REVEALS NON-UNIFORMITARIAN MESOZOIC PREDATOR-PREY DYNAMICS

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Camouflage is a widespread adaptation for, and against, predation, with varying expression between organisms and across habitats. Nonetheless, there are general features that characterize certain habitats and organismal ethologies. Countershading, possessing a darker dorsum and lighter ventrum, acts to counter illuminate shading on the body of animals in order to conceal this conspicuous cue to their shape. Countershading has been shown to vary predictably with the light environment a direct testament to the efficacy of camouflage, and the strong selective pressure that predation has in evolving these patterns.

Today the largest bodied animals encounter low predation risk as adults. Hence, elephants, rhinos, hippos and moose do not exhibit countershading and may even enhance their shape by making the ventral surface darker. However, modern predators (e.g. wolves and large cats) differ from Mesozoic forms, such as large theropod dinosaurs (e.g Ceratosauria, Megalosauroidea, Allosauroidea and several members of the Coelurosauria), which likely incurred very different predation pressures that may have made even large herbivorous dinosaurs vulnerable in life. However, direct evidence for megaherbivore predation is scarce, as coprolite and tooth mark evidence could result from scavenging, while healed attack scars represent failed attempts.

Here we show that a large Early Cretaceous nodosaurid ankylosaur weighing about 1300 kg was countershaded. Organic material preserves the integument on the dorsal surface of the large epiosteodermal scales that would have originally been keratinized as well as the thick inter-scale epidermis. The organic material does not preserve distinct melanosomes, but TOF SIMS analyses reveal signatures consistent with melanin that are abundant in sulfur rich moieties, previously identified for phaeomelanin.

The body mass of this new dinosaur greatly exceeds the largest modern terrestrial mammals that are countershaded. Furthermore, it sports heavy armor, in the form of osteoderms up to half a meter in length. Being countershaded is direct evidence for active predatory selection in adulthood, which demonstrate that Mesozoic theropod predators incurred predation risks to megaherbivores in a fashion that is incomparable to any living terrestrial predator. This highlights the non-uniformitarian terrestrial ecosystem of this time in which gigantic theropod dinosaurs with extremely good tri or tetra-chromatic vision roamed and selected for fine tuned camouflage strategies.

Grant Information:
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

MORPHOLOGICAL RESPONSE OF THREE CLOSELY RELATED SMALL-BODIED MAMMALS (EULIPOTYPHLA, ERINACEOMORPHA) TO CLIMATE CHANGE ACROSS THE PALEOCENE-EOCENE THERMAL MAXIMUM

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Dental morphology (size and shape) through time can reflect how mammals responded to past climate change related to shifts in body mass, dietary ecology, or population distributions. One interval to study these dynamics in is the Paleocene-Eocene Thermal Maximum (PETM) of the Bighorn Basin (BHB), Wyoming ~56 Ma. The PETM is marked by the rapid onset of a negative carbon isotope excursion that lasted ~175 ky with an associated shift towards warmer global mean annual temperatures (MAT) by ~5-10 °C, followed by a return to pre-excursion MAT. At least 40% of measured mammalian genera recovered from the BHB are smaller during the PETM compared to adjacent intervals. Size change among taxa is not predicted by trophic category, endemism, or phylogeny. Tooth crown shape in a single previously studied endemic taxon (*Ectocion*) remains relatively static, while two immigrant taxa (*Cantius*, *Macrocranion*) undergo short-term change during and after the PETM, raising the question of whether endemism influences the response to climate change in terms of this metric.

To address this question we created 3D digital models of the lower first and second molars (M_1, M_2) of *Macrocranion* (n = 21, 20), cf. *Colpocherus* sp. (n = 13, 14), and *Talpavoides* (n = 14, 12), three putatively anagenetic lineages of small-bodied (~22 g, ~22 g, ~9 g) erinaceomorph insectivores. *Talpavoides* is an endemic taxon. *Macrocranion* and cf. *Colpocherus* sp. both first appear at the beginning of the PETM (Wa-0). *Macrocranion* persists in the BHB after the PETM through the late Eocene but cf. *Colpocherus* sp. disappears shortly after the end of the PETM. We characterized the morphology of each tooth by calculating tooth size, relief index (RFI), and Dirichlet Normal Energy (DNE).

Macrocranion decreases in size from the early PETM to the relatively warmer mid-PETM then returns to a larger size post-PETM. *Talpavoides* and cf. *Colpocherus* sp. do not change significantly in size through the interval. In contrast to *Talpavoides*, *Macrocranion* and cf. *Colpocherus* sp. both show similar patterns of shape change: RFI decreases ($p = 0.017$, Macrocranion) and DNE increases ($p = 0.004$, 0.051). In Wa-2, when cf. *Colpocherus* sp. is absent, DNE and RFI of *Macrocranion* return to early-PETM values. The immigrant taxa appear to be more morphologically sensitive to environmental change than the endemic *Talpavoides*, similar to previous results. Other factors, such as geographic affinity and locomotor habit may also help explain the differences in patterns in these three taxa and should be explored.

Grant Information:
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Technical Session X (Friday, August 25, 2017, 11:15 AM)

PRESERVATION OF ENDOGENOUS COLLAGEN I IN A MARINE CROCODILE, *THORACOSAURUS NEOCESARIENSIS*

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Still-soft tissues and the molecules comprising them persist in the fossil record, but the majority of these discoveries derive from just a few preservational environments (e.g., fluvial sandstone, overbank deposits, marine phosphatic chalk). Long-term (My+) saturation in water was once thought to inhibit biomolecular preservation over geologic timescales, resulting in fewer investigations of marine fossils compared to those from terrestrial environments. Cretaceous fossils from a rare marine depositional environment (glauconite or "marl" sand) recorded at Edelman Fossil Park at Rowan University, NJ, have recently been investigated for preservation of tissues, cells, and their biomolecules. Similar to terrestrial environments documented to preserve biomolecules, this environment is rich in iron, which has been suggested to facilitate preservation.

Here we report results from analyses of a femur from the marine crocodile, *Thoracosaurus neocesariensis*, only the second marine vertebrate taxon from which endogenous biomolecules have been reported. Protein extraction was performed and the resultant supernatants were electrophoretically separated on a polyacrylamide gel. Silver-staining supported the presence of organics exclusively in fossil lanes (all controls were negative). Protein extracts were also subjected to enzyme-linked immunosorbant assay, and showed specific binding to anti-alligator collagen antibodies. Further, immunohistochemistry analyses on sections of demineralized bone showed specific *in situ* binding with anti-avian collagen I antibodies. Collagen I is a highly conserved protein and these samples react to antibodies against modern archosaurs, providing robust support for the endogeneity of these remains. Soft tissue products morphologically consistent with osteocytes and fibrous matrix were also recovered after demineralization of *Thoracosaurus* cortical bone. These results agree with previous models of decay processes indicating long-term submersion in water does not exclude soft tissue and molecular preservation, if these materials are in chemical equilibrium with their environment, and stabilized early in diagenesis. By documenting molecular preservation in a siliciclastic marine environment, this research increases the potential range of depositional settings and taxa available to future molecular paleontological studies.

Grant Information:
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Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

ENAMEL DIFFERENTIATION IN SORICID MOLARS

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Most Soricomorpha and even most of the Lipothyphla share a one-layered schmelzmuster consisting of radial enamel. The prisms reach the outer enamel surface or vanish among the interprismatic matrix in an outer zone. Transverse sections of lower molars in about 60 fossil and extant shrews were analyzed. Heterosoricidae and the soricid Crocidorsoricinae, Crocidurinae and Limnoecinae fit into the general pattern of a one-layered schmelzmuster with minor modifications. Soricinae, however, the shrews with reddish pigmented teeth, are characterized by a more differentiated two-layered schmelzmuster. The inner layer of a specialized radial enamel with inter-row sheets is a new feature. Prisms and inter-row sheets are partially laterally inclined. This lateral inclination varies in direction and intensity. It may be so intense that it resembles tangential enamel.

Three levels of differentiation of the inner layer can be recognized within the Soricinae that roughly correlate to the tribes exemplified in the paralophids of lower molars. First, the *Sorex*-schmelzmuster, with a lateral inclination only at the paraconid and metaconid, is found in most Soricini. Secondly, *Notiosorex*-schmelzmuster showing a very thin inner layer with little inclination, but a broadened outer layer, occurs only in this genus. Thirdly, *Blarina*-schmelzmuster, with an inclination in positive direction at paraconid and in negative inclination towards the protoconid, including a neutral point in between. This third and highly derived schmelzmuster characterizes Blarinini, Blarinellini, Beremendini, and Nectogalini.

Some discrepancies with the standard systematics occur: The Anourosoricini lack the inner layer found in other Soricinae. *Zelceina* and *Deinsdorfia*, although listed as Soricini, have the typical *Blarina*-schmelzmuster. These taxa, however, occur at varying positions in different cladograms.

The few soricine taxa from early and middle Miocene show the less derived one-layered schmelzmuster. The differentiation of the schmelzmuster occurred during the uppermost Miocene and Pliocene, most probably evolving several times independently. The pigmentation is independent from the schmelzmuster.

The differentiation on the enamel of shrews might provide an additional tool for clarifying their phylogenetic relationships.

Grant Information:
Deutsche Forschungsgemeinschaft FOR 771

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

DINOSAUR EGGSHELL ASSEMBLAGE FROM THE UPPERMOST CAMPANIAN—LOWER MAASTRICHTIAN ST. MARY RIVER FORMATION OF SOUTHERN ALBERTA, CANADA

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Alberta possesses one of the best Upper Cretaceous fossil records in North America with respect to dinosaur eggshells and skeletal material. Dinosaur eggshell assemblages have been reported from the upper Santonian (Milk River Formation) through the upper Maastrichtian (Willow Creek Formation), but a major gap in the fossil record of eggshells exists for the lower Maastrichtian. Here we report a dinosaur eggshell assemblage from the uppermost Campanian-lower Maastrichtian St. Mary River Formation of southern Alberta, a rock formation that preserves abundant dinosaur tracks yet little skeletal remains. Eighty-four eggshell fragments were recovered from seven localities distributed stratigraphically through the entire formation. The eggshells were sorted into different morphotypes, their thickness measured, and their structure described via scanning electron microscopy and radial thin sections. The St. Mary River eggshell assemblage consists of four theropod ootaxa (*Continuoolithus* cf. *C. canadensis*, *Montanoolithus* cf. *M. strongorum*, *Prismatoolithus* cf. *P. levis*, and an unidentified ootaxon) and a single hadrosaur ootaxon (*Spheroolithus* cf. *S. albertensis*). The St. Mary River Formation records a lower diversity of ootaxa than the overlying Willow Creek Formation and the next underlying terrestrial formation, the Oldman Formation, although this could potentially be an artifact due to small sample size. Nearly all ootaxa recognized in the St. Mary River Formation first appear in the Campanian (Oldman Formation of southern Alberta and Two Medicine Formation of northern Montana) and persist into the upper Maastrichtian Willow Creek Formation. The exceptions are *Continuoolithus*, which first appears in the upper Santonian Milk River Formation, and the unidentified theropod eggshell, which may be unique to the St. Mary River Formation. Given the positive relationship between eggshell thickness and body mass in theropods, the St. Mary River eggshells were compared to those found in other Upper Cretaceous formations of Alberta. Our results confirm the previous claim of an overall increase in theropod eggshell thickness (except for *Montanoolithus*) between the upper Santonian and upper Maastrichtian, indicating that small theropods increased in body size during the Upper Cretaceous.

Grant Information:
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Technical Session I (Wednesday, August 23, 2017, 11:15 AM)

EVIDENCE FOR ONTOGENETIC TOOTH REDUCTION IN OVIRAPTOROSAURS AND BIRDS, AND THE MACROEVOLUTION OF EDENTULISM IN THEROPODA

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Beaks are innovative structures characterizing several theropod lineages including modern birds, but little is known about how developmental processes influenced the macroevolution of these important structures. Here we show that vestigial alveoli are present in several beaked lineages of theropod dinosaurs. In caenagnathid oviraptorosaurs, the occlusal grooves present on the lateral margins of the dentary are interpreted as vestigial alveoli. These structures communicate via foramina with an additional mandibular canal superior to the neurovascular canal in some small specimens, a pattern similar to that observed in *Limusaurus*. This additional canal is also present in the Early Cretaceous bird *Sapeornis*, and the morphology of anterior alveolar vestiges in this taxon is comparable to that of caenagnathids. Based on new morphological data and study of macroevolutionary patterns of tooth reduction in extant vertebrates, we propose that ontogenetic truncation of tooth development is a mechanism contributing to tooth reduction in various theropod lineages that eventually reach edentulism. Dental reduction in theropods appears to have passed through at least four common steps: (I) normal tooth development and tooth replacement with an apomorphic keratinized rhamphotheca covering only the rostral-most portion of the jaws; (II) tooth replacement is impeded by external closure and/or constriction of alveoli, perhaps in association with adjacent growth of the rhamphotheca—regional tooth reduction occurs; (III) as the keratinized rhamphotheca enlarges, the remaining teeth are either functionally reduced or redundant; and (IV) alveolar remodeling is complete or nearly complete, the edentulous beak is completely covered by the rhamphotheca.

The transitions involved in this process can be observed in both ontogenetic and phylogenetic dimensions, though the rarity of taxonomically and stratigraphically controlled ontogenetic series hinders documentation of ontogenetic reduction in the fossil record. However, an analysis of neontological and paleontological evidence from numerous independently edentulous vertebrate lineages suggests ontogenetic reduction of the dentition is a relatively common phenomenon. Evidence for a model of progenesis heterochrony involving progressively earlier truncation of odontogenesis (postnatally and embryonically) can be observed in most extant edentulous lineages, supporting this hypothesis for the macroevolution of non-avian and avian theropod beaks.

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Technical Session VII (Thursday, August 24, 2017, 2:15 PM)

A NEW ENANTIORNITHINE BIRD WITH A PLOUGH-SHAPED PYGOSTYLE AND UNIQUE TIBIOTARSAL FEATHERS

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Enantiornithes are the most successful clade of Mesozoic birds, the fossil remains of which have been reported from every continent except the Antarctic. The hitherto oldest known specimen of the Enantiornithes is from the Early Cretaceous Huajiying formation of northeast China that dates back to 130.7 million years ago. Recently, we collected a new enantiornithine specimen from the same horizon. Despite as one of the oldest enantiornithines, the new specimen preserves derived morphologies that are unexpected to be developed in that early evolutionary stage of the Enantiornithes. Our phylogenetic analysis recovered the new specimen in a derived position within the Enantiornithes, thus pushing back the origin of the major basal avian clades. The tibiotarsus of the new specimen bears unique feathers that are proximally sheet-like with filamentous distal tips, a morphotype unknown in fossil and modern feathers, further increasing the diversity of primitive feather morphologies. More importantly, the new specimen preserves a plough-shape pygostyle, a structure previously considered unique to the Ornithuromorpha, the clade that living birds nest in, adding to the tally of numerous instances of homoplasy that characterize early bird evolution. Previously, the co-occurrence of the plough-shaped pygostyle with fan-shaped tail feathers only in the Ornithuromorpha led some study to argue that these two structures coevolved. However, fan-shaped rectrices are absent from the new specimen, indicating that the pygostyle morphology is not as strongly linked to the evolution of tail fanning as previously claimed.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

TAXONOMY OF "*GYPOSAURUS*" *SINENSIS* YOUNG, 1941 FROM THE EARLY JURASSIC LUFENG FORMATION OF YUNNAN PROVINCE, SOUTHWESTERN CHINA

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Basal sauropodomorphs represent the first radiation of herbivorous dinosaurs, which were diversified across all continents from the Late Triassic to Early Jurassic. The Lower Jurassic Lufeng Formation in Lufeng Basin of Yunnan Province, southwestern China has yielded numerous dinosaurs, most of which have been referred to basal sauropodomorphs, including *Lufengosaurus huenei* Young 1941, *Gyposaurus sinensis* Young 1941, *Lufengosaurus magnus* Young 1942, *Yunnanosaurus huangi* Young 1942, *Yunnanosaurus robustus* Young 1951, *Jingshanosaurus xinwaensis* Zhang and Yang 1994, *Chuxiongosaurus lufengensis* Lü et al 2010 and *Xingxiulong chengi* Wang et al. 2017. However, the taxonomic status of some of them has been debated ever since, including "*Gyposaurus*" *sinensis*, the most debated Lufeng basal sauropodomorph taxon. Here we redescribe the holotype specimens of "*Gyposaurus*" *sinensis* (IVPP V26, V27) and demonstrate that the material can be referred to a juvenile *Lufengosaurus huenei*. Both the unfused dorsal vertebrae and the bone histology of the fibula suggest that "*Gyposaurus*" *sinensis* was a young juvenile. In addition, the morphology of the holotype specimens of "*Gyposaurus*" *sinensis* strongly resembles that of *Lufengosaurus huenei*: they share coarsely serrated teeth, a slender scapula with a symmetrical distal end that lacks a posteroventral process, a humerus with a convex proximal end and a sinuous proximolateral margin of deltopectoral crest, and similar proportions of humeral /femoral length as well as tibial/femoral length. Preliminary phylogenetic analysis, in which "*Gyposaurus*" *sinensis* and *Lufengosaurus huenei* were included as separate terminal units, recovered "*Gyposaurus*" *sinensis* as part of a polytomy with *Lufengosaurus huenei*, *Glacialisaurus*, and *Coloradisaurus*, indicating a close relationship between these taxa. Therefore, we consider "*Gyposaurus*" *sinensis* is a junior synonym of *Lufengosaurus huenei*. However, the status of the referred material of "*Gyposaurus*" *sinensis* (such as IVPP V43, V45 and V95) still needs further investigation.

Grant Information**:**
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Technical Session XVI (Saturday, August 26, 2017, 9:00 AM)

GROWTH RATES OF GIANTS: HISTOLOGICAL EVIDENCE FOR SIZE RELATED DIFFERENCES IN GROWTH MODELS BETWEEN NORMAL SIZED DIPLODOCOIDS AND A UNIQUE ASSEMBLAGE OF DWARFED LATE JURASSIC DIPLODOCOIDS FROM THE MOTHER'S DAY QUARRY (MORRISON FORMATION, MONTANA, USA)

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Sauropods were not only the larges terrestrial vertebrates ever; they also have an enormous ontogenetic size range from hatchlings to adults. Therefore, their growth rates are of special interest, but histological quantification of growth from long bone samples was difficult in the past. Based on the growth mark record in anterior dorsal rib cross sections, taken at the proximal end of the shaft, this study allows the erection of growth curves, revealing logistic growth models (LGM) for sauropods, including estimations of age at sexual and skeletal maturity. Since bones of juveniles are rare, the Mother´s Day Quarry (Morrison Formation, Montana, USA), a low-diversity bone bed of over 2000 mainly small diplodocoid bones, was of special interest. The quarry yielded diverse skeletal elements in complete disarticulation and was previously interpreted as drought-induced mass mortality event killing only juveniles. Surprisingly, histological analysis of the ribs revealed that 15 of the 19 samples are ontogenetically older. They show an

external fundamental system, three generations of secondary osteons, and a decrease in vascularization, indicating a subadult to adult ontogenetic stage. The remaining four samples do represent juveniles, which would not have grown to normal adult sauropod size, either. All samples likely represent different individuals and not different bones of the same individual because the growth record differs from rib to rib. Additionally, 8 samples of humeri and femora were taken; also documenting a subadult to adult ontogenetic stage for half of the samples. This suggests the presence of a dwarf taxon among Morrison diplodocoids because all known taxa are of large to very large adult size. Island dwarfing as an explanation, as inferred for *Europasaurus* (Late Jurassic of Germany) and *Magyarosaurus* (Late Cretaceous of Romania), appears inconsistent with the paleogeography of the Morrison Formation, however. The Mother's Day Quarry dwarfs may have evolved rapidly on a transient island formed by the transgression of the epicontinental sea from the north. The life history traits of this special dwarf assamblage, most likely representing a biological population, was compared to the LGM of normal-sized diplodocoids. The growth record of the dwarfs fits best with a von Bertalanffy growth model, but age at sexual and skeletal maturity does not vary between both groups, indicating that the dwarfs evolved via a decrease in growth rate.

Grant Information**:**
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Technical Session XII (Friday, August 25, 2017, 10:45 AM)

LARGE-SCALE MORPHOMETRIC ANALYSIS REVEALS PATTERNS OF CRANIAL SHAPE EVOLUTION ACROSS SQUAMATES

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Squamata, with over 9,000 extant species, exhibits remarkable diversity in cranial morphology that mirrors its incredible range in ecological modes. With such wide variation, elucidating how and why certain skull configurations evolved in squamates and their extinct relatives have an enormous potential to formulate general principles underlying cranial evolution. Achieving such tasks, however, requires a systematic and robust characterization of skull morphology and a comprehensive taxonomic sampling of extant and fossil groups. Here, we harness 3-D reconstructions from high-resolution CT and surface scans of 150 taxa to generate a dense geometric morphometric characterization of skull morphology. With a suite of computational tools, we test the tempo, mode, and drivers of cranial shape evolution through deep time and compare evolutionary patterns among cranial regions. The dataset, capturing the morphological and ecological breadth of non-snake squamates, shows elevated disparity and evolutionary rates from the late Triassic to the Jurassic. Subsequently, a period of high rates and disparity occurs in the late Cretaceous which terminates at the K-Pg boundary, showing the devastating impact of the end-Cretaceous extinction event on the phenotypic evolution of squamates. Model selection of trait evolution supports an Ornstein-Uhlenbeck model compared to Brownian motion model for overall skull shape. Intriguingly, while the same model is favored for rostral evolution, Brownian motion model broadly characterizes neurocranial evolution. We also find that allometry, after phylogenetic correction, accounts for ~10% of the total variation in skull shape, with a greater effect on the neurocranium than the rostrum. The results, therefore, suggest distinct modes underlying rostral and neurocranial evolution, where the former was driven more by selection regimes. As phenomic data accumulate rapidly in paleontology, this study demonstrates an emerging class of evolutionary analyses that combines rich phenotypic data with a deep time perspective—one with incredible potential for understanding the morphological evolution of major vertebrate clades.

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Technical Session III (Wednesday, August 23, 2017, 2:00 PM)

COMPARATIVE ONTOGENY OF AVIAN LIMB SKELETON: IMPLICATIONS FOR ONTOGENETIC AGEING AND EVOLUTIONARY VARIABILITY

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Specialization of the limbs to various locomotor modes has been considered to be a key process in evolutionary diversification of modern birds (Neornithes). Although much effort has been made to detect functional signals in avian limb skeleton, relatively little is known on developmental and phylogenetic constraints on its evolution. The scarcity of quantitative data on avian skeletal ontogeny and the lack of ageing criteria have been major obstacles in the study on this topic. This study aims to explore potential roles of ontogeny in evolution of avian limb skeleton, through the study of skeletal ontogeny in modern birds.

Ontogenetic variation of macroscopic morphology, dimensions, surface textures, and histological structures of major limb bones were described in five species: *Calonectris leucomelas* (Procellariidae), *Ardea cinerea* (Ardeidae), *Phalacrocorax capillatus* (Phalacrocoracidae), *Larus crassirostris* (Laridae), and *Cerorhinca monocerata* (Alcidae). For each species, 14–28 individuals of known ontogenetic stages were collected. It was found that longitudinal bone growth generally ceases around the time of fledging, whereas circumferential growth continues slightly thereafter. Rough surface textures were exclusively observed in bones of immature individuals, and are associated with active circumferential growth. The results confirmed the validity of the textural ageing as a practical means of ontogenetic ageing in avian skeletons and fossils.

Next, the relationship between ontogenetic and evolutionary variations of limb proportion was examined by morphometric analyses in six families (Anatidae, Procellariidae, Ardeidae, Phalacrocoracidae, Laridae, and Alcidae). Data were mainly collected by original measurements, supplemented by published ontogenetic data of *Anas platyrhynchos* (Anatidae). It was revealed that 1) major axes of ontogeny were diverse among lineages, 2) evolutionary variability was strongly anisotropic, and 3) directions of major axes of evolutionary variability were significantly correlated with those of ontogeny. These results imply that evolutionary variability of avian limb skeleton is constrained by ontogenetic integration.

Lineage-specific diversification patterns in birds, such as high variability in distal leg length in Ardeidae and propensity for loss of flight in Anatidae, may have ontogenetic basis. Such lineage-specific ontogenetic integration may have profound implications in evolutionary diversification of birds.

Grant Information**:**
Partly supported by the Kyoto University Foundation.

Technical Session XV (Friday, August 25, 2017, 2:45 PM)

OSTEOHISTOLOGY OF THREE MULTITUBERCULATE FEMORA FROM NORTHEASTERN MONTANA SUGGESTS VARIATION IN GROWTH RATE NEAR THE K-PG BOUNDARY

WEAVER, Lucas N., University of Washington, Seattle, WA, United States of America; WHITNEY, Megan, University of Washington, Seattle, WA, United States of America; WILSON, Gregory P., University of Washington, Seattle, WA, United States of America

The Multituberculata were the most abundant and species-rich mammalian clade in many Late Cretaceous terrestrial ecosystems. Osteohistological proxies can provide insight into life history traits of these extinct animals. Despite the rich fossil record of multituberculates, the only descriptions of their bone microstructure have come from two Late Cretaceous species from Mongolia and one Paleocene species from North America. To develop a more comprehensive view of growth strategies in multituberculates, we report on the osteohistology of three multituberculates specimens from northeastern Montana, which are tentatively assigned to the abundant genus *Mesodma*. One specimen comes from latest Cretaceous Hell Creek Formation and two specimens come from the Bug Creek Anthills locality, which yields a mixed assemblage of Cretaceous and Paleocene taxa. We manually sectioned the proximal portion of the mid-diaphysis from one isolated fragmentary femur from the lower part of the Hell Creek Formation and used µCT scans to virtually section two isolated fragmentary femora from the Bug Creek Anthills locality.

In cross-section, all three femora are elliptical with the cortical bone thickened dorsally and medially. Except for a pronounced nutrient canal in the dorso-lateral cortex, vascularity of any sort is absent in the lower Hell Creek specimen. In contrast, there is a low density of both radial and longitudinal canals in the Bug Creek specimens. The lower Hell Creek specimen has densely packed osteocyte lacunae that are arranged circumferentially and embedded in a parallel fibered matrix. Several lines of arrested growth (LAGs) are present in the outer third of the cortical bone of this specimen that could represent an external fundamental system. µCT scans of femora recovered from the Bug Creek Anthills lack sufficient detail on osteocyte lacunae density, their morphology, and matrix fiber orientation.

Although our sample size is small, the osteohistology of the lower Hell Creek specimen shows a lack of vascularity and the presence of LAGs near the periosteal surface that implies slow growth. Conversely, the osteohistology of the Bug Creek Anthills specimens shows radial and longitudinal vascularity that implies a slightly faster growth rate than in their lower Hell Creek counterpart. Further sampling of Late Cretaceous and Paleocene taxa is in progress and has the potential to illuminate patterns of growth across the Cretaceous-Paleogene boundary.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

PREDMORE MICROSITE, EL GOLFO DE SANTA CLARA, SONORA, MEXICO: THE GIFT THAT KEEPS ON GIVING

WEAVER, Melody A., La Brea Tar Pits and Museum, Monrovia, CA, United States of America; CROXEN, III, Fred W., Arizona Western College, Yuma, AZ, United States of America; PREDMORE, Robert, Arizona Western College, Yuma, AZ, United States of America; SHAW, Christopher A., La Brea Tar Pits and Museum, Los Angeles, CA, United States of America

Microsites are an underappreciated treasure trove providing insight into the interpretation of the prehistoric ecosystem. The Predmore Microsite (PMS) is an elevated and weathered area that was an abandoned meander channel in the ancient Colorado River that persisted as a backwater, probably marginally connected to the main river, especially during floods. The pools slowly filled with sediment during overbank flooding. The microvertebrates are therefore a time-averaged accumulation. Moreover, the present surface-concentrated microvertebrates are probably a winnowing of an unknown thickness of sediment. This site was discovered in 2002. It is an east-facing, windswept exposure that has yielded >4,000 fossil specimens. There have been 16 separate surveys of this site over the past 15 years.

Methods utilized for recovering specimens at the PMS are two-fold. Field staff at the base of the site work a pathway upslope on their hands and knees searching and picking as they go, while a team works a designated linear area approximately one meter wide to a depth of about 3” and 20-30 meters long, shoveling material that is double-screened on-site; this concentrate is carried off-site to a laboratory to be water-washed and sorted, and for the recovered fossils to be identified using a dissecting microscope.

Taxa found at the PMS include fish, turtle, lizard, snake, bird, insectivore, rodent, and carnivore. This sample supports the hypothesis that during the Irvingtonian Land Mammal Age (~1.5 mya), El Golfo had extensive local, riparian habitats supporting a diverse biota along the ancient Colorado River delta, which had subtropical climates.

The PMS has yielded 4437 specimens, representing 36% of the total recovered from the El Golfo badlands explored by our research team. Interestingly, 51% of the total collection has been found at 15 different microsites, thus emphasizing the importance of microsites. The PMS, in particular, is a rich source of information for building the Irvingtonian regional paleo-environmental picture in northwestern Sonora, Mexico.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

SUCCESSFULLY SUPPORTING MULTIPLE CURRICULA ONSITE AT A SINGLE DINOSAUR LOCALITY

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The Homestead Site (SNOMNH V1694) lies in the Morrison Formation of Cimarron County, Oklahoma, and produces dinosaurs, crocodylians, turtles, snails, ostracods, and charophytes. It is being screen-washed for microvertebrates. The site is on private property, but all fossils from it have been gifted to the Sam Noble Museum.

In gifting the fossil resource, the landowner specified that education must have at least equal priority with research, so we have involved students in every stage of excavation. Participating students have included: high-school students in the Sam Noble Museum's ExplorOlogy program, college students in Oklahoma State University (OSU)'s Native Explorers program, and graduate students enrolled in OSU's Field Methods in Vertebrate Paleontology course. Each group has program-specific educational goals and a unique curriculum, and all groups overlap in some of their time at the site. Delivering diverse curricula simultaneously, using the same site, requires a combination of several elements to succeed.

Elements critical to successful delivery of multiple curricula include: (1) an experienced core team executing set-up, logistics, safety oversight, paleontological methods instruction, and take-down; (2) elements in curricula that are overlapping and site-appropriate, such as excavation and collection methods, rock identification, skeletal identification, and an overview of geological processes; (3) staggered scheduling, such that graduate students start before undergraduate students who precede high school students, which allows mentoring between students and encourages more advanced students to reinforce their knowledge gained by teaching it; (4) sustained support and approval of the landowner.

Most significantly, students are accompanied by program instructors who provide introductory and post-excavation education to integrate the field paleontological experience with each of the programs' wider goals. This may include museology, fossil preparation, vertebrate osteology, ecology, or geology. Communications between the core team and programs in the months before quarry opening and in feedback at the end of each season insures that student and instructor expectations are met.

Technical Session XX (Saturday, August 26, 2017, 3:15 PM)

RESOLVING THE AFFINITIES OF NOTOUNGULATA: CHARACTER SELECTION, TAXON SAMPLING, AND THE INFLUENCE OF ANCIENT MOLECULAR DATA

WEST, Abagael R., Carnegie Museum of Natural History, Pittsburgh, PA, United States of America

Notoungulata is an extremely diverse and disparate, entirely extinct order of placental mammals, largely endemic to South America, which persisted through Cenozoic. There are disagreements on intraordinal relationships among notoungulates, but the roots of the order within Placentalia are even more enigmatic. A critical challenge is the lack of DNA (though one taxon now has yielded collagen protein sequences), thus the greater impact of the interpretation of morphological homology across superorders, particularly for herbivorous ungulate placentals. This is because most characters used in higher-level analyses of Placentalia do not adequately capture the nuances of unguligrady, cursoriality, lophodonty, and hypsodonty, hindering accurate phylogenetic reconstructions.

A long-held, recently reinforced, morphology-based hypothesis for Notoungulata is that they are most closely related to Tethytheria, an afrothere group including elephants and manatees. An alternative hypothesis, recently corroborated by ancient collagen sequence data, is that notoungulates and litopterns (another extinct South American ungulate order) are sister to Perissodactyla. To test these starkly different alternatives, as well as the hypothesis implicit in both that Notoungulata is monophyletic, I built on a published large total-evidence matrix that was built to test placental interordinal relationships. I added seven notoungulate and one litoptern species, a 10% taxon sampling increase. I expanded character sampling, adding two morphological characters often used in notoungulate intraordinal systematics, one dental and one cranial, and I added the recently published collagen loci that had linked notoungulates and litopterns to Perissodactyla. In multiple analyses of the total-evidence dataset and its partitions, my results show that notoungulates form a clade sister to Tethytheria, supporting the morphological hypothesis and overturning the hypothesis based only on the collagen data. Intriguingly, nested consistently within the notoungulate clade in my results is an extant taxon that also has oscillated from Perissodactyl to Afrothere: hyraxes. Molecular data put hyraxes in Paenungulata (Afrotheria); I found new morphological character support for this, and for the placement of Notoungulata.

In testing affinities of fossil taxa, morphology retains critical importance even in light of ancient molecular data. My results also reinforce the value of well-constructed homology statements and thorough taxon sampling.

Grant Information**:**
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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

A MECO RAIN FOREST COMMUNITY FROM THE MIDDLE EOCENE LAREDO FORMATION

WESTGATE, James W., Lamar University, Beaumont, TX, United States of America

The primary evidence for the Middle Eocene Climate Optimum (MECO) has come from micro-fossils in deep sea drill cores. The MECO occurred during the early Bartonian Stage, about 40 million years ago and lasted up to 750,000 years. The MECO began in Chron 18r and peaked during Chron 18n. Nannoplankton from the upper half of NP 16 and planktonic forams from zone P13 are found in MECO deep sea cores. Records of MECO-age continental communities are rare. An exception is the late middle Eocene Casa Blanca community (TMM vertebrate locality 42486). The stratigraphic layer it came from lies 32 meters above the *Turritella cortezi* zone in the Laredo Formation at Laredo, Texas. The *T. cortezi* zone allows biostratigraphic correlation between the middle portion of the Laredo Formation in northeastern Mexico and Laredo, Texas, and the Hurricane Lentil in the Landrum Member of the Cook Mountain Formation at Alabama Ferry on the Trinity River. Cook Mountain Formation nannoplankton come from the upper half of zone NP16 and its planktonic forams come from zone P13, indicating the Hurricane Lentil and the Casa Blanca fossils were deposited during the MECO event. Paleomagnetic analysis of a 30 meter-long core drilled near the Lake Casa Blanca spillway indicates that the Casa Blanca community remains were deposited during Chron 18n, approximately eight meters above the reversal from Chron 18r. The Casa Blanca community indicates the local climate supported coastal mangroves living adjacent to a lowland tropical rain forest and was home to a diverse tropical terrestrial vertebrate community including the perissodactyls *Amynodon advenus, Epihippus gracilis & Notiotitanops mississippiensis.* Rodents include *Microeutypomys karenae, Pauromys simplex, Microparamys sp., & Mytonomys* new sp. Primates include *Mahgarita* cf. *M. stevensi, Mytonius* new sp. and two unidentified omomyids. Artiodactyls include *Protoreodon petersoni* & *P. pumilus*. Plus an additional 17 mammal species. The aquatic community includes *Crassostrea amichel*, sharks & rays, *Pterosphenus schucherti*, plus crocodilians and turtles.

Technical Session II (Wednesday, August 23, 2017, 8:00 AM)

THE PALEOZOIC RISE OF EUNEKTIC VERTEBRATES

WHALEN, Christopher D., Yale University, New Haven, CT, United States of America; BRIGGS, Derek E., Yale University, New Haven, CT, United States of America

It has been suggested that the advent of nektic ecomorphologies in vertebrates occurred relatively suddenly in a cross-phylum "Devonian Nekton Revolution" of comparable import to the Cambrian Explosion and the Great Ordovician Biodiversification Event. We reassessed the timing and degree of Paleozoic "nektonization" using the Paleobiology Database, Sepkoski's *Compendium of Fossil Marine Animal Genera*, and other biodiversity datasets, such as the *Handbook of Paleoichthyology*. All non-terrestrial Paleozoic vertebrate genera recorded in these datasets were assigned to one of five ecomorphology classes: nektobenthos, planktonekton, demersus (benthonekton), eunekton, and nektoxeron. Invertebrates were assessed using these and an additional eight ecomorphology classes. The "revolution" appears to be an artifact of inadequate taxon sampling and generalized life-mode assessments. The proliferation of nektic marine vertebrates proceeded more gradually, earlier, and with less cross-clade congruence than previously posited. While vertebrate eunektic richness does correlate relatively well with invertebrate eunektic richness, the observed increases in the vertebrate eunekton appear to have occurred concurrent with rather than at the expense of increases in more demersal, nektobenthic, and planktic groups. Rather than discussing a nekton revolution, it may be more revealing to distinguish Early, Middle, and Late Paleozoic macroecological regimes punctuated by mass extinction events.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

GLOBAL WARMING AND IMMIGRANTS: LESSONS FROM THE EOCENE

WHITE, Lisa D., University of California Berkeley, Berkeley, CA, United States of America; HOLROYD, Patricia A., University `of California Berkeley, Berkeley, CA, United States of America

The story of high-latitude dispersal in the Northern Hemisphere during episodes of global warming in the Eocene is well-known within the vertebrate paleontological community, as these immigration events fundamentally changed the vertebrate communities of Holarctica and led to increased diversity. The compelling narratives of tiny mammals and giant turtles migrating across the Arctic have been underused in developing lesson plans and learning materials about the effects of global warming for a K-12 audience.

Building on the University of California Museum of Paleontology's rich websites and collections of early Eocene vertebrate fossils, we have developed a new web resource to highlight the links between the causes of global change, Earth systems, and biotic changes within the story of Eocene warming and migration. This resource uses the conceptual framework central to our newest website, *Understanding Global Change* (currently in development), to explore these connections. This conceptual framework is embodied in an infographic that illustrates how Earth systems are perturbed and how changes propagate through different aspects of the biosphere, allowing teachers and students to better visualize these complex, dynamic interactions. The narrative of Eocene climate warming and biotic change uses the framework to explore the connections among the distribution of continents, atmospheric circulation, greenhouse effect, elemental cycles, and ecosystems. The narrative is accompanied by framework-based storyboards that focus users' attention on relevant aspects of the infographic. The storyboards and narrative also encourage users to dive deeper into the content of Understanding Global Change to access more detailed explanations of the drivers, cycles, and systems that underlie the story as well as the evidence for our understanding of these phenomena. In this way, the story of Eocene warming and migration serves as a hook to help learners understand basic concepts related to global change that are critically important to grasping how global changes are affecting Earth systems today.

Grant Information**:**

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Technical Session XVIII (Saturday, August 26, 2017, 9:00 AM)

TAPHONOMIC INDICATORS OF TOOTH ATTACHMENT IN FOSSIL SYNAPSIDS WITH IMPLICATIONS FOR ORAL FOOD PROCESSING IN TAPINOCEPHALIDS

WHITNEY, Megan, University of Washington, Seattle, WA, United States of America; SIDOR, Christian A., University of Washington, Seattle, WA, United States of America

The dentition of mammals is considered among the most specialized within vertebrates and includes an extensive suite of derived traits including a soft tissue attachment (gomphosis). Recent paleohistological research has shown that gomphosis has a complicated evolutionary history, with multiple independent transitions from ankylosis (fusion of jaw and tooth) to gomphosis inferred among non-mammalian therapsids. However, as histological analysis is not always possible due to its destructive nature, we examined the proportion of empty tooth sockets within the jaws of synapsids to quantify patterns of tooth attachment, with the proviso that empty tooth sockets can indicate taphonomic loss or tooth shedding prior to replacement.

Upper and lower jaws from 124 specimens of fossil synapsids were examined for the proportion of teeth remaining in the jaw. Fossil taxa previously known to be characterized by ankylosis (e.g. most 'pelycosaurs') rarely exceed half of their teeth missing from their jaws. Within early therapsids, our results confirm preliminary observations that tapinocephalids lose their teeth more frequently than other synapsid clades. However, our data also reveal that several clades that are known or suspected to have had a gomphosis vary remarkably in the proportion of teeth typically retained. For example, gorgonopsians have been shown to have a gomphosis, yet rarely lose their teeth and subclades of derived cynodonts show little consistency in the percentage of teeth preserved in their jaws.

It is possible that the discrepancy in tooth loss percentages between tapinocephalids and other therapsid clades with a gomphosis can be related to the geometry of their periodontal ligament. We hypothesize that taxa like tapinocephalids that frequently lose the vast majority of their teeth had an enlarged periodontal space and correspondingly wider anchoring ligament than cynodonts or gorgonopsians. In modern mammals, a wider ligament is related to increased stress imposed upon the tooth. Tapinocephalid incisors are characterized by interlocking talon-and-heel morphology that forms a well-developed grinding occlusal surface and preserves evidence for increased oral food processing. At least for tapinocephalids, we hypothesize that there is a strong relationship between the periodontal ligament width and the amount of oral processing, which manifests itself taphonomically in the failure of teeth to remain anchored in the jaw after death.

Grant Information:
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Technical Session IX (Thursday, August 24, 2017, 1:45 PM)

TRACKING DOWN CELLS, NERVES, AND VASCULARITY FOSSILIZED IN VERTEBRATE HARD TISSUES: A FIELD GUIDE

WIEMANN, Jasmina, Yale University, New Haven, CT, United States of America; BRIGGS, Derek, Yale University, New Haven, CT, United States of America

Hard tissues (bones, eggshells, teeth, and enamel scales) are the key to the success of vertebrates. They are biocomposite materials consisting of mineral crystallites which enclose a potentially vascularized (blood vessels), innervated (dental tubuli), and cell-bearing (osteocytes) organic scaffold. These soft tissues are composed of hierarchically organized fibrous proteins. Postmortem, however, this biomolecular architecture is thought to degrade rapidly together with the morphological and metabolic information stored in it. Thus, biomolecular preservation is still controversial, and Mesozoic examples appear enigmatic and random in their spatial distribution. Here we present a mechanism for protein survival through deep time which applies to all vertebrate hard tissues, to explain geographical biases in the molecular fossil record and provide macroscopic proxies for identifying promising fossil material in the field. Investigation of decalcified extant, artificially matured, and fossil material with Confocal Raman Microspectroscopy revealed that original proteins were likely transformed to brownish-staining Advanced Glycoxidation End Products (AGEs) via oxidative crosslinking. The staining is organic: mineral staining was shown to be absent in all samples from oxidative conditions. Samples from reducing chemoenvironments, in contrast, did not yield any proteinaceous preservation. This discovery explains major biases in the vertebrate soft tissue record. High resolution evidence of cellular, nervous, and vascular tissues is contingent on a chemoenvironment favoring diagenetic crosslink-based stabilization of proteins, which only occurs in oxidative sediments. Target settings include light colored or red terrestrial siliciclastic deposits, light colored lacustrine and shallow marine calcareous deposits, and other intensively bioturbated sediments. In these sediments, hard tissues have the potential to preserve cell walls, nerve canals, and vascularity macroscopically as a brownish colored residue. Our study provides a mechanistic explanation for the survival of ancient proteins and a target for the discovery of organic molecules in vertebrate hard tissues.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

INVESTIGATING $^{234}U/^{238}U$ ACTIVITY RATIOS AND U UPTAKE IN VERTEBRATE MICROFOSSIL TEETH FROM THE RISING STAR CAVE (CRADLE OF HUMANKIND, SOUTH AFRICA) TO RECONSTRUCT PHREATIC WATER TABLE FLUCTUATIONS ASSOCIATED WITH PLEISTOCENE CLIMATE CHANGE IN SOUTHERN AFRICA.

WIERSMA, Jelle P., James Cook University, Townsville, Australia; HILBERT-WOLF, Hannah L., James Cook University, Townsville, Australia; PLACZEK, Christa J., James Cook University, Townsville, Australia; DIRKS, Paul H., James Cook University, Townsville, Australia; ROBERTS, Eric M., James Cook University, Townsville, Australia

The Rising Star Cave in the Cradle of Humankind, South Africa is predominantly known for its wealth of hominin fossils that led to the 2013 discovery of the new species *Homo naledi*. To date, fossil material belonging to *H. naledi* exceeds 1,800 elements and this quantity continues to increase. Vertebrate microfossil assemblages are equally abundant but receive far less attention, yet they record the faunal and environmental history in the Rising Star Cave. Most of the microfossils can be assigned to Rodentia and Lagomorpha, and consist of cranial and postcranial elements no longer than a few cm in length. The microfossils are primarily concentrated in unconsolidated erosional remnants of stratigraphic units that are distributed throughout various chambers (e.g., Dinaledi, Dragon's Back, Postbox, and Superman Crawl) within the Rising Star Cave. The stratigraphic and sedimentary architecture of the Rising Star Cave system is dictated by episodic and alternating periods of Plio-Pleistocene sedimentation and erosion. The fossil material is chalky, brittle, and frequently stained with Mn/Fe oxy-hydroxides, resulting from exposure to waterlogged conditions in flooded cave chambers and moist soils, respectively.

Scalloped and partial dissolution structures preserved on cave walls and flowstone deposits indicate fluctuating phreatic water tables within the Dinaledi, Dragon's Back, and Superman Crawl chambers of the Rising Star Cave. Geochemical and radioisotopic (U-Th) analyses on enamel and dentine of fossil teeth sampled from the Dinaledi Chamber revealed atypically high concentrations of $^{234}U/^{238}U$. U-Th ages indicate a series of discrete U uptake events around 44 ka, 73 ka, 85 ka, and ~200 ka. The $^{234}U/^{238}U$ ratios associated with each event are anomalously high (6.9-8.1), suggesting that the U uptake events are associated with a chemically stable and isotopically unique water source. Measured $^{234}U/^{238}U$ ratios of flowstones in the Dinaledi and Dragon's Back Chamber are relatively low (1.8-2.2) compared to ratios found in teeth, arguing contemporaneous formation of flowstones and U uptake events in the teeth. Both types of events indicate wetter climate conditions during the Pleistocene in the Cradle of Humankind and southern Africa in general. Investigating U uptake in fossil teeth and associated flowstones represents a relatively unexplored area of taphonomy, and has significant potential for understanding not only fossil preservation, but also paleoecological and paleoenvironmental conditions before, during, and following burial.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW FOSSIL HERPETOFAUNA FROM THE LATE PLEISTOCENE OF THE NORTHERN CALIFORNIA CHANNEL ISLANDS, CHANNEL ISLANDS NATIONAL PARK

WILKINS, William J., The Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States of America; MEAD, Jim I., The Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States of America; SWIFT, Sandra, The Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States of America; COLLINS, Paul, Santa Barbara Museum of Natural History, Santa Barbara, CA, United States of America; BUGBEE, Monica M., The Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States of America

The four northern islands of Channels Islands National Park (CHIS; San Miguel, Santa Rosa, Santa Cruz, and Anacapa; southern CA), have been the subject of numerous archaeological and paleontological investigations for well over 50 years. Most research has focused on fossil mammals and birds, especially the pygmy mammoth and small, owl-roost faunas from rock-shelter sites. Recent investigations of new and pre-existing collections have recovered several specimens pushing back the earliest known records on CHIS of Anura (Hylidae) and Squamata (Colubridae, Anguidae) to >13.4 ka (calibrated) and Caudata (Plethodontidae) to >16.34 ka (calibrated). As no evidence supports a land connection between the mainland and these islands in the Late Pleistocene, the presence of these fossils at these ages suggests waif dispersal as the most logical immigration mechanism. These results suggest further investigation of these and other Channel Islands fossil deposits may provide additional evidence with which to test this hypothesis.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

ONTOGENETIC VARIATION IN THE BONE HISTOLOGY OF CAENAGNATHID MANDIBULAR SYMPHYSES

WILKINSON, Ryan D., University of Alberta, Edmonton, AB, Canada; FUNSTON, Gregory F., University of Alberta, Edmonton, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

Caenagnathidae is a group of middle to late Cretaceous theropod dinosaurs found in Asia and North America. The isolated nature of their remains means their growth, development, and variation is difficult to study, as skeletal morphology is the primary investigative tool used in palaeontology. This study examines the histological characteristics of four caenagnathid mandible specimens from the Dinosaur Park Formation of Alberta, Canada, to identify trends or patterns in the cell- and tissue-level features of these dinosaurs. Thin sections of the mandibular symphysis were examined with light microscopy and their histological features were observed and described. The specimens were interpreted as an ontogenetic series characterized by a reduction in the rate of growth, an increase in fibrolamellar bone, and an accumulation of secondary remodelling structures such as Haversian canals. Lines of arrested growth indicated an

increased developmental age in two of the specimens. Additionally, developmental and growth patterns including the rapid fusion and obliteration of the mandibular symphysis and the widening of the mandible at the symphysis were identified. The concentration of Haversian canals along the occlusal margin and lingual ridges suggests remodelling as a histological response to high levels of repeated stress. These descriptions add to our knowledge of the growth and development of Caenagnathidae and the identification of an ontogenetic series may aid in the taxonomic classification of partial or incomplete caenagnathid skeletons.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

THERIAN MAMMALS FROM THE LOWER BLACK PEAKS FORMATION, BIG BEND NATIONAL PARK, TEXAS ARE TORREJONIAN, NOT PUERCAN, IN AGE

WILLIAMSON, Thomas E., New Mexico Museum of Natural History, Albuquerque, NM, United States of America; STANDHARDT, Barbara, Stanton, TX, United States of America; LESLIE, Caitlin, Baylor University, Waco, TX, United States of America

The early Paleocene mammal faunas from the Black Peaks Formation, Big Bend National Park, Texas, represent the southernmost of North America and thus are important for understanding mammalian diversity and biogeographic patterns soon following the end-Cretaceous mass extinction. Some workers have argued the faunas from the lower parts of the Black Peaks Formation are Puercan in age based primarily on fossils collected from localities in or near the Dawson Creek area: TMM 41400 (LSU VL-111; "Tom's Top") in Dawson Creek and TMM 42327 (LSU VL-108; "Dogie") from nearby Rough Run Amphitheater about 5 miles (8 km) east of the Dawson Creek section. "Tom's Top" and "Dogie" have yielded diverse microvertebrate assemblages that are 20 m and 80 m, respectively, above the highest occurrence of dinosaur bones in those areas. A re-evaluation of these faunas indicates that they are Torrejonian, rather than Puercan, in age.

The therian mammals from "Tom's Top" includes a new small species of the carnivoramorph *Bryanictis*, the euarchontan *Mixodectes malaris*, the plesiodapiform *Plesiolestes wilsoni*, and the "condylarth" *Promioclaenus* cf. *P. lemuroides*. "Dogie" contains a more diverse fauna including the metatherian *Peradectes* sp., a generically unidentifiable cimolestid, the new small species of *Bryanictis*, and six "condylarths"; cf. *Goniacodon levisanus*, *Periptychus carinidens*, *Haploconus* sp., *Ellipsodon* cf. *E. inaequidens*, and a new species of *Mioclaenus*. The presence of *Periptychus carinidens* indicates a Torrejonian age by definition. The other mammals present are consistent with a Torrejonian age assignment. Several of the mammalian genera appear to be restricted to the American Southwest supporting the presence of a distinct southern mammalian faunal province during the Torrejonian.

Grant Information:
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Technical Session XVI (Saturday, August 26, 2017, 11:00 AM)

A NEW CENTROSAURINE CERATOPSID FROM THE UPPER CRETACEOUS TWO MEDICINE FORMATION OF MONTANA AND THE EVOLUTION OF THE 'STYRACOSAUR' DINOSAURS

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The Late Cretaceous Two Medicine Formation of northwestern Montana has produced numerous remains of centrosaurine ceratopsids, from which three stratigraphically separated taxa, *Rubeosaurus ovatus*, *Einiosaurus procurvicornis*, and *Achelousaurus horneri*, are currently recognized. *Rubeosaurus*, the stratigraphically lowest at 60 meters below the upper contact with the Bearpaw Formation, is diagnosed by a parietal with medially inclined P3 processes, elongate P4 and P5 processes, and a tall, erect nasal horn. This taxon was originally known only from the isolated holotype parietal and first named *Styracosaurus ovatus*. With the recent referral of the more complete MOR 492 to *S. ovatus,* new characters were attributed to this taxon which separated it from *Styracosaurus* and created the need for the new genus name *Rubeosaurus*. Here we reassess MOR 492 and provide evidence that it is not referable to *S. ovatus*. Rather than possessing seven parietal processes (P2-P8) per side, with elongate P4 and P5 processes as previously thought, MOR 492 only exhibits six processes (P2-P7) per side. This is supported by imbrication of the two anteriormost processes (P6 and P7), as conserved in all Two Medicine Formation centrosaurines. With P6 and P7 identifiable, P5 is demonstrably non-elongate and P4 only somewhat elongate, unlike *S. ovatus*-. Further, there is no evidence that the preserved P3 process of MOR 492 was medially inclined, but rather the anteroposteriorly near-straight left lateral bar of MOR 492 produces a posteriorly inclined P3, as conserved in the stratigraphically successive *Einiosaurus*. Therefore, the characters from MOR 492 used to erect *Rubeosaurus* no longer pertain to the diagnosis of *S. ovatus*, making *Rubeosaurus* a junior synonym of *S. ovatus*. *S. ovatus* is a genuine taxon represented only by the holotype.

MOR 492 possesses a unique combination of characters drawn from *Styracosaurus albertensis* and *E. procurvicornis*, which is consistent with its intermediate stratigraphic placement and recovered phylogenetic position, and warrants diagnosing a new taxon. Like *Styracosaurus*, MOR 492 possesses an elongate, erect nasal horn, but like *Einiosaurus* exhibits a reduced P5. The somewhat elongate P4 of MOR 492 is intermediate in length between the stratigraphically highest *Styracosaurus* specimens and lowest *Einiosaurus* specimens. This is consistent with the hypothesis that these taxa represent anagenetic evolution, though cladogenesis remains a viable alternative. Overall, this study refines hypotheses of North American ceratopsid evolution.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

NEW GENERA AND SPECIES OF FOSSIL MARINE AMIOID FISHES (ACTINOPTERYGII, HOLOSTEI) FROM THE LATE CRETACEOUS AGOULT LOCALITY IN SOUTHEASTERN MOROCCO

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The Late Cretaceous Agoult locality in southeastern Morocco has yielded a diverse array of marine fishes including †Macrosemiidae, †Pycnodontidae, †Aspidorhynchidae, †Cladocyclidae, †Sorbinichthyidae, †Paraclupeidae, †Clupavidae, †Dercetidae, †Aipichthyoidei, and †Pycnosteroididae. Housed in University of Alberta collections from Agoult are numerous specimens of at least two undescribed amioid fishes. They share derived features with the Amiidae including a rounded or almost rounded caudal fin. They share with derived amiids an elongate dorsal fin, although the length of the fin differs somewhat between the new species. Four subfamilies are currently recognized in Amiidae: †Amiopsinae, †Solenhofenamiinae, †Vidalamiinae, and Amiinae. We recognize two new species, each in a monotypic genus. Compared to representatives of the amiid subfamilies, the two new species differ in retaining the more primitive S-shaped as opposed to semicircular posterior border of the hypural complex in the caudal fin. The new species differ from each other in the length of the dorsal fin, the number of supraneurals, and the number and posterior extent of the ossified ural centra. Preliminary phylogenetic analysis suggests that the Moroccan amioids may be related to another amioid genus, †*Tomognathus*, and that these together should be recognized as a new family that is the sister group of the Amiidae. The †Sinamiidae are the sister group of the new family plus the Amiidae. These new amioids add to the known taxonomic and morphological diversity of earlier marine members of the Amiiformes, a group represented today only by a single North American freshwater species, the Bowfin, *Amia calva* Linnaeus.

Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

SEABIRDS AS ECOLOGICAL INDICATORS IN LATE CRETACEOUS MARINE ENVIRONMENTS

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In modern marine ecosystems, seabird geographic distribution is correlated with physical, chemical, and biological oceanographic factors. Pursuit diving seabirds – those that actively pursue prey underwater using wing or foot propulsion – are more limited in distribution and closely tied to oceanographic factors because diving ability is often gained at the expense of flight capabilities. Today, pursuit diving seabird populations are restricted to waters cooler than 15ºC. In contrast, Late Cretaceous marine environments were characterized by greenhouse climate and high sea levels, producing marine environments generally warmer than 15ºC. Despite this, flightless pursuit diving seabirds called hesperornithiforms are particularly well-represented from North American Western Interior Seaway (WIS) deposits. The contrast in distribution implies that different biotic and abiotic factors may have affected Late Cretaceous epicontinental ecosystems than seen in today's oceans.

Biotic factors like predator-prey relationships and competition are hypothesized to have affected fossil penguin diversity in the Cenozoic, and are also suggested to influence modern pursuit diving seabird distributions. However, the spatio-temporal overlap between hesperornithiforms, marine reptiles, and large predatory fishes does not support the same type of temperature-based competition or predator-prey relationships as the biogeographic driver in the WIS. Rather, is seems that the presence of different apex predators (most notably the lack of marine mammals) may partially account for biotic factors affecting hesperornithiform distribution. Additionally, the shallow depth, abundance of shoreline, and high primary productivity characterizing epicontinental seas are the abiotic factors that likely explain why pursuit diving seabird distribution was so different in the Late Cretaceous compared to today.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

IMPLICATIONS OF AN ANALYSIS OF DEEP PES TRACES AND MANUS IMPRESSIONS FOR THE SUPPOSED *ATREIPUS-GRALLATOR* ICHNOGENERIC PLEXUS*:* AN APOMORPHY-BASED APPROACH

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The apparent continuum between the Triassic ichnogenera *Atreipus* and *Grallator* has been used as a basis for hypothesizing an evolutionary continuum between their track makers. We use an apomorphy-, cladistics-based methodology of track maker identification to test the hypothesized *Atreipus*-*Grallator* complex that we argue does not reflect a biological entity. Eastern North American *Atreipus* (*A. milfordessis, A. sulcatus,* and *A acadianus*) morphology, in well-preserved examples, is consistent with a silesaurid, based on the presence of a highly reduced digit I (hallux) on the pes that is an apomorphy of *Silesaurus* as seen in deep footprints in which the metatarsus is impressed. In marked contrast, brontozoids, including *Grallator,* have pedal traces consistent with early saurischians in retaining the primitive condition of a relatively long digit I, always present in deep footprints. *Atreipus* is usually a quadrupedal ichnite with a manus bearing 3 to 5 short digits and small claws. In contrast, the simplest hypothesis for dinosaur monophyly has the primitive condition for the dinosaurian manus with elongate manual digits I-III that restricted quadrupedal locomotion (e.g., *Heterodontosaurus* and *Herrerasaurus*), and did not allow significant pronation, or extreme hyperextension. Examination of the very few brontozoid and basal sauropodomorph manus impressions is consistent with this interpretation in which manus impressions are present only in resting traces. In medium sized brotozoids (*Anchisauripus*) the manus trace consists only of knuckle impressions of digits II and III. *Atreipus* had small manus with small claws primarily used for locomotion that would itself be highly derived compared to the primitive dinosaurian condition. As silesaurs were a separate clade from dinosaurs and

the common ancestor of dinosaurs and silesaurs was not itself a silesaur, linking the ichnotaxa *Atreipus* and *Grallator* (brontozoids) in any kind of conceptual evolutionary continuum conflates biological characteristics with poor preservation and generalized resemblance that does not hold up to phylogenetic analysis. Therefore the so-called *Atreipus-Grallator* plexus reflects a non-biological concept for generalized facultatively three-toed pes impressions, primitive at least at the level of Dinosauromorpha.

Technical Session XXI (Saturday, August 26, 2017, 4:00 PM)

THE AMAZING PLESIOSAUR NECK: SUBCENTRAL FORAMINA AND IMPLICATIONS FOR THERMOREGULATION AND DEEP DIVING

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A long, stiff neck characterizes most plesiosaurs, with different lineages showing evolution towards extreme neck elongation. Bone histology and other new evidence suggests that plesiosaurs had high metabolic rates, raising the question of how they coped with cold water encountered during deep diving and at high latitudes. On the ventral side of the plesiosaur centrum are large paired foramina, generally known as subcentral foramina, which are particularly pronounced in the neck. Well-developed subcentral foramina appear as autapomorphy at the node Plesiosauria. Thin sections and CT data indicate that the paired ventral foramina lead into paired vascular canals that extend dorsally through the entire centrum, emerging on the floor of the neural canal in another set of paired foramina. The canals approach each other or merge in the center of the centrum, forming a slight x-shape in transverse section. Foramina in vertebral centra are not unusual for amniotes as entry ways for blood vessels serving the bone interior. However, the foramina and canals in plesiosaurs are different as they penetrate the centrum. The canals must have housed arteries, here termed subcentral arteries, which must have been additional to the two lateral arteries. We posit that the general the function of the subcentral arteries was to increase blood flow to the muscles, specifically to the expaxial musculature. High blood flow was required for storing oxygen during deep diving, as also known in modern endothermic deep-diving amniotes such as whales. Furthermore, non-pliosaurid plesiosaurs faced the problem of excessive heat loss in the aquatic environment caused by the poor volume-to-surface ratio of the long neck. While tetrapod extremities may have lower temperatures then the body core, this could not have applied to a plesiosaur neck and skull because it housed the spinal cord and brain. The subcentral arteries may have prevented hypothermia of the neck and head by ensuring sufficient heat transport to this region from the body core, where it was generated in the viscera and by the muscles used in underwater flight.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

EXCEPTIONAL ARVICOLINE DENTITIONS FROM FROMAN FERRY (PLIOCENE) AND LITTLE DELL DAM (PLEISTOCENE)

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Studies on fossil remains of the lower first molar of arvicoline rodents (voles, lemmings, and muskrats) form an important part of our understanding of North American Pliocene and Pleistocene biochronology. The emphasis on the m1 results from both rapid evolution in that tooth, the purported diagnostic utility of the m1 relative to other teeth, and the wealth of isolated teeth recovered from Pliocene and Pleistocene localities. Other teeth are rarely considered diagnostic, in part because few remains preserve associated dentitions of extinct forms. Here we describe two cases of extraordinary preservation of associated fossil arvicoline rodent dentitions from Froman Ferry, Idaho (Pliocene) and Little Dell Dam, Utah (Pleistocene).

X-ray computed tomography (CT) was used to digitally prepare small sediment blocks containing associated dentitions. Both blocks include some degree of associated dentitions from extinct taxa, permitting the first descriptions of teeth other than the m1 for several taxa. Charles Repenning collected a Pliocene sediment block from Froman Ferry in the late 1980s, including one of the only known instances of an associated upper and lower dentition in a Pliocene arvicoline. The block preserves a record of *Ophiomys* with a right mandible with m1-m2 and an associated palate that preserves a complete sequence of right cheek teeth and a left M3.

A sediment block from Little Dell Dam is thought to preserve remains from the Irvingtonian LMA, based on other records from the site. Analysis of our CT-data indicates that the block preserves over 30 teeth of *Allophaiomys*, *Phenacomys*, and *Mictomys*. In five instances, complete lower dentitions of these genera are present, and we hypothesize that the sediment block represents a fossilized regurgitation pellet. If our interpretation of the material is correct, then the specimen provides some of the first evidence of contemporaneous arvicoline taxa that are not time averaged. This would demonstrate sympatric association of the three constituent taxa, at least at the geographic scale of the hunting range of the predator that generated the pellet. These data strengthen the argument that the taxa were actually sympatric, and that similar taxonomic associations at other sites are not mere artifacts of time-averaging.

Technical Session XXI (Saturday, August 26, 2017, 3:30 PM)

FINITE ELEMENT HYDRODYNAMIC INVESTIGATION OF SWIMMING BEHAVIOR OF A MIDDLE JURASSIC PLESIOSAUR IN COMPARISON TO RECENT SEA TURTLES

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Plesiosaurs were globally distributed, highly aquatic marine diapsids that had evolved a unique locomotory apparatus with four hydrofoil-shaped flippers. Over 135 Ma of evolution, this locomotor design experienced only minor structural changes. Virtual hydrodynamic analysis of underwater flight started with measuring of a specimen of the Middle Jurassic plesiosaur *Cryptocleidus eurymerus* from England on exhibit at the Goldfuß Museum (University of Bonn, Germany) for reconstruction of the complete body as a finite element model. A reconstruction of a recent underwater flyer, *Caretta caretta* (Cheloniidae), dissected at the Stazione Zoologica Anton Dohrn Napoli, Italy, was used as an anatomical and functional analog.The dissection gave important insights into locomotor muscles, lines of action and cross sectional areas of these muscles, maximum muscle forces, and flipper profiles. For plesiosaur and sea turtle alike, pairs of agonistic and antagonistic muscles were identified for the main phases of the limb motion cycle, i.e., upstroke and downstroke. Finite element models for both, the plesiosaur and the turtle, were studied in a virtual flume with different flow velocities to simulate different flight speeds, enabling us to determine drag, lift, and propulsion of the flipper using finite element-computational fluid dynamics software. All profiles of both flipper reconstructions, based on skeletal remains, evidence from preserved soft tissues, and dissection were in conformity with technical NACA (National Advisory Committee for Aeronautics) profiles. The flipper tip of *Caretta caretta* describes a skewed “O” shape during upstroke and downstroke, which we detected by flipper beat cycle video analysis. In the virtual flume, every profile along the flipper length has optimal angles of attack from 6°to 9° and necessary angles of profile twisting from 0° to 83°. At a flight speed of, e.g., 2 m/s, *Caretta caretta* drag peaks at 29 N and maximal propulsion at 67.8 N. *Cryptocleidus eurymerus* drag peaks at 55.4 N, and maximal propulsion generated by one foreflipper reaches 404 N. All flow patterns observed delineate ideal body shapes with laminar stream lines and positive influences of head and neck contours on reducing drag.

Grant Information**:**
German Research Foundation WI1398/8-1 and SA469/42-1

Technical Session VI (Thursday, August 24, 2017, 10:30 AM)

NEW DATA ON SKULL AND POSTCRANIUM OF BYSTROWIANID CHRONIOSUCHIANS, AND THE POSITION OF CHRONIOSUCHIANS WITHIN EARLY TETRAPODS

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Chroniosuchians form a still enigmatic clade of Permian and Triassic crocodile- or varanid-like tetrapods from Asia and Europe, usually considered stem-amniotes, but with disputed affinities within that grade. They are characterized by their butterfly-shaped dorsal osteoderms and the ball-shaped intercentra. Two groups of chroniosuchians can be distinguished, the chroniosuchids and the bystrowianids. The skeletal morphology of chroniosuchids is well known based on well-preserved skulls and articulated postcranial remains. In contrast, our knowledge of bystrowianids has so far been restricted to single vertebrae and osteoderms, a few isolated skull bones, and fragments of the pelvic girdle and the hind limbs. Nothing was known about the skull proportions, the morphology of ribs, forelimbs, and the pectoral girdle in bystrowianids. Newly discovered material of the Middle Triassic bystrowianid *Bystrowiella schumanni* from southwestern Germany allows a full description of cranial and postcranial remains from this taxon. The material comprises large parts of the dermal skull roof, the pectoral girdle, ribs, and limbs and sheds light on many anatomical regions formerly completely unknown in bystrowianids. Among other features, *Bystrowiella* is characterized by the premaxilla with an edentulous crest lateral to the choana, the premaxillary teeth with conspicuous size differences, the jugal with an extremely long, narrow anterior process, and the enlarged postparietals and tabulars forming facets for articulation with the anteriormost osteoderm. Unlike in chroniosuchids, the internarial fontanelle and the antorbital fenestra are absent. In the amniote-like postcranium, the interclavicle is slender and has a conspicuous parasternal process, the humerus is waisted and bears a short supinator process, and the long, curved trunk ribs have widely separated rib heads and a slender shaft without blades or processes. Our phylogenetic analysis, particularly based on numerous new postcranial features, robustly supports the bystrowianid *Bystrowiella* and the chroniosuchid *Chroniosaurus* as sister groups, even when the constituent synapomorphies (osteoderm and vertebral characters) are excluded. This forms a convincing argument for chroniosuchian monophyly, even though the skull architecture of bystrowianids and chroniosuchids has little in common. In our analysis, chroniosuchians nest at the base of the amniote stem, forming an unresolved polytomy with *Silvanerpeton*, embolomeres, and more advanced stem-amniotes.

Technical Session XXI (Saturday, August 26, 2017, 2:15 PM)

A REASSESSMENT OF THE CRANIAL ANATOMY OF *CYMBOSPONDYLUS* AND ITS IMPLICATIONS ON THE TAXONOMY AND PHYLOGENY OF CYMBOSPONDYLIDAE

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Cymbospondylus is an iconic ichthyosaur genus that provides valuable information on the anatomy of basal members of the clade. Well preserved material of *Cymbospondylus*, including complete and partially complete skulls, has been known for over a century from the Middle Triassic of Nevada, USA and southern Switzerland. However, there is still a lack of consensus regarding the cranial anatomy of *Cymbospondylus*, with different authors presenting markedly different interpretations of the circumorbital, temporal and skull roof regions. This lack of consensus hinders our understanding of early ichthyosaur evolution and obscures character polarity at the base of the ichthyopterygian phylogenetic tree. First hand examination of all well preserved skull material referred to *Cymbospondylus* worldwide, clarifies previous controversies surrounding its cranial anatomy. Important identified anatomical characters include: a small lacrimal, without neurovascular foramina or an opening for the nasolacrimal duct; an anteroposteriorly elongated prefrontal forming the dorsal orbital margin; a triangular posterodorsal process of the postorbital; a posteroventral process of the jugal; an internasal suture forming a sharp crest; an anterolateral process of the parietal; and a postfrontal with an anteroposteriorly elongated depression running along the dorsal surface of its anteromedial portion. The new observations have implications on taxonomy and phylogeny of Cymbospondylidae. Personal examination of the holotype skull of *C. nichollsi* indicates that all discrete character states proposed as autapomoprhies for the taxon have arisen from misinterpretation of the cranial anatomy and no differences in discrete character states are found between the type skull of *C. piscosus* and *C. nichollsi*, questioning the validity of the latter. First hand examination of the type skull of *Thalattoarchon saurophagis*, a colossal ichthyosaur which co-occurs with *Cymbospondylus* in the Middle Triassic of Nevada, USA, has revealed that *T. saurophagis* shares many synapomorphies with *Cymbospondylus*. This provides further

evidence to support the recently proposed, but weakly supported, cymbospondylid affinity for *T. saurophagis*. Cymbospondylidae thus includes durophagous (*Xinminosaurus*) and macropredatory (*Cymbospondylus*, *Thalattoarchon*) forms, and indicates rapid diversification of the clade in the first part of the Middle Triassic and suggests fast recovery of marine ecosystems after the P/T extinction event.
Grant Information:
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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

LIFE HISTORY OF *EDMONTOSAURUS* FROM THE LATE CRETACEOUS (MAASTRICHTIAN) RUTH MASON DINOSAUR QUARRY, SOUTH DAKOTA, UNITED STATES

WOSIK, Mateusz, University of Toronto, Toronto, ON, Canada; CHIBA, Kentaro, University of Toronto, Toronto, ON, Canada; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada

The Late Cretaceous (Maastrichtian) Ruth Mason Dinosaur Quarry (RMDQ) represents a monodominant *Edmontosaurus annectens* bonebed from the Hell Creek Formation of South Dakota and has been determined as a catastrophic death assemblage of a single population. Therefore, it provides a near ideal sample to investigate hadrosaurid growth and population dynamics. For this study, size-frequency distributions were constructed from linear measurements of long bones (humeri, femora, tibiae) from RMDQ that reveal five relatively distinct size classes along a generally right skewed distribution, which is consistent with a catastrophic assemblage. To test the relationship between morphological size ranges and ontogenetic age classes, subsets from each peak were transversely thin-sectioned at mid-diaphysis to conduct an ontogenetic age assessment based on growth marks and observations of the bone microstructure. When combining the independent datasets, growth marks aligned with size-frequency peaks, with the exclusion of the overlapping adult size range, indicating a strong size-age relationship in early ontogeny. A preliminary growth curve analysis of the tibia shows that *E. annectens* exhibited a similar growth trajectory to the Campanian hadrosaurid *Maiasaura* and attained a slightly larger asymptotic body size by seven years of age. Retrocalculation and section-stacking of growth marks revealed that the first growth mark had been obliterated by medullary cavity expansion, even in the youngest individuals. Interestingly, all sectioned elements show a layering of laminar bone near the periosteal surface that signals the imminent formation of a growth mark, providing further evidence for a catastrophic origin and indicating a preservation pattern associated with the slow-growing season. Considering the RMDQ sample originates from a single population, the missing yearling size class significantly adds to the mounting evidence that suggests juvenile hadrosaurids were segregated from the main herd.

This study is the most thorough attempt to assess growth and demography using a novel combination of frequency distributions and long bone histology in an extinct dinosaur. It presents the first *E. annectens* growth curve and provides a framework for a detailed life table analysis. When compared with previously published hadrosaurid data, the *Edmontosaurus* growth curve falls within the range of variation observed among other taxa and suggests that the clade as a whole inherited a broadly similar growth strategy.
Grant Information:
Dinosaur Research Institute Student Project Grant

Technical Session X (Friday, August 25, 2017, 12:00 PM)

NEW INFORMATION ON *TOMISTOMA PETROLICA* YEH, 1958

WU, Xiao-Chun, Canadian Museum of Nature, Ottawa, ON, Canada; SATO, Tamaki, Tokyo Gakugei University, Koganei City, Tokyo, Japan; SHAN, Hsi-Yin, National Musum of Natural Science, Taichung, China; CHENG, Yen-Nien, National Museum of Natural History, Taichung, China

*Tomistoma petr*olica Yeh, 1958 was represented by a very fragmentary specimen and later restudied by Li (1975) based on the posterior half of a skull with a part of the left mandibular ramus. Since then, *T. petrolica* has been often included in the phylogenetic studies of other tomistomines but no consensus on its relationships has been made. Recently, 18 new specimens have been collected from the same horizon (upper Eocene) of the type and the referred specimen in Maoming, Guangdong Province, China. Our study of the 18 specimens reveals that *T. petrolica* is morphologically incomparable with the extant species *Tomistoma schlegelii* and other species referred to *Tomistoma* in a number of osteological features. The most striking of them include the penetration of the first dentary tooth into the anterior tip of the rostrum, the premaxillary-maxillary suture with a strong anterior projection on the palate, the jugal-quadratojugal suture starting from the posteroventral corner of the infratemporal fenestra, the anterior process of the palatine long, the palatine-pterygoid suture anteriorly positioned, and the broad tip of the neural spine of the third cervical vertebra. Therefore, these differences indicate that a new genus should be erected for *"T". petrolica*. With new information from the 18 specimens, our phylogenetic analysis suggests that *"T". petrolica* may be grouped in a clade including *Tomistoma lusitanica* (Portugal), *Gavialosuchus eggenburgensis* (Austria), the living species *T. schlegelii*, *Paratomistoma courti* (northern Africa), and *Tomistoma coppensi* (central Africa). Within the clade, *T. schlegelii* is most probably related to the *T. lusitanica-G. eggenburgensis* subclade rather than to *"T". petrolica*. Our study of the 18 specimens also agrees with the view that a common pattern of the phylogenetic relationships among the Tomistominae cannot be obtained before collecting more specimens of the fragmentary taxa and sampling a suitable set of characters for the phylogenetic analysis of the group. In this case, the origin and dispersal history of the extant species may have been much more complicated than what we previously thought.
Grant Information:
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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

STRATIGRAPHY, BIOSTRATIGRAPHY AND X-RAY FLUORESCENCE ANALYSIS OF MUDSTONE AND HETEROLITHIC FACIES IN THE DINOSAUR PARK FORMATION, DINOSAUR PROVINCIAL PARK, ALBERTA

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This research aims to recognize any cyclical packaging within the Dinosaur Park Formation (DPF) at Dinosaur Provincial Park (DPP), Alberta, and to determine whether the packages correlate with dinosaur biostratigraphy. X-Ray Fluorescence (XRF) analyses on selected heterolithic, shale, mudstone and bentonite samples collected from measured stratigraphic sections in DPP are used to help identify stratigraphic packages and interpret depositional environments of mud-rich sedimentary facies. Different features between each of mud-rich facies include the presence or absence of laminae, pedogenic features, roots and root-hairs, transported plant material, as well as grain size and trace fossil assemblages. The packaging of heterolithics, shales, and paleosols appears to be repetitive and predictable, suggesting that the stratigraphy of the DPF can be subdivided, potentially by using flooding surfaces and their correlatives landward of the coastal-plain to estuarine transition. XRF analysis was completed using an Olympus hand-held analyzer on powdered samples, which were also analyzed for grain-size using a Sedigraph for the 0.5 to 65 micron fraction. Chemically distinct horizons within the DPF are recognized especially by fluctuations in Cr, Zn, Ni, and K abundances, which help to correlate the mudstone horizons. Determination of repeating stratigraphic packages that host the mudstones could potentially help determine if higher frequency base level fluctuations affected the vertebrate fossil assemblages recorded in the DPF. Dinosaur and palynomorph turnover appears to coincide with peaks at 16-17m, 28-29m, 41-42m and 52m above the Oldman/DPF contact (+/- 5m). At these horizons, significant changes in the concentrations of Cr, Ca/Sr and Fe are observed. The correlation between changing elemental concentrations and dinosaur/palynomorph turnover suggests that base level changes at the 4th or 5th order may have influenced the packaging of the DPF.

Technical Session II (Wednesday, August 23, 2017, 11:45 AM)

DIVERSITY OF CHONDRICHTHYANS THROUGH THE UPPERMOST CRETACEOUS (MAASTRICHTIAN) HELL CREEK FORMATION OF GARFIELD COUNTY, MONTANA, WITH IMPLICATIONS FOR THE CRETACEOUS-PALEOGENE MASS EXTINCTION

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The Cretaceous-Paleogene (K-Pg) mass extinction is the most well-studied of the 'Big Five' mass extinction events. However, its causal factors are still not fully understood. The two major competing hypotheses are: (1) a bolide impact (Chicxulub) at the K-Pg boundary was the sole cause of the sudden loss of many species; and (2) the mass extinction event resulted from a "one-two punch" in which massive volcanism in India (Deccan Traps) led to gradual declines in diversity ca. 250,000 years prior to the more sudden losses associated with the bolide impact at the K-Pg boundary. Here, we test these hypotheses using fossil chondrichthyans from the uppermost Cretaceous Hell Creek Formation (HC) and lowermost Paleocene Tullock Formation (TU) of Garfield County, Montana. In this study area, the ~90-m thick HC was deposited during the last ca. 1.9 Ma of the Cretaceous, where, in most places, the K-Pg boundary layer is found immediately below the base of the overlying Tullock Formation. We analyzed diversity dynamics of euselachians (e.g., orectolobiform sharks, rajiform skates) on the basis of 769 fossil teeth from 42 fossil localities stratigraphically distributed through the HC and across the K-Pg boundary.

Our study revealed that the taxonomic composition of euselachian assemblages changed leading up to and across the K-Pg boundary. Raw taxonomic richnesses, which were calculated from samples in three 30-m stratigraphic bins (lower, middle, and upper HC), varied through the section, from six species in the lower HC to a peak in the middle HC (eight species), followed by a decline in the upper HC (five species). These estimates include the occurrences of four potentially new shark species based on distinct morphotypes from the lower and middle HC, as well as the first non-reworked occurrence of the sawtooth shark *Ischyrhiza avonicola* in the upper HC, which better constrains the stratigraphic range for this taxon. Only one confirmed species was found above the K-Pg boundary in the TU. Our study increases the known diversity of euselachians from the HC. This pattern of raw taxonomic richness for euselachians mirrors that for some tetrapods from this study area (e.g., caudates, squamates). Although the retreat of the Western Interior Seaway could have contributed to these patterns, we contend that the pre-K-Pg declines in the richnesses of euselachian and some tetrapod assemblages could also represent biotic responses to environmental perturbations associated with Deccan Traps volcanism.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

MIDDLE PLEISTOCENE "LARGER SIZED" HAMSTER FOSSILS FROM LOCALITY 2 OF SHANYANGZHAI IN QINHUANGDAO AREA, CHINA, AND DISCUSSION ON THE VALIDITY OF *CRICETINUS VARIANS* (RODENTIA: CRICETIDAE)

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A large quantity of micro-mammalian fossils were discovered in Middle Pleistocene fissure deposits in the locality 2 of Shanyangzhai Village, Qinhuangdao area, Hebei Province of China. Among those fossils, there are abundant and well preserved hamsters' remains. The aim of this paper is to give the detailed description and comparison of the "larger sized" (length of M1~3 and m1~3＞5.00mm) hamsters' fossils, including 21 skulls, 152 maxillaries, 375 mandibles and 287 isolated molars.

The comparison shows that molar characteristics of fossil materials are highly similar to those of recent *Tscherskia triton*. The similarities between them mainly reflected in: relatively larger and almost identical molar's size, mesoloph on M1 and M2 connecting to metacone, weakly divided or undivided anteroconid of m1, etc. So, all these "larger

sized" hamster materials should be identified as *T. triton*. But there are also a few differences between fossil materials and recent species, which mainly display in the development rate of mesolophid on m1 and m2 of the former are a little higher than the latter's (m1, 43% to 30%; m2, 95% to 87%). We believed this phenomenon seems to reflect a certain evolutionary trend, namely the age of *T. triton* more later, its mesolophid more degenerate.

Besides, in order to solve the long-standing dispute issue of validity to *Cricetinus varians*, we detailedly compared differences between *C. varians* and *T. triton* from three aspects —— molar's size, shape and structure, and the results showed the differences between them are very small. So, we suggest *C. varians* should be discarded as *T. triton*'s junior synonym. And since *C. varians* is type species of *Cricetinus*, *Cricetinus* should also be discarded as junior synonym of *Tscherskia*. Thus, except *C. varians*, the remaining 6 species (*C. europaeus*, *C. gritzai*, *C. beremendensis*, *C. janossyi*, *C. koufosi*, *C. mesolophidus*) belonging to *Cricetinus* should also be transposed in *Tscherskia*. The diagnoses of *Tscherskia* are also given in the paper: a kind of medium-sized hamster, which size is usually between *Cricetulus* and *Cricetus*; the teeth crown are relatively low; the mesoloph on M1~3 usually exist（free or connected to metacone）, but rarely reach the edge of the teeth; mesolophid on m3 is almost always very developed; mesolophid can also exist on m1 and m2, but rare of them can reach the edge of the teeth. According to the distribution and first emergence time of *Tscherskia* species, it is tentatively believed that the genus originated from Europe in Early Pliocene and then spread to Asia.

Technical Session XIII (Friday, August 25, 2017, 3:45 PM)

SKELETAL OSSIFICATION AND FUSION PATTERNS IN JEHOL DROMEOSAURID THEROPODS, AND IMPLICATIONS FOR IDENTIFICATION OF POSTNATAL ONTOGENETIC STAGES AND GROWTH STRATEGIES

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In morphological and systematic studies, it is important to know the ontogenetic stages of the specimens under study, but it is often difficult to obtain such information for fossils. Patterns of ossification and fusion within the skeleton are among several lines of evidence that can be used to infer ontogenetic stages, and are more easily documented than histological features and other potential ontogenetic indicators. However, skeletal ossification and fusion patterns vary among and even within major vertebrate clades, so taxon-specific information is needed in order to exploit these patterns for assessment of ontogenetic stages. More than twenty dromaeosaurid specimens of different ontogenetic stages from the Lower Cretaceous Jehol Group of western Liaoning, China were examined with respect to the ossification and fusion of selected skeletal elements, and about 25 features were found to be ontogeny-related. These features pertain to the fusion of several cranial elements, of the neural arch to the centrum in different regions of the vertebral column, of the scapula to the coracoid, of the distal carpals to the metacarpals, of the pubis to the ilium, and of the tarsals to tibia and metatarsals, as well as to the ossification of the sternum, sternal ribs, and uncinate processes. An ontogenetic model of the sequence of ossification and fusion events within the skeleton was established based on these features, and five ontogenetic stages were clearly identified for these dromaeosaurid specimens. However, several observed features are inconsistent with this postnatal ontogenetic model, suggesting that Jehol dromaeosaurids, which varied in their ecology and locomotion, varied in their growth strategies. The Jehol dromaeosaurid data suggest that ossification and fusion patterns of skeletal elements can be cautiously used to infer the ontogenetic stages of fossil specimens. They further imply that some variations are useful in investigating growth strategies and developmental patterns among dinosaurs, and are probably also related to differences in locomotion and other ecological parameters.

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Technical Session IV (Wednesday, August 23, 2017, 2:45 PM)

THREE DIMENSIONAL MICROWEAR ANALYSIS WITH ISO SURFACE ROUGHNESS PARAMETERS FOR EXPLORING THE DOMESTICATED PIG IN THE PAST

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As represented in a word "livestock", animal domestication enabled humans to own, increase, and improve animals as resources, which had been simply hunted and consumed. To reveal origin and dispersal process of domestication, archaeological remains of animals provided the most important evidences. Discriminating archaeological animal remains into domesticated individual and wild one, however, is often difficult because of their morphological and genetic similarity. In addition, such dichotomous approaches for zooarchaeological remains, are not enough to describe sequential and reversible processes during domestication. Instead, revealing whether each individual was reared (i.e., fed) can be a key to understand the process, because feeding of wild animals probably preceded the origin of domestication.

We focused on the change in diet and foraging behavior, which would be accompanied by domestication, and investigated whether these changes can be detected by dental microwear texture left on tooth enamel surface during mastication. We scanned the three-dimensional morphology of lower tooth surface of two wild and one stall-fed modern boar populations by a confocal laser microscope. The textures were quantified using the industrial "roughness" standard, ISO 25178, to prevent inter-observer errors and to distinguish small differences that were difficult to detect by the conventional microwear methods based on two dimensional images.

Multiple comparisons suggested that the parameters of tooth surface texture related to height and volume were significantly larger in the stall-fed population. Among 35 ISO parameters examined, up to 21 parameters were significantly different between the stall-fed and the wild populations, though their size, shape of skull, and genetic characters were similar to each other. Contrary, no parameters deferred significantly between the wild with much smaller body size and the stall-fed populations, whereas 20 parameters differed between the two morphologically and genetically different wild populations. None of the parameters differed significantly among the first, second, and third molars.

The results suggested that this method has potential to increase our understanding about the domestication processes in ancient times by reconstruction the change of feeding ecology of wild animals. Further studies, such as experiments on pig and boar with controlled diet, are necessary to conclude whether the microwear texture reflects solely their feeding ecology.

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Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

THE RELATIONSHIP BETWEEN HARD AND SOFT TISSUE OF THE EYE IN EXTANT LIZARDS: TOWARD RECONSTRUCTION OF THE VISUAL SENSITIVITY AND DIVING BEHAVIOR IN FOSSIL REPTILES

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In the Mesozoic marine ecosystems, the niche of apex predators was occupied by reptiles such as ichthyosaurs, plesiosaurs and mosasaurs, making their paleoecology such as diving behaviors an essential clue for understanding the organismal interactions in the marine realm. However, quantitative assessments of such behaviors are mostly lacking.

In marine taxa, the sizes of the eye or its components such as the lens are considered as reflecting their diving depth. Although the size of the lens cannot be directly observed in fossil taxa, such information may be obtained based on the size and morphology of the bony sclerotic ring, which is present in eyes of extant reptiles including birds (but excluding crocodiles and snakes) and is variously preserved in fossil taxa including Mesozoic marine reptiles.

In order to establish the basis for inferring the size of the lens in fossil squamates such as mosasaurs, we investigated the relationship of the size between the sclerotic ring and lens in extant Squamata. 3D morphological data on the eye and head region of 29 lizard species covering most major clades were collected using micro-CT scanner in two steps. Firstly, 70% ethanol-fixed specimens were scanned to collect data on skeletal elements. Secondly, the same specimens were stained with 1% Lugol's iodine solution and scanned to obtain data on soft tissues. Based on these two datasets, the sizes of the sclerotic ring and lens were measured and the correlation between these sizes was analyzed. As a result, a strong correlation was found between the internal diameter of the sclerotic ring and the lens diameter ($r^2 = 0.80$). Furthermore, the lens diameter shows strong negative allometry against the internal diameter of the sclerotic ring (OLS slope: 0.64, RMA slope: 0.72), in contrast to the condition in birds, in which these two sizes are isometrically scaled. The tight correlation found here allows a reliable estimation of the lens diameter in fossil squamates such as mosasaurs based on the internal diameter of the preserved sclerotic ring. The result also demonstrates that the regression equation obtained on birds cannot simply be applied to squamates, suggesting the necessity of clade-specific investigations of such correlations. Similar analyses on the correlations among other eye structures will further constrain their sizes and provide necessary information for inferring the visual sensitivity and diving behavior in fossil reptiles.

Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

COMPARISON OF DIFFERENT STORE BOUGHT AND HOMEMADE CONTACT PAPERS USED TO STABILIZE JACKETED FOSSILS WITH POTENTIAL BIOLOGICAL MATERIAL

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During the 2016 field season, dinosaur skin impressions were found at the Homestead Site (SNOMNH V1694) and were jacketed with two sauropod vertebrae. The site is located in the upper Morrison Formation, likely the Brushy Basin Member, and is part of a Pleistocene or Holocene landslide. All fossils are highly fragmented, but the pieces remain in close proximity. Typical stabilization techniques include organic solvents, but discussions at the 2016 SVP meeting suggested that there may be biological material preserved. Therefore, a new technique was needed to keep the highly-fragmented fossil material aligned without harming potential biological material. It was hypothesized that shelf liner might be an effective contact paper. To test the effectiveness of a two manufactured and three homemade contact papers, I created plaster disks with four different surfaces (smooth plaster, fine sand, coarse sand, and clay from the Homestead Site) plus clay without plaster to test the effectiveness of each contact paper. The plaster disks were created from one batch of plaster and allowed to set in a low humidity lab. Each disk was broken into fragments to represent the sites highly fractured fossils. Each plaster disk was tested against these five treatments: Contact brand shelf liner, masking tape, high-density plastic (HDPE) sheeting with a thin layer of Butvar B-76, HDPE sheeting with a thick layer of Butvar B-76, and Renown Select trifold paper towels with a thick layer of Butvar B-76. The Butvar B-76 was allowed to dry until tacky before being placed against the plaster disks to ensure no acetone was seeping into the plaster. The manufactured shelf liner was successful in holding together the pieces of smooth plaster, but failed with every other comparison. Masking tape was not effective on the fine-grained sand, but would be an acceptable method for other surfaces. HDPE sheeting with a thin layer of Butvar B-76 was effective at holding together larger pieces, but the small fragments did not adhere as well and their orientation was not preserved. HDPE sheeting with a thick layer of Butvar B-76 successfully held together all pieces on all treatments, and it was more structurally sound than the previous tests. The most effective option was the trifold paper towel with two layers of Butvar B-76. It stabilized all pieces, and the stiffer texture gave more support when simulating removal from the jacket and transport around the lab. While the paper towel was the most effective, we are currently using the HDPE sheeting with 2-3 coats of Butvar B-76 so the bone is visible to volunteers.

Technical Session XV (Friday, August 25, 2017, 4:00 PM)

THE DYNAMICS OF STARVATION AND RECOVERY: A MECHANISTIC MODEL FOR A WITHIN-LINEAGE DRIVER OF COPE'S RULE

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The eco-evolutionary dynamics of species are fundamentally linked to the energetic constraints of its constituent individuals. Of particular importance are the tradeoffs between reproduction and the dynamics of starvation and recovery in resource-limited environments. To elucidate the consequences of this tradeoff, we introduce a minimal nutritional state-structured model that incorporates two classes of consumer: nutritionally replete consumers that reproduce, and undernourished, non-reproducing consumers that are susceptible to mortality. As a function of the transition rates between these replete and undernourished states that are determined by the presence or absence of resources, consumer populations can either undergo cyclic dynamics or reach a steady state. We obtain strong constraints on starvation and recovery rates by deriving allometric scaling relationships and find that population dynamics subject to these constraints can approach the cyclic regime but are typically driven to a steady state. Moreover, we find that these rates fall within a 'refuge' in parameter space, where the probability of extinction of the consumer population is minimized. Thus we identify a potential mechanism that may both drive and constrain the dynamics of animal populations. Our model provides a natural framework that predicts maximum body size for mammals by determining the relative stability of an otherwise homogeneous population to a mutant population with altered percent body fat. For body masses less than ca. 10^7g, individuals with increased energetic reserves can invade resident populations, and for body masses greater than ca. 10^7g, increased with lower energetic reserves have the advantage. Our findings thus provide a principled mechanism for a within-lineage driver of Cope's rule.

Technical Session XII (Friday, August 25, 2017, 9:30 AM)

ESTIMATING AGILITY OF THE FOSSIL SNAKE *DINILYSIA PATAGONICA* (REPTILIA: SQUAMATA), USING THE SEMICIRCULAR CANALS AS AN ECOMORPHIC PROXY IN SQUAMATES

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Dinilysia patagonica was the largest terrestrial snake in the Cretaceous. The large eyes and body size of *Dinilysia* suggest it was surface active, but the enlarged vestibule in its inner ear suggest *Dinilysia* was a burrower. This study estimates the ecology of *Dinilysia* using data from the bony semicircular canals that, together with the vestibule, form the balance apparatus in vertebrates. The size and geometry of the semicircular canals have been associated with agility in lizards, primates and cetaceans, but similar comparative data of snakes remain sparse. This study compares *Dinilysia* with extant snakes and lizards, using the length of the three semicircular canals and the angle between adjacent canals measured on three-dimensional CT models. The taxon sampling includes 38 species of terrestrial lizards and snakes divided into two groups: generalists, which are surface active, and burrowers that actively dig into the substrate. Morphologically, *Dinilysia* has slender semicircular canals and small ampullae. The anterior and posterior semicircular canals of *Dinilysia* form a wide angle, which also occurs in extant burrowers with various body sizes (blind snakes, amphisbaenian lizards, and the sand boa *Loxocemus*). Phylogenetic linear regression shows the length of the semicircular canals is correlated with the length of the skull. After correcting for skull length, the burrowers have shorter anterior canal, shorter posterior canal, and longer lateral canal than those of the generalists. Although it remains to be fully understood how the dimension of semicircular canals affects sensory performance, previous studies have suggested lizards with long anterior and posterior canals are more stable in roll movement. *Dinilysia* resembles modern burrowing snakes in having reduced anterior and posterior canals in proportion to skull length, indicating limited stability when rolling. This provides another line of evidence that *Dinilysia* was adapted to living in underground tunnels, in addition to a previous study suggesting *Dinilysia* has an enlarged vestibule for detecting substrate vibrations. Furthermore, phylogenetic ANOVA analysis between extant generalists and burrowers found significant difference in the angle between the anterior and posterior canals. This shows relative position of the semicircular canals are related to habitat in squamates, providing an ecomorphic proxy that applies to extant and extinct species.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

A NEW CAENAGNATHID (THEROPODA: OVIRAPTOROSAURIA) FROM THE UPPER CRETACEOUS WANGSHI GROUP OF SHANDONG, CHINA

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Over the last decade we have organized several major excavations in exposures of the Upper Cretaceous Wangshi Group at the Zangjiazhuang and Kugou localities in Zhucheng, Shangdong, China. These excavations have resulted in the discoveries of at least four new dinosaur taxa. Here we report a new oviraptorosaur based on a recently collected specimen comprising a partial left hindlimb from the Kugou Locality, which adds one more dinosaur species to the Zhucheng dinosaurian fauna. The new taxon can be referred to the oviraptorosaur clade Caenagnathidae based on the following combination of features: femur with a proximodistally long accessory trochanter, femoral head dorsomedially oriented, lesser trochanter finger-like and closely adhering to the greater trochanter, trochanteric crest anteroposteriorly wide and well separated from the femoral head by a shallow sulcus, and metatarsal III with a transversely pinched proximal end, a short anterior flange near the proximal end, and a non-ginglymoid distal end. This systematic hypothesis was supported by a numerical cladistic analysis based on a recently published theropod phylogenetic data set, with the inclusion of the new specimen and 10 new characters derived from the hindlimb. The specimen differs from other caenagnathids in having the following unique combination of features: femoral head anteroposteriorly compressed, accessory trochanter low, and weak fourth trochanter present. With a femoral length of about 300 mm, the new specimen is larger than is typical for Oviraptoridae, but smaller than is typical for Caenagnathidae, which displays a much greater size disparity than the former group. The new caenagnathid oviraptorosaur, along with previously described dinosaurs from Zhucheng including a tyrannosaurid, two leptoceratopsids, a ceratopsid, and at least one hadrosaurid, provides strong evidence supporting a close biogeographical relationship between the Zhucheng dinosaurian fauna and the contemporary North American ones.

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

AN ENIGMATIC NEW UNGULATE FROM THE EARLY EOCENE OF INDIA

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The early Eocene Cambay Shale Formation in Gujarat State, India has produced a rich mammalian fauna, including the earliest artiodactyls, perissodactyls, primates, hyaenodonts, rodents, lagomorphs, chiropterans, and tillodonts from the Indian Subcontinent. While some of these groups show endemism at the generic or familial level, all belong to clades that are widely distributed across Laurasian continents, and some show particularly close similarities to contemporary taxa from other continents, particularly Europe.

We report here a distinctive new taxon, represented by a mandible with p3-m3 and a second mandibular fragment with m3. The morphology of the new taxon is broadly comparable to diverse early ungulates from around the world but shows a unique suite of features including a strongly fused mandibular symphysis, enlarged anterior tooth alveolus, simple premolars lacking paraconids and with only a rudimentary metaconid on p4, progressive size increase of the molars distally, molar exodaenodonty/unilateral hypsodonty, molar paraconids absent, hypoconulids absent on m1-2, incipient development of selenodont buccal cusps and an incipient entolophid formed by a transverse entoconid, well-developed, and prominent m3 hypoconulid. One particularly distinctive feature is the presence of large, cuspate ectostylids on molar hypoflexids.

While there are similarities to a variety of taxa, most notably periptychids, louisinids, early African "ungulates" (*Abdounodus*, *Ocepeia*), and even early anthracotheres, none of these is detailed enough to indicate a close relationship, and all appear to be better interpreted as convergence. Our present understanding suggests that these fossils represent a new family of "condylarth"-grade ungulates perhaps endemic to India. Although their overall adaptations are very different, there are some intriguing similarities to another group of enigmatic Eocene mammals from the Indian Subcontinent, Quettacyonidae. While more material is needed to test this possible relationship, quettacyonids and the new taxon may represent remnants of the eutherian fauna present in India prior to its first faunal exchange with the northern continents, and the new taxon likely has a lengthy, undocumented history in the Indian Paleocene.

Grant Information:
Fieldwork and research supported by Leakey Foundation, National Geographic Society, Wadia Institute of Himalayan Geology, and Belgian Science Policy Office.

Technical Session XII (Friday, August 25, 2017, 9:45 AM)

A NEW SPECIMEN OF THE NEST PREDATOR *SANAJEH INDICUS* (SERPENTES) SUGGESTS A MORE BASAL POSITION WITHIN SNAKE PHYLOGENY

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Recent field work in 'infratrappean' deposits of the Lameta Formation cropping out near the village of Dholi Dungri in the Gujarat State, India has produced important new vertebrate specimens, including associated remains of turtles, crocodilians, and snakes. Among the new snake material is an individual that preserves the rear portion of the skull and numerous vertebrae that are identical to those of *Sanajeh indicus* and—like the holotypic specimen—was found in association with eggshells. The referred skull includes a well preserved braincase and skull roof, partial palate, and partial mandible, some elements of which are not present in the holotypic specimen. Additional preparation to the holotypic skull revealed important details of the anatomy not visible before, which allowed us to identify or re-interpret some of the skull elements. For instance, we interpret the element previously identified as the supratemporal in the holotype to be the stapedial footplate, the element identified as the palatine is here interpreted to be the septomaxilla, and the element identified as an anterior fragment of the left mandible as the premaxilla. Importantly these newly discovered elements, particularly those of the skull roof, are symplesiomorphic, suggesting a more basal divergence for *Sanajeh* than its previously suggested position within "Madtsoiidae."

To test this hypothesis, we conducted a phylogenetic analysis that includes revised scorings for *Sanajeh indicus*, the hind-limbed pachyophiid snakes, the "madtsoiids" *Yurlunggur* sp. and *Wonambi naracoortensis*, and the four-legged squamate *Tetrapodophis amplectus*. The preferred topology corroborates *Tetrapodophis* as the sister-taxon of Ophidia and places the hind-limbed pachyophiids and "madtsoiids" as stem-alethinophidians. *Sanajeh* is recovered in a more basal position, near *Najash* and *Dinilysia*, reinforcing the view that "madtsoiids," as presently viewed, constitute an assemblage of distantly related taxa. These results contrast with recent hypotheses of higher-level snake relationships and have important implications for the evolution of macrostomy within snakes. Our results suggest that large-bodied Cretaceous snakes such as *Sanajeh* and *Dinilysia* developed macrophagous predatory habits but lacked key attributes of the macrostomatan condition. True macrostomy first appeared in the common ancestor of limbed pachyophiids, extinct Australian "madtsoiids," and extant

macrostomatans—and involved key modifications in both palatomaxillary and quadratomandibular arches.

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

TAXONOMIC TRENDS IN FOSSIL EGG REMAINS DURING THE LATE CRETACEOUS OF ALBERTA, CANADA

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The province of Alberta is well renowned for its numerous discoveries of dinosaur embryos, eggs, and eggshells. Although most dinosaur egg remains are from the upper Campanian Oldman Formation, eggshells have also been reported from other Upper Cretaceous rock units, including the Milk River (Santonian), Dinosaur Park (upper Campanian), St. Mary River (uppermost Campanian- lower Maastrichtian) and Willow Creek formations (upper Maastrichtian-lower Paleocene). Collectively, these formations preserve a relatively continuous record of fossil eggshells spanning the last 17.5 million years of the Cretaceous and permit the study of ootaxonomic trends through time. In this study, we observe that several ootaxa (*Continuoolithus*, *Porituberoolithus*, *Prismatoolithus* and *Spheroolithus*) are present from the Santonian through the upper Maastrichtian, whereas other ootaxa (*Montanoolithus*, *Prismatoolithus*) are restricted to the upper Campanian-upper Maastrichtian interval. The long stratigraphic range of most ootaxa suggests that they represent inclusive dinosaur clades that lived through the Upper Cretaceous rather than individual species. Based on eggshell morphology and previously known egg-embryo associations, eggs remains from Alberta are ascribable primarily to Ornithopoda and Theropoda, whereas eggs of ankylosaurs and marginocephalians are presently unknown. Ornithopod eggs include those of the lambeosaurine *Hypacrosaurus stebingeri* (containing embryos) as well as the ootaxa *Spheroolithus albertensis* and *S. choteauensis*, which may belong to saurolophine hadrosaurs or more basal ornithopods. Theropod egg remains are the most morphologically diverse and include several oospecies of *Continuoolithus*, *Dispersituberoolithus*, *Montanoolithus*, *Porituberoolithus*, *Prismatoolithus*, *Triprismatoolithus*, and *Tristragaloolithus*. *Prismatoolithus levis* belongs to the Troodontidae based on previously-discovered embryos *in ovo*. All other theropod ootaxa from Alberta are relatively thin (< 1mm) and likely belong to small non-avian maniraptorans or birds. The oodiversity in some formations (e.g., Willow Creek) is greater than the taxonomic diversity represented by skeletal remains, suggesting that eggshells may be better indicators of faunal diversity than bones due to preservational biases in some formations. In general, theropod oogenera increase in thickness between the Santonian and upper Maastrichtian, which may reflect an increase in body size of some maniraptoran clades during the Late Cretaceous.

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Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

A NEARLY COMPLETE SKELETON OF A TRANSITIONAL SAUROPODIFORM DINOSAUR FROM THE EARLY JURASSIC OF LUFENG, YUNNAN PROVINCE, CHINA

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Sauropodiformes is often defined as the most inclusive clade containing *Saltasaurus* but not *Massospondylus*, representing one of the two latest diverging clades within Sauropodomorpha. The basal members of sauropodiforms achieved a global distribution during the Early Jurassic and formed a set of successive sister-groups towards Sauropoda. On account of giving rise to sauropod dinosaurs, characterizing the evolutionary history of sauropodiforms is crucial to understand the origin and diversification of sauropods, especially on issues regarding the complex processes of body size change, quadrupedal acquisition and dietary shifting. The most basal sauropodiforms currently known are all recovered from the Lower Jurassic Lufeng Formation in Lufeng County of Yunnan Province, China, including *Yunnanosaurus*, *Jingshanosaurus* and *Xingxiulong*.

Here we introduce another member of sauropodiforms, which is represented by a nearly completely and exquisitely preserved skeleton that was excavated from the uppermost unit of the Zhangjiaao Member (Dark Red Beds) of the Lufeng Formation in Chuanjie Basin of Lufeng County. This specimen has been informally reported as a basal sauropod in 2010 Geological Society of America meeting bearing the name "*Yizhousaurus sunae*", but it has never been fully studied until now. Our detailed research of the specimen reveals a mosaic set of primitive and derived features, in addition to its own unique characters, such as the small and spoon-shaped antorbital fenestra, the vertical lacrimal, the rather small external mandibular fenestra, and the broad axial intercentrum wider than its centrum. The specimen also shows some derived features, such as the deep fossae on the lateral surface of the anterior dorsal centra, the expanded tip of the neural spines in the posterior cervical and dorsal vertebrae, the shortened robust manus, and the subelliptical cross-section of the midshaft of the femur. Our phylogenetic analysis suggests that this specimen is more derived than the three aforementioned basal sauropodiforms from Lufeng, therefore it represents another transitional stage in the evolution towards Sauropoda.

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Technical Session XVI (Saturday, August 26, 2017, 11:30 AM)

A NEW BASAL ANKYLOSAURINE DINOSAUR (ORNITHISCHIA: ANKYLOSAURIDAE) FROM THE ALBIAN–CENOMANIAN OF CHINA, WITH IMPLICATIONS FOR THE EVOLUTION OF THE TAIL CLUB

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The tail club is a highly specialized structure thought to characterize a subgroup of the ankylosaurine ankylosaurians, and the oldest documented tail club in the fossil record occurs in the Campanian ankylosaurine *Pinacosaurus*. Here we report a new ankylosaurid based on six specimens at different ontogenetic stages collected from the Albian–Cenomanian Liangtoutang Formation, Jinyun County, Zhejiang Province, China. These specimens include a nearly complete skull and collectively provide information on most of the postcranial skeleton, making the new taxon the most completely known ankylosaurian from southern China. The new ankylosaurid differs from other ankylosaurs in possessing several unique cranial features, including two paranasal apertures level with and posterior to the external naris, an antorbital fossa between the maxilla, lacrimal and jugal, contact between the maxillary posterodorsal process and the prefrontal, and an anterior process of the prearticular that lies ventral to the splenial. Our numerical phylogenetic analysis recovers this new ankylosaurid as the most basal ankylosaurine dinosaur. The new ankylosaurid has a tail handle which is composed of at least ten interlocking caudal vertebrae, and covered ventrally by irregularly-shaped flat osteoderms. The tail knob is drop-shaped in dorsal view, and larger than the skull. The new discovery thus demonstrates that a large and highly modified tail club evolved at the base of the ankylosaurine ankylosaur at least about 100 million years ago.

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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

THE FIRST JUVENILE SPECIMEN OF *MANCHUROCHELYS MANCHOUKUOENSIS* FROM THE EARLY CRETACEOUS JEHOL BIOTA

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As part of the basal eucryptodires, the sinemydid turtles are dominated and widely distributed in the Early Cretaceous of East Asia. In the last decades, sinemydids (*Manchurochelys manchoukuoensis*, *Ordosemys liaoxiensis*, *Liaochelys jianchangensis*, *Xiaochelys ningchengensis*) have been discovered from the Jehol Biota and a large number of well-preserved fossils have been described. However, descriptions are mainly focused on the taxonomic diversity, with little focus on ontogenetic change. To date, three ontogenetic series have been reported in the Sinemydidae. As known in *Sinemys lens*, the ontogenetic series show the morphology varied from the juvenile to adult, with the carapacial outline is nearly rounded in the juvenile and becomes to an oval in adults; vertebral scales 2–4 are wide in juvenile but much narrower in adult. In contrast, the ontogenetic change is relatively less developed in *O. liaoxiensis* and *Changmachelys bohlini*.

Here, a juvenile turtle from Yixian Formation of Yixian, western Liaoning, which is the same as the type locality and horizon of *Manchurochelys manchoukuoensis*, is described. It is similar to *M. manchoukuoensis* in cranial and shell morphology, sharing features such as the postorbital isolated from the squamosal, a relatively elongated crista supraoccipitalis, and a smaller anterior suprapygal. In addition, the juvenile features, such as a nearly circular shell, open lateral fontanelles and wider vertebral scales, are shown for the first time in *M. manchoukuoensis* by this specimen. In contrast to the adult morphology, which has an oval carapace, closed lateral fontanelles, and longer vertebrals 2–4, the juvenile of *M. manchoukuoensis* is more comparable to that of *Sinemys lens*, except for earlier occurrence of the well-ossified carapace of the latter. Differs from *Changmachelys bohlini*, and *Ordosemys liaoxiensis*, in which the circular carapace is relatively independent of ontogenetic age, and the lateral fontanelles are only closed in adult stage of *O. liaoxiensis*. Therefore, the trajectory of ontogenetic change appears to be highly diversified in the sinemydids.

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Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

DIGITAL CRANIAL RECONSTRUCTION: DOCUMENTING VISUALIZATION METHODOLOGY AND DECISION-MAKING IN THREE-DIMENSIONAL COMPUTED TOMOGRAPHIC RECONSTRUCTION OF FOSSIL SKULLS, AS EXEMPLIFIED USING THE EARLY CRETACEOUS BASAL SQUAMATE *NORELLIUS NYCTISAUROP*

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Digital reconstruction of fossils skulls and skeletons, now commonplace in the paleontological literature, are often presented as a fait accompli with little documentation regarding the many decisions made along the way and with little or no access to these stages or the digital reconstruction itself.

The holotype and only known specimen of Norellius nyctisaurops, regarded as a basal gekkonomorph, is a skull approximately 20mm in length that was reconstructed based on a microCT scan as interpreted and extended by a sequence of standard visualization programs. We document that complex process of reconstruction and decision-making with standardized forms using new cloud based software to create a comprehensive multi-user database. The skull requires significant reconstruction in order to be properly

evaluated. Using visualization tools such as data segmentation, animation, and 3d printing, important skull features can be better delineated for a more accurate reconstruction. MicroCT data of the original skull was interpolated into 3d models, which were then reconstructed. The entire process was animated to show the original skull, reconstructed skull, brain endocast, reconstruction of vestibular system, and path of the internal carotids. The remodeled skull models were 3d printed at larger size for physical examination. Because such skull reconstructions are usually presented with little information on the sequence of decisions involved in their creation, a collaborative database was created to formalize and efficiently record the work flow. We compare the 3d skull reconstruction *of Norellius nyctisaurops* to previous graphical depictions of the taxon and discuss its bearing on its phylogenetic position.

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