

SVP 84th ANNUAL MEETING

2024 Program Guide

Hyatt Regency | Minneapolis, Minnesota, USA
October 30 - November 2, 2024



[VISIT VERTPALEO.ORG/SVP-ANNUAL-MEETING/](https://vertpaleo.org/svp-annual-meeting/)



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OCTOBER/NOVEMBER 2024 ABSTRACTS OF PAPERS

HOST COMMITTEE

David L. Fox, Co-Chair, Peter Makovicky, Co-Chair, Catherine Early, Alex Hastings, Kieran McNulty, Kristi Curry Rogers, Raymond Rogers, John Westgaard

EXECUTIVE COMMITTEE

Margaret Lewis, President; Jessica Theodor, Past President;
Stuart Sumida, Vice-President; Samantha Hopkins, Secretary; Ted Vlamis, Treasurer;
Karen Chin, Member-at-Large; Zerina Johansson, Member-at-Large;
Paul Koch, Member-at-Large; Taissa Rodrigues, Member-at-Large (Ethics); Lindsay Zanno, Member-at-Large (Ethics)

SYMPOSIUM CONVENORS

Luke Weaver, Elsa Panciroli, Greg Funston, and Elis Newham

PROGRAM COMMITTEE

Alistair Evans, Co-Chair, Brandon Peacock, Co-Chair, Bin Bai, Juan Benito, Alessio Capobianco, Kimberley Chapelle, Alfio Alessandro Chiarenza, Brian Davis, Rafael Delcourt, Dana Ehret, Matteo Fabbri, Aryeh Grossman, Pedro Godoy, Juan Liu, Benjamin Otoo, Felipe Pinheiro, Selina Robson, John Rowan, Tiago Simoes, Shuo Wang, Megan Whitney

EDITOR

Dana Ehret

WITH SPECIAL THANKS TO...

SVP Collections & Repository Committee, SVP Ethics Committee, SVP Government Affairs Committee, SVP Education & Outreach Committee, SVP Preparators' Committee

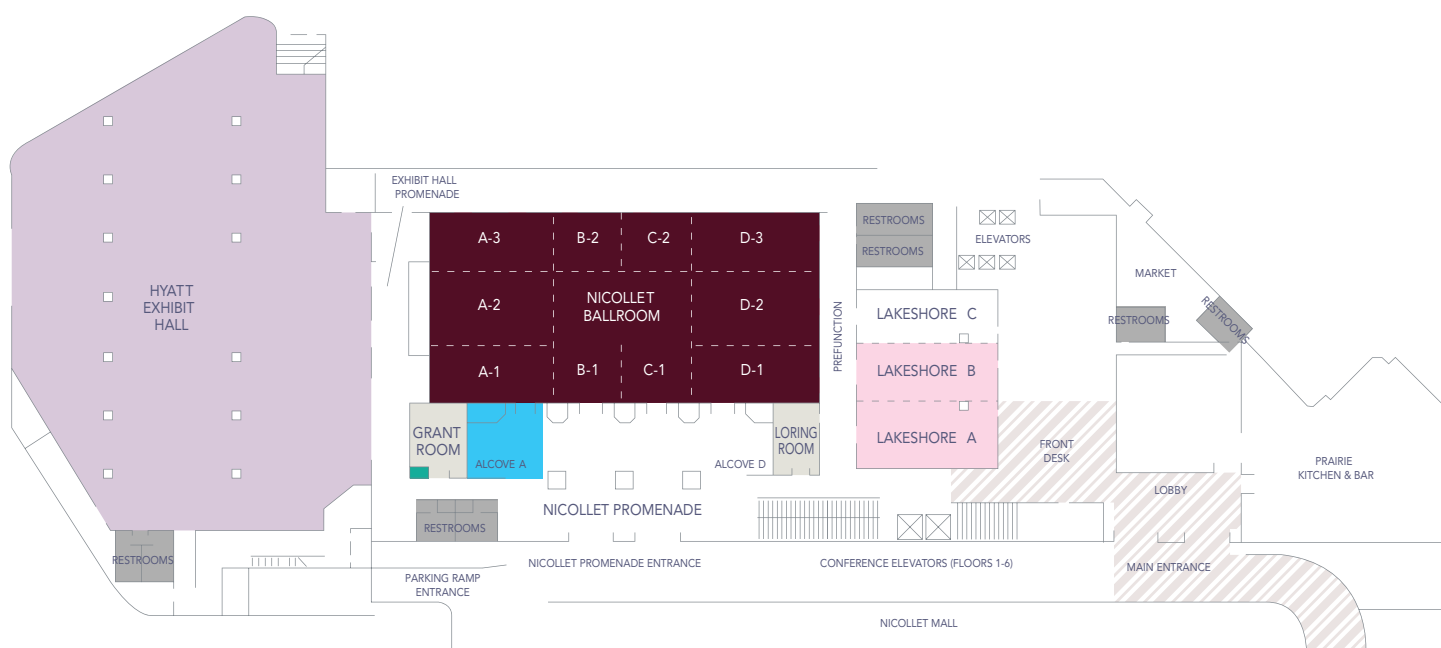
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HYATT REGENCY MAP

Floor Plan - Main Level Meeting Rooms



 Registration Desk (this will be located outside the Nicollet Grand Ballroom in the foyer area)

 Posters and Exhibits (Exhibit Hall)

 3 Concurrent Session Rooms (Nicollet Ballroom A, B/C, D)

 Awards Banquet (Nicollet Ballroom)

 Restrooms

 Gender-Neutral Restroom

 Committee Meetings - Lakeshore A and B

 Main Entrance (by Lakeshore Ballrooms)

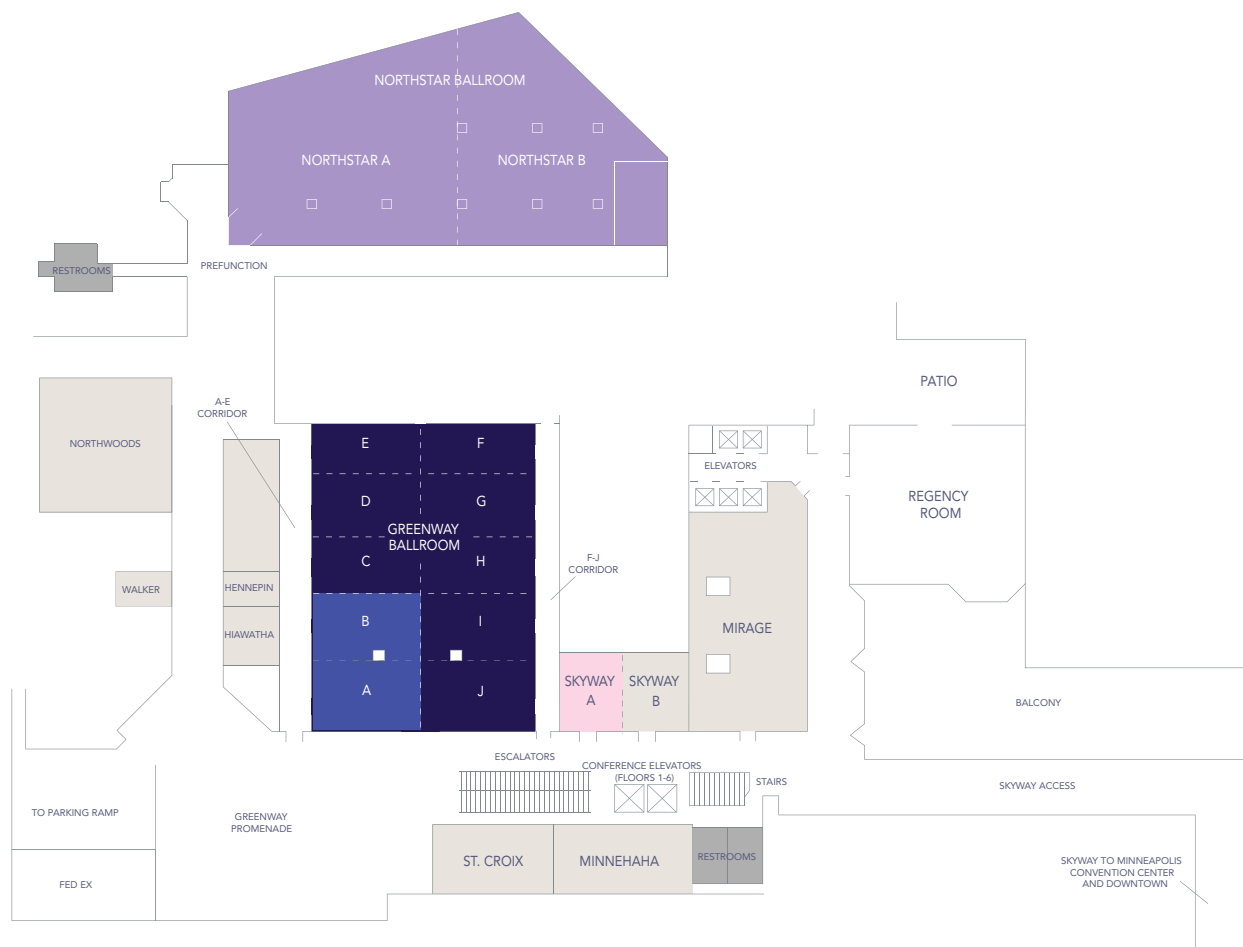
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HYATT REGENCY MAP

Floor Plan - Second Level Meeting Rooms



■ Student Round Table (Greenway A,B)

■ Auction Event (Northstar Ballroom)

■ After Party (Greenway Ballroom)

■ Committee Meetings - Skyway A

■ Restrooms

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WELCOME TO THE TWIN CITIES

The Host Committee of the 84th Annual Meeting is excited to welcome all participants to the Society of Vertebrate Paleontology's 2024 meeting in the Twin Cities of Minneapolis and St. Paul, Minnesota, USA. Minnesota is known as the Land of 10,000 lakes, though it actually has more than 23,000 lakes. You may also know Minnesota as the "State of Hockey" and as the home of a major music scene, whether your taste is Bob Dylan, The Replacements, Hüsker Dü, Jimmy Jam and Terry Lewis, or Prince, the artist who inspired this year's meeting logo.

The meeting will take place in the Hyatt Regency Hotel, located in city center Minneapolis, and the Welcome Reception will take place in the Science Museum of Minnesota on the left bank of the Mississippi River in downtown St. Paul. The name Minneapolis is derived from the Dakota and Greek words for water and city, respectively; the original name of St. Paul is Pig's Eye, the nickname of a one-eyed tavern owner, Pierre Parrant, who is considered the founder of what became the city of St. Paul.

This will be the second annual meeting of the Society of Vertebrate Paleontology in the Twin Cities, and we look forward to having you here, whether as a return visitor or for the first time. This year's meeting is co-hosted by faculty and staff at the University of Minnesota-Twin Cities, the Science Museum of Minnesota, and Macalester College in St. Paul. The Twin Cities has a community of paleontologists working on a range of taxa, from dinoflagellates to dinosaurs at sites across the globe.

Chartered in 1851, the University of Minnesota Twin Cities is a public research university and the flagship of the five-institution University of Minnesota system with campuses in both Minneapolis and St. Paul. With enrollment of about 55,000 undergraduate, graduate, and professional students, it is the largest university in Minnesota and one of the top 10 largest universities in the USA. Both the Department of Earth & Environmental Sciences and the Department of Evolution, Ecology, and Behavior are highly ranked in the US with long historical connections to vertebrate and invertebrate paleontology and Quaternary paleoecology. Macalester College, founded in 1874, is a highly ranked liberal arts college with an enrollment of about 2,000 undergraduate students from every state and more than 100 countries around the world. Macalester's mission centers on multiculturalism, internationalism, and service to society. Since the 1960s, paleontology has been a central component of the geology curriculum, and in recent decades, many Macalester students have been inspired to pursue careers in paleontology.

For more than 100 years, the Science Museum of Minnesota has been a feature destination and place of scientific learning. It moved into its current location in the heart of Saint Paul in late 1999 and serves as the largest fossil repository in the state, with hundreds of thousands of specimens. The paleontology collection spans roughly two billion years of history here in Minnesota as well as the world beyond. One major highlight is the ecosystem-level preservation of the Paleocene Wannagan Creek fauna from North Dakota, with its incredibly high abundance of crocodyliforms, as well as fish, amphibians, turtles, squamates, birds, mammals, and very well-preserved champsosaurs, also an inspiration for this year's meeting logo. The museum's paleontology exhibits feature original skeletons collected by teams directed by former paleontology curator Bruce Erickson over his many decades of work in Montana, Wyoming, and North Dakota.

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WELCOME TO THE TWIN CITIES - CONTINUED

The Minnesota Discovery Center in Chisholm, MN, is a nonprofit institution and the state's largest museum complex outside of the Twin Cities metro area. Comprised of a Museum, Research Center, and park - encompassing 660 acres, Minnesota Discovery Center tells the story of the Iron Range - "The Land, The Mines, The People and The Work" - through exhibits, interpretation, programming and research materials. Often referred to as the "Museum of the Iron Range," the center explores the region's unique history and tells the stories of the immigrant communities, mining industry, and cultural evolution that shaped the Iron Range, making it a vital resource for understanding this significant part of Minnesota's history. Beyond its focus on the mining industry and immigrant communities, the center also highlights the paleontological and archaeological significance of the region, particularly through its connection to the Hill Annex Mine and as host to the Hill Annex Paleontology Project. This historic mine is not only a landmark of the Iron Range's industrial past but also a treasure trove of fossil discoveries, offering insights into the area's prehistoric life. The Minnesota Discovery Center plays a crucial role in interpreting these findings, showcasing fossils, and providing context for the ancient environments that existed long before the Iron Range became known for its iron ore. The Minnesota Discovery Center tells the full story of the region's natural and cultural evolution.

The geological and paleontological records in Minnesota stretch from the Archean Eon to the Holocene Epoch, albeit with very uneven representation of the timescale. The Proterozoic banded iron formations in northern Minnesota have been economically important to the state and the country for more than 100 years, and some units host microbial fossils that, when first discovered in the Gunflint Chert, were the oldest direct fossil evidence of life on Earth. The lower Paleozoic rocks in southeastern Minnesota, and in particular the trilobite faunas, were critical to early concepts of the Cambrian and Ordovician stratigraphy and biostratigraphy of North America. Thin, fossiliferous Cretaceous deposits occur in several parts of Minnesota, including the Cenomanian Coleraine Formation, comprising coastal deposits of the interior seaway that sit on top of Proterozoic iron formations in northern Minnesota and produce marine vertebrates and invertebrates and occasional terrestrial vertebrates. The landscapes of much of Minnesota are the result of late Pleistocene glacial processes, and the resulting sediments continue to produce scattered fossils of late Pleistocene megafauna and Holocene bison. The pollen records in the sediments of many lakes have been used to produce high-resolution records of environmental changes across the state following the end of the last glacial period.

The Twin Cities Metro is a vibrant region with diversity that defies stereotype. Minneapolis and St. Paul, and the institutions hosting the annual meeting, are located on the land of the Dakota people, who were dispossessed of their land in Minnesota by the governments of the state of Minnesota and the United States. Many Dakota people still reside in Minnesota and elsewhere, and some may be participating in the annual meeting. Today, Minnesota has 11 Federally recognized Native American tribes, and the Twin Cities has one of the largest urban populations of Native Americans of any US city. Minneapolis is also home to the largest Somali community in North America and possibly anywhere outside of eastern Africa, and St. Paul has the largest population of Karen peoples outside of southeast Asia and a large Hmong community as well.

Needless to say, the murder of George Floyd is still a painful and challenging moment in the recent history of Minneapolis. The corner

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WELCOME TO THE TWIN CITIES - CONTINUED

of 38th Street South and Chicago Avenue South remains a memorial to George Floyd that is a space for reflection on social issues in Minneapolis and beyond and a focal point of community organizing in South Minneapolis.

While we recognize that the annual meeting is a busy time, we hope that you will be able to enjoy some of what the Twin Cities has to offer outside the conference hotel. The blocks of Nicollet Avenue to the south of the Hyatt Regency are called Eat Street because of the range of global cuisines available at the large number of restaurants, including excellent options for Mexican, Vietnamese, Jamaican, German, Malaysian, and Japanese food, as well as gourmet doughnuts. The Twin Cities are also home to numerous award-winning restaurants as well as many breweries and cafes, catering to any and all tastes. Minneapolis is ranked as the best large city for biking in the US, and so long as we don't get a repeat of the Halloween Blizzard of '91 during the annual meeting you can rent a bike and ride around the Chain of Lakes or along the Mississippi River or elsewhere on the miles of trails and dedicated bike lanes. You can also try your hand at curling at the Saint Paul Curling Club! The Twin Cities has a thriving arts scene, with theaters that range from fringe to Broadway, including the Guthrie Theater, with three separate stages, and Penumbra Theater, Minnesota's only Black professional theater, in Minneapolis and the Ordway in St. Paul. The Minneapolis Institute of Art is one of the largest art museums in the US with collections that cover most of art history, and the Walker Art Center in Minneapolis is a multidisciplinary contemporary art museum with a sculpture garden that includes the famous Spoonbridge and Cherry. Maybe you'll even have time to take in a show at First Ave, the nightclub featured in the film *Purple Rain* that was owned by Prince, and you can tour Prince's home and studio at Paisley Park in the nearby suburb of Chanhassen. The Twin Cities are also home to major sports teams including the Vikings (NFL), Twins (MLB), Timberwolves (NBA), Wild (NHL), Loons (MLS), Lynx (WNBA), and Minnesota PWHL, the reigning champions of the Professional Women's Hockey League.

Whatever you choose to do, we hope you enjoy your time in the Twin Cities and have an excellent meeting!

David Fox

SVP 84th Annual Meeting Host Committee Co-chair

Peter Makovicky

SVP 84th Annual Meeting Host Committee Co-chair

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PRESENTATION POLICIES

SVP Abstracts are reviewed by the Program Committee and members of the Collections & Repository, Education & Outreach, Ethics, Government Affairs, Preparators, and Romer Prize Committees, as appropriate. 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/video tape 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 2024 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, 2024, <insert page number here>*.

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PRESENTATION POLICIES - CONTINUED

SVP CODE OF CONDUCT

Please familiarize yourself with [SVP's Code of Conduct](#) as well as our [supplemental COVID Code of Conduct](#). The Society of Vertebrate Paleontology (SVP) is dedicated to providing a courteous, professional, harassment-free conference experience for everyone, regardless of gender, gender identity and expression, sexual orientation, disability, physical appearance, race, or age. Demeaning, abusive, harassing, or threatening behavior towards other attendees, staff or the public is not permitted in either personal or electronic interactions. Personal and electronic interactions should be professional, rational, and mutually respectful at all conference events, both formal and informal. Intellectual property should be respected by not disseminating photographs, recordings, or other reproductions of presentations or artwork without permission of the author. Please respect authors' requests regarding the dissemination of embargoed materials.

EXPECTED BEHAVIOR

Treat one another with respect, consideration, and dignity regardless of gender, gender identity and expression, sexual orientation, marital or parental status, age, immigration status, disability, neurodiverse status, physical appearance, body size, race, ethnicity, nationality, religious affiliation, socioeconomic background, educational background, career stage, or military service.

- Questions and discussions should be respectful and constructive and focus on ideas rather than individuals or groups.
- Comments or behaviors that may reasonably be assumed to have the effect of creating, contributing to, or maintaining an environment that is hostile toward or damaging to a person or group are prohibited, no matter whether they are made directly (e.g., in person or directly online) or indirectly (e.g., via social media).
- Do not use legal intoxicants to the extent that your ability to act professionally and follow this Code of Conduct is compromised.
- Do not take or disseminate photographs, recordings, or reproductions of materials presented as part of the Annual Meeting without express permission of the author(s).

Obey the rules and policies of any SVP-contracted facilities or services utilized during the meeting or anywhere your SVP badge/affiliation is on display.

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PRESENTATION POLICIES - CONTINUED

UNACCEPTABLE BEHAVIOR

- Harassment, intimidation, or discrimination in any form will not be tolerated.
- Physical or verbal abuse of any meeting participant.
- Examples of unacceptable behavior include, but are not limited to, disparaging verbal comments or gestures related to gender, gender identity and expression, sexual orientation, disability, age, physical appearance, body size, race, religion, national origin.
- Epithets, slurs, or negative stereotyping; threatening, intimidating, or hostile acts; denigrating jokes; display or circulation of written graphic material that denigrates or shows hostility or aversion towards an individual or group. Harassment intended in a joking manner still constitutes unacceptable behavior.
- Inappropriate use of nudity and/or sexual images in public spaces or in presentations.
- Threatening or stalking any meeting participant.
- Inappropriate physical contact.
- Unwelcome sexual attention, including sexual advances or propositions; verbal comments or physical actions of a sexual nature; sexually degrading words used to describe an individual; a display of sexually suggestive objects or pictures; sexually explicit jokes.
- Disruption of talks at oral or poster sessions, in the exhibit hall, or at other events organized by SVP at the meeting venue, hotels, or other SVP-contracted facilities.
- Invasive photography or recording, including no photographs or recordings of minors (under 18 years of age) without explicit permission from guardians.
- Recording or photography of talks or posters without express permission from the authors.

Anyone requested to stop unacceptable behavior is expected to comply immediately. Retaliation against any individual who reports harassment or assists in an investigation will not be tolerated and is also subject to disciplinary action.

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PRESENTATION POLICIES - CONTINUED

REPORTING AN ALLEGATION OF CODE OF CONDUCT VIOLATION

If you witness or experience prohibited behavior, SVP provides several ways that you can submit a report. Allegations of misconduct must be submitted in writing (see "What to include in a report") via one of the following:

1. Anonymous or non-anonymous reports may be submitted through the [NAVEX Platform accessible here](#).
2. Non-anonymous reports may be submitted to the Ethics Committee using safesvp@vertpaleo.org.
3. Non-anonymous reports may also be submitted in writing to:

Chair of Ethics Committee
Society of Vertebrate Paleontology
1660 International Drive, Suite 600
McLean, VA 22102 USA

WHAT TO INCLUDE IN AN ALLEGATION REPORT

All allegations must be made in writing in one of the three ways described in the previous section. Allegation reports must contain the following:

1. Unless this is an anonymous report via the NAVEX Platform, the name and affiliation of the individual(s) submitting the allegation.
2. Name(s) of individuals alleged to have engaged in the prohibited behavior(s), if known, or as much identifying information as possible.
3. If there is a victim (and if this is not an anonymous report by the victim), then include the name of the victim(s) and affiliation when possible.
4. Description of the allegation that includes the date(s) and circumstances of the alleged ethics violation. This should include the type of prohibited behavior(s) as defined in the Code of Ethics that is being alleged. Include names and affiliations of witnesses, when possible.
5. Any documentation or other relevant items with a description of how each item relates to the allegation.
6. A statement of any real or perceived conflicts of interest related to any party named in the allegation (e.g., reporters, victims, alleged perpetrators, witnesses) and any members of the Ethics Committee or Executive Committee to ensure a fair and unbiased process.

Allegations may be returned if they do not contain the above information.

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PRESENTATION POLICIES - CONTINUED

WHAT IF YOU NEED IMMEDIATE HELP DURING AN SVP EVENT?

If you witness a crime or behavior that is an immediate threat to public safety, make sure you are safe and then call emergency services (e.g., 911 in the US).

If you are experiencing or witness prohibited behavior that is not an immediate threat to public safety during an SVP event (meeting, fieldtrip, symposium, online event, etc.), but you need to report DURING the event to stop the observed behavior, please alert the leader of that event immediately (e.g., field trip leader, online event organizer) and, as soon as possible, contact the Vice President/ Chair of the Ethics Committee Stuart Sumida (ssumida@csusb.edu), anyone on the SVP Executive Committee, or who is wearing a "Safe SVP" button or email safesvp@vertpaleo.org. Once you are able, please submit an official written report documenting what happened using one of the above three listed methods of reporting and including "What to Include in an Allegation Report".

REQUIRED REPORTERS

Society members acting in leadership positions, whether elected (Ex Comm members), appointed (e.g., committee members) or temporary (e.g., field trip leaders, symposium organizers), are required to report any incidents of prohibited behavior that they observe directly or that are reported to them. They must document the incident and any action(s) taken. This report will be submitted to the Ethics Committee to determine whether or not actions taken were appropriate and whether there is need for additional sanctions.

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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 videotape 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 #2024SVP. We look forward to seeing your thoughts and discussion online!

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SVP 2024 SCHEDULE OF EVENTS

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Tuesday, October 29

TIME	TRIP	LOCATION
2:00 pm – 7:00 pm	Registration Open	Nicollet Ballroom Foyer
7:00 pm – 8:00 pm	Special Lecture by Brandon Kilbourne Natural History, the Curious Institution: An Evening with an Evolutionary Biologist and Poet (for pre-registered attendees)	University of Minnesota, Bell Museum**

Wednesday, October 30

TIME	EVENT	LOCATION
7:00 am – 6:00 pm	Registration Open	Nicollet Ballroom Foyer
8:00 am – 12:15 pm	Symposium: Evolution of Mammalian Life Histories	Nicollet B/C
	Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I	Nicollet A
	Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation	Nicollet D
9:30 am – 6:30 pm	Exhibit and Poster Viewing Hours Colbert Prize Competition Posters (B1-B27) Poster Session 1 (B28-B100)	Exhibit Hall
1:45 pm – 4:15 pm	Technical Session 3: Sauropodomorpha	Nicollet B/C
	Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria	Nicollet A
	Technical Session 5: Paleozoic Herpetology	Nicollet D
4:30 pm – 6:30 pm	Exhibits/Poster Mixer Authors will be Present at the Following Posters: Colbert Prize Competition Posters (B1-B27) Poster Session 1 (B28-B100)	Exhibit Hall
7:00 pm – 10:00 pm	Welcome Reception	Science Museum of Minnesota**

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Thursday, October 31

TIME	EVENT	LOCATION
7:30 am – 6:00 pm	Registration Open	Nicollet Ballroom Foyer
8:00 am – 12:15 pm	Romer Prize Session	Nicollet B/C
	Technical Session 6: Ornithischia II	Nicollet A
	Technical Session 7: Ungulates	Nicollet D
9:30 am – 6:30 pm	Exhibit and Poster Viewing Hours Colbert Prize Competition Posters (B1-B27) Poster Session 2 (B101-B200)	Exhibit Hall
1:45 pm – 4:15 pm	Technical Session 8: Paleontological Practices: Management & Ethics	Nicollet B/C
	Technical Session 9: Triassic Herpetology	Nicollet A
	Technical Session 10: Fishes	Nicollet D
4:30 pm – 6:30 pm	Exhibits/Poster Mixer	
	Authors will be Present at the Following Posters: Colbert Prize Competition Posters (B1-B27) Poster Session 2 (B101-B200)	Exhibit Hall
6:30 pm – 8:00 pm	Film Screening: Why Dinosaurs?	Nicollet A
8:00 pm – 11:30 pm	Student and Postdoc Committee Roundtable Forum	Greenway Ballroom A/B

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Friday, November 1

TIME	EVENT	LOCATION
7:30 am – 5:00 pm	Registration Open	Nicollet Ballroom Foyer
8:00 am – 12:15 pm	Technical Session 11: Theropoda I	Nicollet B/C
	Technical Session 12: Euarchontoglires	Nicollet A
	Technical Session 13: Synapsida	Nicollet D
9:30 am – 6:30 pm	Exhibit and Poster Viewing Hours Colbert Prize Competition Posters (B1-B27) Poster Session 3 (B201-B284)	Exhibit Hall
1:45 pm – 4:15 pm	Technical Session 14: Paleobiology: evolution, ecosystems, taphonomy, & traces	Nicollet B/C
	Technical Session 15: Jurassic & Cretaceous Herpetology	Nicollet A
	Technical Session 16: Mammal Evolution	Nicollet D
4:30 pm – 6:30 pm	Exhibits/Poster Mixer Authors will be Present at the Following Posters: Poster Session 3 (B201-B284)	Exhibit Hall
6:30 pm – 11:30 pm	Annual Benefit Auction and Social	Northstar Ballroom

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Saturday, November 2

TIME	EVENT	LOCATION
7:30 am – 2:00 pm	Registration Open	Nicollet Ballroom Foyer
8:00 am – 12:15 pm	Technical Session 17: Theropoda II	Nicollet B/C
	Technical Session 18: Carnivora & Co	Nicollet A
	Technical Session 19: Squamata & Co	Nicollet D
9:30 am – 6:30 pm	Exhibit and Poster Viewing Hours Colbert Prize Competition Posters (B1-B27) Poster Session 4 (B285-B368)	Exhibit Hall
1:45 pm – 4:15 pm	Technical Session 20: SVP Saturday Spectacular	Nicollet B/C
	Technical Session 21: Cenozoic & Modern Herpetology	Nicollet A
	Technical Session 22: Paleontological Practices: Education & Outreach	Nicollet D
4:30 pm – 6:30 pm	Exhibits/Poster Mixer Authors will be Present at the Following Posters: Poster Session 4 (B285-B368)	Exhibit Hall
7:30 pm – 10:00 pm	Awards Banquet Ticket required for admittance	Nicollet Ballroom
10:30 pm – 1:00 am	After Hours Party	Greenway Ballroom

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2024 SVP FIELD TRIPS

*For Pre-registered Attendees

Sunday, October 27 - Tuesday, October 29

TIME	TRIP
8:00 am - 5:00 pm	The Geology and Paleontology of North Dakota

Tuesday, October 29

TIME	TRIP
9:00 am - 5:00 pm	Twin Cities field trip to St Anthony Falls Lab and Science Museum of Minnesota

2024 SVP WORKSHOPS

*For Pre-registered Attendees

Tuesday, October 29

TIME	TITLE	LOCATION
9:00 am - 12:00 pm	Current Best Practices for Generating and Managing CT Scan Data of Fossils <i>Sponsored by North Star Imaging</i>	Nicollet A
1:00 pm - 5:00 pm	Wrapping, Packing, and Shipping Fossils on Institutional Loan: Tips and Tricks for Fossil Trips	Greenway Ballroom A/B

For field trip and workshop pickup and drop-off location and time, please check with your workshop or field trip leader or check the mobile app.

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2024 TALK SCHEDULE

Wednesday, October 30

TIME	NICOLLET B/C Symposium: Evolution of Mammalian Life Histories	NICOLLET A Dinosaur Evolution, Soft Tissues, & Ornithischia I	NICOLLET D Paleontological Practices: Preparation & Scientific Methods, Collections & Curation
8:00 am	Kulik	Chiarenza	Williams
8:15 am	Whitney	Kirkland	Rose
8:30 am	Newham	Wilkinson	Hieronymus
8:45 am	Meng	Puetz	Narducci
9:00 am	Luo	Fiorillo	Reeves-Wolf
9:15 am	Weaver	Fricke	Norton
9:30 am	Gill	Sharpe	Camaiti
9:45 am	Wiemann	Boyd	Bastien
10:00 am	COFFEE		
10:15 am	Funston	Saitta	Dzenowski
10:30 am	Smith	Chiappone	Fridel
10:45 am	Goswami	Tsai	Swenson
11:00 am	D'Emic	DeVries	Sagebiel
11:15 am	Unruh-Friesen	King	Rhue
11:30 am	Kufeldt	Habib	Mohler
11:45 am	Medina-González	Cross	Metz
12:00 pm	WITHDRAWN	Schachner	Steffen
12:15 pm - 1:30 pm	LUNCH		
TIME	NICOLLET B/C Sauropodomorpha	NICOLLET A Mesozoic Mammals, Xenarthra, & Afrotheria	NICOLLET D Paleozoic Herpetology
1:45 pm	Chinsamy	Muñoz	Otoo
2:00 pm	Zhang	Wang	Jia
2:15 pm	Diepenbrock	Magallanes	Bohus
2:30 pm	Britt	Germano	So
2:45 pm	Curtice	Tablizo	Mann
3:00 pm	Kim	Williams	Stine
3:15 pm	Gorscak	Sanders	Huttenlocker
3:30 pm	Vidal	Yang	Carter
3:45 pm	Yamaguchi	Butler	Jenkins
4:00 pm	Finch	Shirley	Peacock

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2024 TALK SCHEDULE

Thursday, October 31

TIME	NICOLLET B/C Romer Prize Session	NICOLLET A Ornithischia II	NICOLLET D Ungulates
8:00 am	Wilson	Dunfee	Sweedler
8:15 am	Wilken	Hannebaum	Janis
8:30 am	Widrig	Crow	Schwartz
8:45 am	van Zoelen	Poole	Machado
9:00 am	Schap	Czepinski	Landry
9:15 am	Peng	Cassiano	Croft
9:30 am	Ong	Dudgeon	Kurre
9:45 am	Ledesma	Hoffman	Gallucci
10:00 am	COFFEE		
10:15 am	Lang	Ford	Ekdale
10:30 am	Kuo	Radermacher	Uhen
10:45 am	Korneisel	DeNarie	Nelson
11:00 am	Igielman	Son	Gohar
11:15 am	Hunt	Barrera Guevara	Strauch
11:30 am	Grand Pre	Cajune	Laker
11:45 am	Demuth	Bamforth	Robson
12:00 pm	Asakura	Brennan	Hardy
12:15 pm - 1:30 pm	LUNCH		
TIME	NICOLLET B/C Paleontological Practices: Management & Ethics	NICOLLET A Triassic Herpetology	NICOLLET D Fishes
1:45 pm	Macias	WITHDRAWN	Miyashita
2:00 pm	Kellner	Mestriner	Schnetzer
2:15 pm	Breithaupt	Melstrom	Leong
2:30 pm	Hunt-Foster	Irmis	Wilson
2:45 pm	Atwater	Reyes	Caron
3:00 pm	Santucci	Weiss	Stack
3:15 pm	Tweet	Armour Smith	Kane
3:30 pm	Flint	Piechowski	Costa
3:45 pm	Huynh	Fitch	Quinn
4:00 pm	Liggett	Pritchard	Liu

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2024 TALK SCHEDULE

Friday, November 1

TIME	NICOLLET B/C Theropoda I	NICOLLET A Euarchontoglires	NICOLLET D Synapsida
8:00 am	Sombathy	Kumar	Angielczyk
8:15 am	Kirmse	Gaetano	Cochran
8:30 am	Choiniere	Pagnac	Mercado
8:45 am	Sereno	Hall	Duhamel
9:00 am	Danison	Crowell	Warshaw
9:15 am	Morris	Bloch	Pardo
9:30 am	Stock	Anderson	Thomas
9:45 am	Coppock	Bakhia	Kammerer
10:00 am	COFFEE		
10:15 am	Lee	Arranz	Shipps
10:30 am	Carr	Ioannidou	Brant
10:45 am	Freimuth	Fox	Acker
11:00 am	Dickson	Hall	Sidor
11:15 am	Hao	McNulty	Abbott
11:30 am	Hedge	Gardner	Viglietti
11:45 am	Therrien	WITHDRAWN	Stuart
12:00 pm	Maranga	WITHDRAWN	Ren
12:15 pm - 1:30 pm	LUNCH		
TIME	NICOLLET B/C Paleobiology: evolution, ecosystems, taphonomy, & traces	NICOLLET A Jurassic & Cretaceous Herpetology	NICOLLET D Mammal Evolution
1:45	Simoes	Atterholt	WITHDRAWN
2:00	Olsen	Chen	Breyak
2:15	Montgomery	Baumgart	Thurber
2:30	Freeman Peters	Caputo	Badgley
2:45	Zugschwert	O'Keefe	Fraser
3:00	Sherman	Wilberg	Beard
3:15	LaBarge	Salem	Grossnickle
3:30	Ullmann	Allen	Secord
3:45	Ovando	Fortner	Behrensmeyer
4:00	Moore	Novas	Barrett

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2024 TALK SCHEDULE

Saturday, November 2

TIME	NICOLLET B/C Theropoda II	NICOLLET A Carnivora & Co	NICOLLET D Squamata & Co
8:00 am	Pei	Chatar	Sobral
8:15 am	Morrison	Hoeflich	Kligman
8:30 am	Varricchio	Parker	Benson
8:45 am	Wang	Ghezzo	WITHDRAWN
9:00 am	Chinzorig	Berger	Wilenzik
9:15 am	Napoli	Witt	Scott
9:30 am	O'Connor	Salcido	Schulp
9:45 am	Uno	Pamfilie	Zietlow
10:00 am	COFFEE		
10:15 am	Clark	Bogner	Powers
10:30 am	Chen	Burt	Head
10:45 am	Early	Deutsch	Georgalis
11:00 am	Musser	Al-Ashqar	Riegler
11:15 am	Hanson	Nelson	Rourke
11:30 am	Sullivan	Pigiore	Jacisin
11:45 am	Rothschild	Evans	Forcellati
12:00 pm	Woolley	DeSantis	Howard
12:15 pm - 1:30 pm	LUNCH		
TIME	NICOLLET B/C SVP Saturday Spectacular	NICOLLET A Cenozoic & Modern Herpetology	NICOLLET D Paleontological Practices: Education & Outreach
1:45	Florsheim	Schaberg	Jones
2:00	Goldsmith	Lindblad	Boll
2:15	Pugh	Cossette	Lukowski
2:30	Keeble	Hoffman	Waweru
2:45	Whalen	WITHDRAWN	Kanipe
3:00	D'Angelo	Brochu	Matzen
3:15	den Ouden	Porro	Hartstone-Rose
3:30	WITHDRAWN	Hill	Levering
3:45	WITHDRAWN	Pereyra	Jones
4:00	WITHDRAWN	Cerio	Simpson

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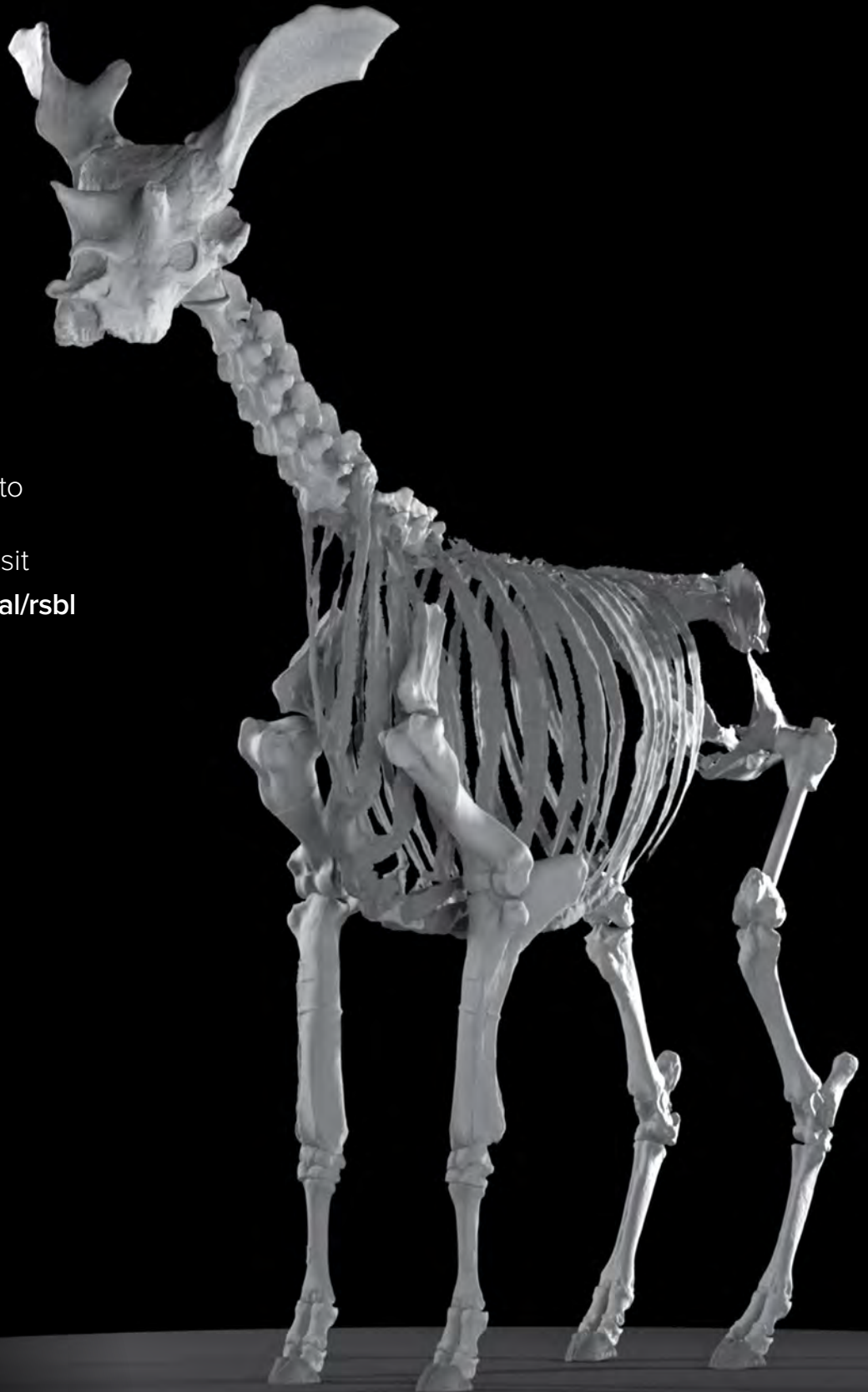


Image: A composite skeletal reconstruction of *Sivatherium giganteum*. Credit: Chris Basu.

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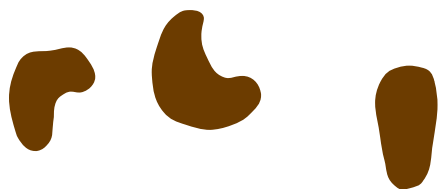
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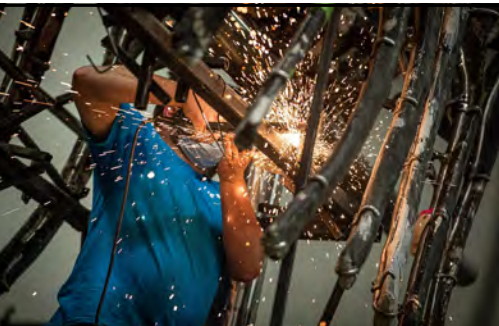


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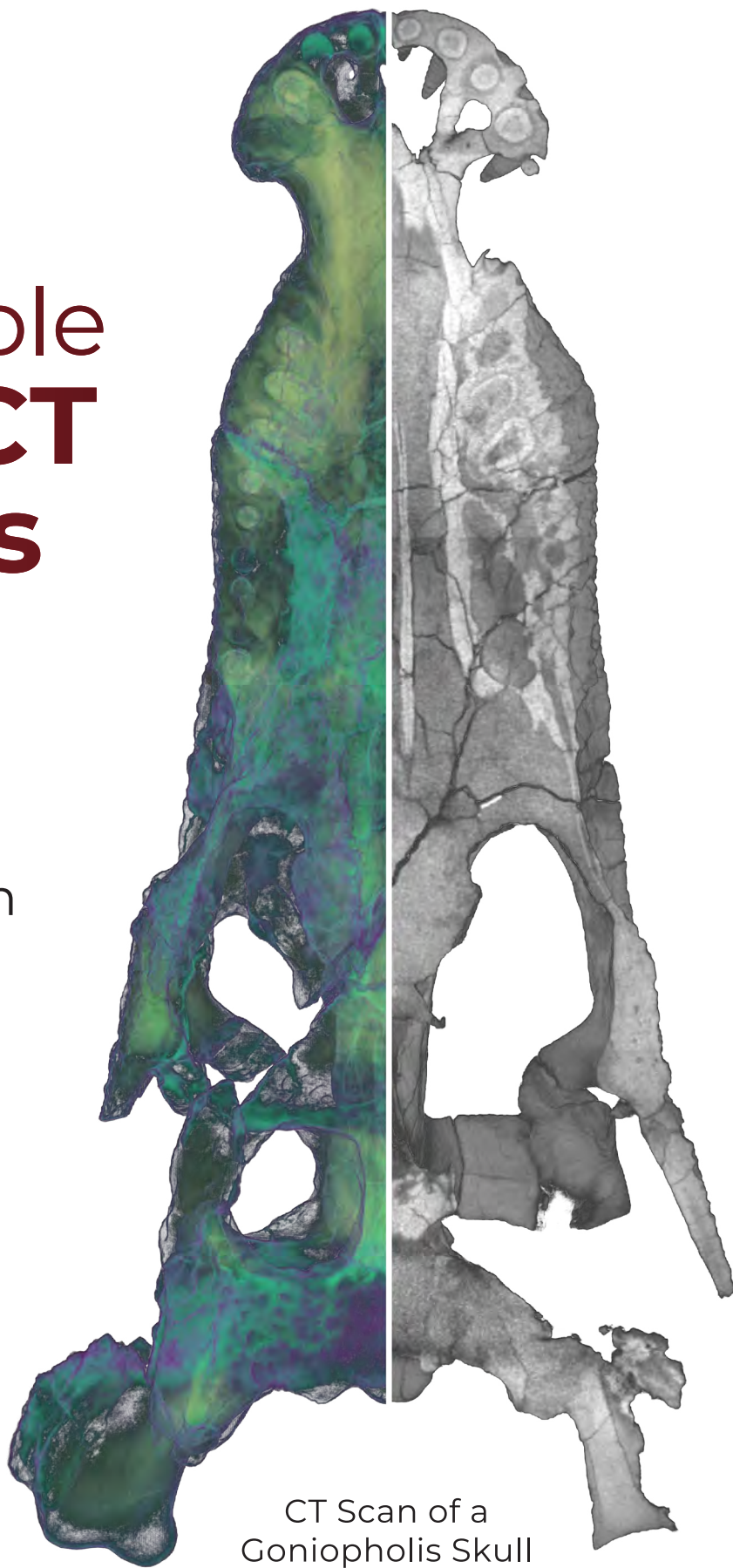




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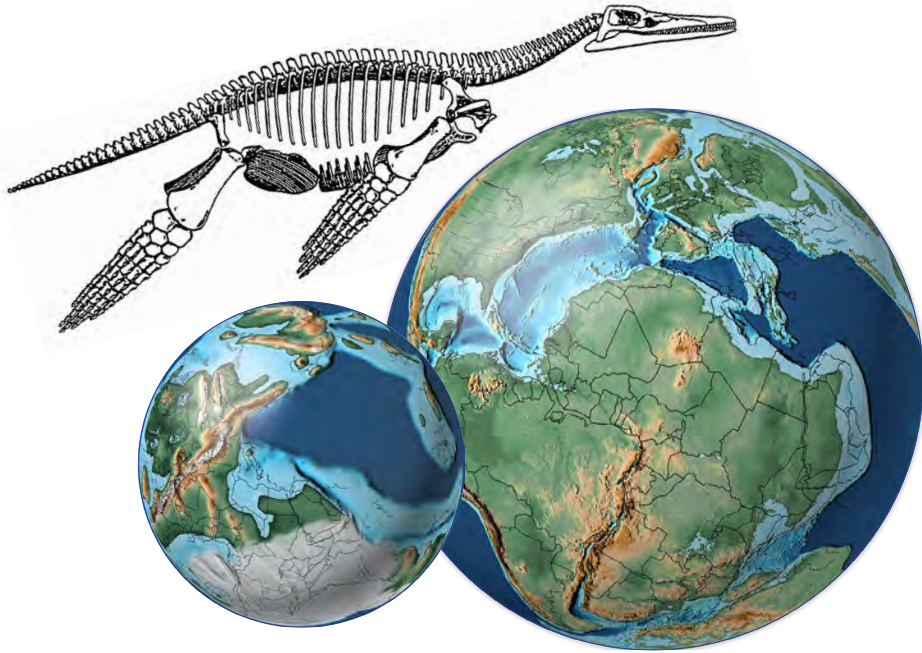
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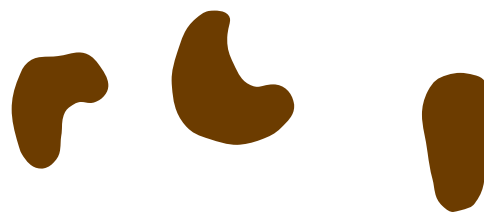
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List of Authors and Abstract Titles in Chronological Session Order

Wednesday Morning, October 30, 2024
Symposium: Evolution of Mammalian Life Histories
Meeting Room Nicollet B/C
Moderators: Elis Newham and Lucas Weaver

- 8:00 **Z.T. Kulik, R.B. Benson** The geologically oldest insights into synapsid life history revealed through synchrotron tomography and femoral histology of *Clepsydrops* (Synapsida: Ophiacodontidae)
- 8:15 **M. Whitney, C.A. Sidor, N.D. Smith, P. Makovicky** Long bone histology of *Lystrosaurus* and *Thrinaxodon* from Antarctica with insights into the evolution of synapsid seasonal physiology
- 8:30 **E. Newham, P.G. Gill, P. Brewer, N.M. Morales-Garcia, A.J. Rowe, E. Rayfield, J. Schultz, T. Martin** Keeping warm in a changing world: reviewing where we stand in understanding physiological evolution amongst synapsids
- 8:45 **J. Meng, F. Mao, Z. Li** An XRF and SEM study of the integumentary system of the Jurassic euharamiyidans and its implication for paleobiology of early mammaliaforms
- 9:00 **Z. Luo, T. Martin** Slow-fast continuum of molar eruption relative to replacement and eruption of antemolars In Mesozoic mammaliaforms
- 9:15 **L.N. Weaver, S. Hoffmann, K. Curry Rogers, E. Panciroli, E. Newham, G.F. Funston, Z.T. Kulik, D.W. Krause** First glimpse into the life history of a Gondwanatherian mammal: The femoral histology of *Adalatherium hui*
- 9:30 **P.G. Gill, E. Newham, A.J. Rowe, N.M. Morales-Garcia, T. Pollock, K. Dollman, T. Rich, P. Vickers Rich, T. Ziegler, E. Rayfield** Live long and prosper: exploring the life histories of Australia's Early Cretaceous polar mammals using synchrotron X-ray cementochronology
- 9:45 **J. Wiemann** Fossil biomolecules reveal metabolic upregulation as a prerequisite for the evolution of mammalian pregnancy
- 10:15 **G.F. Funston, D. Evans** Life histories of latest Cretaceous mammals complicate placental exceptionalism
- 10:30 **B.H. Smith** Mammalian tooth emergence in a seasonal world
- 10:45 **A. Goswami, J. Clavel, J. Mulqueeny, E. Noirault, N. Barber, R.M. Beck, R. Engelman, R. Portela Miguez, A. Fabre** Estimating the consequences of life history for mammal cranial evolution using a high-resolution morphometric approach
- 11:00 **M.D. D'Emic, E.G. Unruh-Friesen, T.M. Smiley, S. Hoffmann** Bone and tooth histology of the large-bodied pantodont *Coryphodon* from the Western Interior of North America
- 11:15 **E.G. Unruh-Friesen, M.D. D'Emic, S. Hoffmann, T.M. Smiley** Stable isotope geochemistry of the large-bodied pantodont *Coryphodon* from the Western Interior of North America
- 11:30 **C. Kufeldt, N.M. Laudicina, T. Yokley, R.L. Anemone** Dental development in Early Eocene adapoids
- 11:45 **P. Medina-González** Angular movement during the stance phase of walking in plantigrade, digitigrade, and unguligrade terrestrial mammals: developing an in vivo database for morphofunctional inferences.

Wednesday Morning, October 30, 2024
Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I
Meeting Room Nicollet A
Moderators: Michael Chiappone and Emily Cross

- 8:00 **A.A. Chiarenza** The role of ancient hyperthermals in shaping dinosaur macroevolution
- 8:15 **J.I. Kirkland, D.D. DeBlieux** Closing in on the Jurassic-Cretaceous terrestrial faunal boundary in Euramerica: Is the loss of the Morrison "style" dinosaur assemblage linked to a giant shield volcano in the northwest Pacific's Shatsky Rise, the Morokweng meteor impact in South Africa, or both?
- 8:30 **R.D. Wilkinson, D. Evans** The influence of climate on dinosaur diversity and community structure throughout the Edmonton Group (Late Cretaceous) of Alberta, Canada
- 8:45 **E. Puetz, J.L. King** The evolutionary significance of cerebral and endocranial volumetric increases on complex behavior across Dinosauria

- 9:00 A. Fiorillo, Y. Kobayashi, P. McCarthy** A rich record of dinosaur tracks from an unnamed Cretaceous rock unit along the Yukon River in west-central Alaska
- 9:15 H.C. Fricke** Interpreting stable isotope ratios of dinosaur tooth enamel: how to reduce ambiguities by considering results in a larger geochemical context
- 9:30 H.S. Sharpe, Y. Wang, T. Dudgeon, M.J. Powers, A. Whitebone, C. Coppock, A.D. Dyer, C. Sullivan** Skull morphology and histology indicate the presence of an unexpected buccal soft tissue structure in dinosaurs
- 9:45 C.A. Boyd, S.K. Drumheller, M.L. Householder, C. Woodruff** Making a good impression: identification of multiple diagenetic pathways for the formation of dinosaurian ‘mummies’
- 10:15 E.T. Saitta, P.C. Sereno, M. Ciudad Real Ballesterro, D. Vidal, T. Keillor, S.L. Baumgart, N.P. Myhrvold, A. Burdick, T.G. Kaye, M. Erikson** Exceptional preservation of integumental structures in hadrosaur ‘mummies’ via clay templating
- 10:30 M.A. Chiappone, M. Guala, R. Rogers, P. Makovicky** Voorhies groups revisited: Critical mobility, travel distance, and sorting of mammal and extinct reptile skeletons
- 10:45 H.P. Tsai** Anatomical reconstruction of ornithischian hip joint soft tissues and its significance for interpreting hindlimb function
- 11:00 R.P. DeVries, P.C. Sereno** Tiny dinosaur from the Kayenta Formation (Early Jurassic: Pliensbachian) of northern Arizona implicates dwarfing and insectivory at the base of the heterodontosaurid radiation
- 11:15 L. King, Y. Wang, J. Lei, X. Ren, X. Xu, S. Singh, M.J. Benton, H. You** An Early Jurassic ankylosaur from the Lufeng Formation of Yunnan Province, China and its implications for early ankylosaur evolution
- 11:30 M.B. Habib, C.M. Brown** Unbreakable: Armor biomechanics in *Borealopelta markmitchelli* (Dinosauria: Nodosauridae) with implications for intraspecific combat and predation defense
- 11:45 E.G. Cross, V. Arbour** Morphometric approaches to classifying isolated ankylosaur teeth, with implications for identifying ‘nodosaurid’ ankylosaurs
- 12:00 E.R. Schachner, A. Martinez, S.L. Baumgart, A.B. Lawson, R.E. Diaz, Jr., T. Skorka, B.P. Hedrick, A. Moore** Divergence of pneumatizing pulmonary tissues in five extant avian taxa: implications for reconstructions of respiratory biology across Ornithodira

Wednesday Morning, October 30, 2024

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation Meeting Room Nicollet D

Moderators: Eric Metz and Vanessa Rhue

- 8:00 S.A. Williams, L. Hall, J. Scannella, C. Knight, D.J. Varricchio** A class of its own: Paleontology lab techniques at Montana State University and the necessity for more courses like it
- 8:15 M. Rose, S. Kuo, T.M. Ryan, M.T. Silcox** The first glimpse into the trabecular bone of a stem primate: use of the Regularized Deep Network (RDN) for segmentation of a 55 Ma femur (*Microsyops latidens*; Wasatchian NALMA, Southern Bighorn Basin, Wyoming)
- 8:30 T. Hieronymus** Sticking up for Cuvier: osteological correlates of performance and ecology from big morphological data
- 8:45 R.E. Narducci, R.C. Hulbert, A. Woodruff, M. Riegler, S.P. Zbinden, C. Lockner, J.R. Bourque, A. Poyer, Z. Randall, J.I. Bloch** Exceptionally large jackets required: Collection of an adult gomphothere skeleton from a sandy bone bed in north-central Florida.
- 9:00 D.D. Reeves-Wolf, D. Fowler, E. Freedman Fowler, S.R. Clawson, T.J. Schoch** Paleontology’s heaviest airlift: The collection and transportation of a complete opisthotonic Judithian tyrannosaur in a calcite-cemented sandstone concretion
- 9:15 L.A. Norton, K.D. Angielczyk, W.F. Simpson, J. Benoit** Supplementing modern 3-D data with historical records of serially sectioned specimens
- 9:30 M. Camaiti, Y. He, H. White, M. Didziokas, A. Sharp, E. Grisan, A. Goswami** New methods for complex morphologies: quantifying three-dimensional complexity in mammalian cranial sutures
- 9:45 S. Bastien, N.G. Toth, B. Noonan, T. Lyson** A technique for cutting and preparing a section of Cretaceous/Paleogene boundary for exhibition
- 10:15 N. Dzenowski** A method for conservation of waterlogged material: A case study using fossil tusk

- 10:30 M.C. Fridel, B.R. Peacock, L. Krumenacker, R.J. Gay** Results of an extensive surface-scanning project of Idaho's Cretaceous fossil record
- 10:45 S.K. Swenson, L.J. Walker, N.A. McGee, B. Rakotozafy, R.R. Hummel, K. MacKenzie, D.W. Krause** Collaborative collections management of the Cretaceous vertebrates of the Mahajanga Basin, Madagascar: from the physical to the digital
- 11:00 J.C. Sagebiel** Love's labor's lost: Texas type, figured and forgotten specimens lost to neglect. Notes on keeping your research associates close and their data closer.
- 11:15 V.R. Rhue** Locate, assess, support, move, repeat: planning considerations when moving collections of specimens and archives time after time
- 11:30 B.F. Mohler** Animal, environmental, and health safety challenges facing paleontological collections in southern Arizona inform climate-calibrated roadmaps for fossil repositories
- 11:45 E.T. Metz, E. Lamm, J. Scannella** Opening the digital door at MOR: reconfiguring the Paleontology Collections to increase accessibility
- 12:00 D. Steffen, J. Gallucci** Digitizing collections in small museums: a case study at Pioneer Trails Regional Museum

Wednesday Afternoon, October 30, 2024
Technical Session 3: Sauropodomorpha
Meeting Room Nicollet B/C
Moderators: Anusuya Chinsamy and Daniel Vidal

- 1:45 A. Chinsamy, F. Toefy, E. Krupandan** Osteohistological insight into the growth dynamics of Sauropodomorpha
- 2:00 Q. Zhang, H. You** A new non-sauropodan sauropodiform specimen from the Lower Jurassic of Yuanmou County, Yunnan Province, China
- 2:15 J.E. Diepenbrock, D. Schumde, C. Weege, E. Tamez-Galvan, H. Petermann, N.G. Toth, T. Lyson, M.T. Clementz** An enigmatic sauropod specimen from the Morrison Formation of northern Wyoming provides insight into the evolution of diplodocoids
- 2:30 B. Britt, C. Boisvert, R. Scheetz, K.A. Stevens** The intrinsic neck posture of an apatosaurine sauropod dinosaur based on virtual and physical models
- 2:45 B. Curtice, R.J. Hunter** A new specimen of *Barosaurus* sp., from the Late Jurassic Morrison Formation, Bone Cabin Quarry, Wyoming
- 3:00 S. Kim, Y. Lee, Y. Gihm, N. Kim** A taphonomic study of the Lower Cretaceous dinosaur nesting colonies preserved in braided stream deposit, in Hwaseong City, South Korea
- 3:15 E. Gorscak, J. Nassif, E. Gomani Chindebvu** A re-evaluation of the *Malawisaurus dixeyi* and *Karongasaurus gittelmani* holotypes with new insights into the referred fossils of these titanosaurian sauropod dinosaurs from the Early Cretaceous Dinosaur Beds of Malawi
- 3:30 D. Vidal, T. Keillor, M. Ciudad Real Ballesterio, F. Gascó Lluna, S.L. Baumgart, N.P. Myhrvold, P.C. Sereno** High sauropod diversity on Africa in the Late Cretaceous: new fossils from Niger (Farak Formation: Cenomanian)
- 3:45 K. Yamaguchi, T. Kubo, M. Kubo.O** The difference in range of motion between manus and pes of the sauropodomorph inferred from trackways
- 4:00 S. Finch, J.A. Wilson Mantilla, B. Britt, M.D. D'Emic** Evolution of tooth replacement rates in sauropod dinosaurs

Wednesday Afternoon, October 30, 2024
Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria
Meeting Room Nicollet A
Moderators: Ethan Shirley and Deming Yang

- 1:45 X. Muñoz, J.J. Eberle, L.N. Wilson, J. Wilson, G.M. Erickson, P.S. Druckenmiller** A comparatively large-bodied, high-latitude therian from the Upper Cretaceous (Campanian) Prince Creek Formation of northern Alaska (USA)
- 2:00 H. Wang, Y. Wang** Middle ear evolution in Early Cretaceous eutherian mammals
- 2:15 I. Magallanes, Z. Luo, T. Martin** Investigating our roots: Assessing the biomechanical significance of diverse tooth root morphologies in mesozoic mammals using 3D FEA
- 2:30 R. Germano, L. Cabral Ribeiro Carvalho, C. Barbosa Amaral, T. Rodrigues** Vertebral injuries of *Eremotherium laurillardi* revealed by the use of CT scans in paleopathological analysis
- 2:45 M.U. Tablizo, G.D. van den Bergh, A.S. Fernando** Mandibular allometry in Asian *Stegodon* (Mammalia, Proboscidea)
- 3:00 J. Williams, Y. Liu, J. Zhang, L. Ma, Y. Wang** Mechanistically testing the relative influence of the Island Rule and Bergmann's Rule on the body size of island populations of *Mammuthus*
- 3:15 W.J. Sanders, L.N. Leakey, T. Gichunge Ibui, M. Kirinya Muthuri** A new cranium of early Pleistocene *Elephas recki atavus* from Koobi Fora, Kenya, and evaluation of phylogenetic and taxonomic hypotheses of the "*Elephas recki* complex"
- 3:30 D. Yang, K. Podkovyrov, K. Uno, G. Bowen, D.P. Fernandez, T.E. Cerling** Strontium isotope mapping of elephant enamel supports a combined workflow of micro-sampling and modeling to reconstruct ancient migrations
- 3:45 D.K. Butler, L.T. Yann, D.J. Peppe** Pathologies as a paleoecological signal in drought-induced placental mammal assemblages: a case study at Waco Mammoth National Monument (Texas, USA)
- 4:00 E.A. Shirley** Forwarding the understanding of proboscidean behavior and diagenesis with chemical analysis of dentin

Wednesday Afternoon, October 30, 2024
Technical Session 5: Paleozoic Herpetology
Meeting Room Nicollet D
Moderators: Kelsey Jenkins and Calvin So

- 1:45 B. Otoo, P. Roopnarine, K.D. Angielczyk** The world comes crawling: restructuring of terrestrial ecological communities during the Carboniferous driven by insect, rather than tetrapod, herbivores
- 2:00 J. Jia, J. Anderson, M. Zhang, J. Jiang, Y. Wang, M. Zhu, N. Shubin, K. Gao** Postaxial rotations of the metapterygial axis promote the origin of postaxial dominance in tetrapod digital arch development
- 2:15 C.P. Bohus, T. Miyashita, D. Fraser, H.C. Maddin** Description of the southern Illinois colosteoid braincase via x-ray computed tomography
- 2:30 C. So, A. Mann, J. Pardo, H. Sues** A new slender and long-bodied amphibamiform temnospondyl from the Late Carboniferous Mazon Creek Lagerstätte reveals the earliest occurrence of body elongation in Dissorophioidea.
- 2:45 A. Mann, H. Sues, C. So, J. Pardo** A new lysorophian from the Kinney Brick Quarry (Atrasado Formation, Upper Carboniferous, New Mexico) reveals new details on body size and body-elongation patterns in molgophid recumbirostrans
- 3:00 J.M. Stine, J.M. Feinberg, A. Huttenlocker, R. Irmis, C.M. Henderson, M.T. Read, D.P. Fernandez** Refining the geochronologic context of vertebrate assemblages from the Carboniferous-Permian transition in western North America
- 3:15 A. Huttenlocker, J.M. Feinberg, A.C. Henrici, R. Irmis, A. Marsh, J.M. Stine, S.S. Sumida, Y. Tse** Diadectomorphs (Pan-Amniota) from the Carboniferous-Permian Cutler Group of Utah and their stratigraphic significance
- 3:30 A.M. Carter, J. Caporale, D. Koditschek, A. Johnson** Elucidating spinal column dynamics in terrestrial Permian taxa
- 3:45 K.M. Jenkins, D. Meyer, B.S. Bhullar** Taxon selection influences tree topology in the early evolution of Amniota
- 4:00 B.R. Peacock, X.A. Jenkins, D. Ford, J. Choiniere, R.B. Benson** The amniote common ancestor was "synapsid"

Wednesday – Saturday, October 30 – November 2, 2024

COLBERT PRIZE POSTER SESSION

Meeting Room Exhibit Hall

Authors must be present from 4:30 – 6:30 p.m. on Wednesday, October 30 and Thursday, October 31

- B1** S.P. Zbinden, M. Riegler, R.E. Narducci, G.J. Naylor, J.I. Bloch First fossil shark rostral node described from Florida: Assessment of taxonomic placement based on internal anatomy
- B2** T. Yu, Z. Li, Z. Zhou The oldest fossil peafowl recovered from Late Miocene China
- B3** G.M. Workman, A.C. Pritchard Assessing anatomy, dimorphism, and possible biological implications of post-cloacal heterotopic bones in *Tanytrachelos ahynis* (Archosauromorpha, Tanystropheidae)
- B4** T. Watanabe, T. Hirasawa Evolution of the tympanic middle ear in the lineage towards birds
- B5** S. Tkacik, J.J. Eberle, H. Meyer A new study of the Florissant fauna and its diversity
- B6** M. Tanaka, Y. Kobayashi, M. Eda, H. Izumi, H. Kikuchi, G. Sun Comparative analysis of modern East Asian crocodylians through mass spectrometry of collagen proteins and application to ancient material
- B7** L.A. Stancik, C. Flis, S. Rosscoe Variation in the Early Permian North American synapsid cleithrum
- B8** B. Slibeck, P.E. Olsen A new ichnospecies of *Ameghinichnus* from the Newark Basin: ichnolistics and palaeoecological implications
- B9** S. Shimizu, Y. Kobayashi Insights into the diversification dynamics of Mesozoic dinosaurs
- B10** N.C. Platt, E. Wilberg, C.A. Brochu New material sheds light on the position of *Calsoyasuchus valliceps* within Crocodyliformes
- B11** R. Palmgren, P. Kuo, T.A. Stidham, J. O'Connor, C. Sullivan Detailed morphology of an isolated avian quadrate from the Upper Cretaceous of southern Alberta (Canada) provides evidence of hesperornithiform affinities
- B12** H.K. Orlowski, A.K. Hastings Use of elliptical Fourier analysis to discriminate osteoderm placement in Alligatoroidea (Crocodylomorpha)
- B13** E. Mulready, S. Finch, L.E. Zanno Microstructural analysis of indeterminate dinosaur teeth from the Western Interior, refining the spatiotemporal bounds of the North American sauropod hiatus
- B14** N.E. Morley, T.C. Wyenberg-Henzler, M.N. Hudgins, C. Sullivan A description of morphological variation among non-hadrosaurid ornithischian dentitions from the Dinosaur Park Formation (Alberta, Canada) with implications for dietary niche partitioning
- B15** A.V. Moore, H.M. Avrahami, L.E. Zanno Preservational bias towards isolated premaxillary teeth in Thescelosaurinae (Dinosauria: Ornithischia)
- B16** K. Miller, K. Beard Re-assessment of the relationships within the plesiadapiform family Microsyopidae in North America
- B17** I.T. McKinney, A. Marsh, B.T. Kligman Exemplary excretions: an examination of a Late Triassic coprolite and possible evidence of cannibalism in parasuchid phytosaurs
- B18** M. Ma, W. Zhu, Y.J. Ma Large number of unbroken unhatched dinosaur eggs in an Upper Cretaceous layer calls for a new hypothesis for dinosaur extinction from incubation failure
- B19** N.E. Loughlin, D.M. Birlenbach, D.L. Fox Investigating changes in North American mammal species ranges by ecological group since the Last Glacial Maximum
- B20** A.J. Lis, S. López-Torres, H.E. Anderson, M.T. Silcox, M. Lang, J. Zalewski First 3D reconstruction of the endocranium of the Miocene strepsirrhine primate *Mioeuticus shipmani* from Kenya
- B21** D.R. Leaphart, T.L. Adams, M.T. Carrano, C.A. Brochu Description and phylogenetic relationships of the "Glen Rose Form", a small crocodyliform from the Early Cretaceous Antlers Formation of Texas
- B22** J.S. Keller, M.I. Pardi, L. DeSantis, K. Lyons, S. Newsome, F.A. Smith "Ground-toothings" ecomorphological, isotopic, and dental microwear paleoecology proxies in a modern Texas small mammal community
- B23** A. Kaur, B. Pobiner, A.K. Behrensmeyer, A.M. Jukar, J.J. Saunders Taphonomy of an excavated Early Pleistocene hyena (*Pachycrocuta brevirostris*) den at the Haro River Quarry, northern Pakistan

- B24 S. Higuchi, N. Kohno** New fossil balaenopterid (Cetacea: Mysticeti) from the Middle Miocene of the western North Pacific
- B25 G.A. Goetcheus** Nanoindentation of *Alligator mississippiensis*: a case study for estimating the material properties of extinct archosaur caudal vertebrae
- B26 C.R. Cope, L.E. Wilson** A histological survey of a large, sub-adult *Tylosaurus nepaeolicus*
- B27 O. Barnett, J.T. Voris, F. Therrien, D.K. Zelenitsky** Comparative analysis of the nasal cavity and paranasal system in four sympatric nodosaurids and ankylosaurids from the Upper Cretaceous (upper Campanian) Dinosaur Park Formation of Alberta, Canada

Wednesday Afternoon, October 30, 2024

REGULAR POSTER SESSION 1

Meeting Room Exhibit Hall

Authors must be present from 4:30 – 6:30 p.m. on Wednesday, October 30

- B28 D. Anduza, J.I. Kirkland** Examining the pace of dinosaur discovery
- B29 T.R. Holtz** From tots to titans: Implications of different modes of parental care on community structure in dinosaurs vs. mammals
- B30 S. Mehew, M.R. King, J.R. Foster, A. Mims, F. Frost, J. Tweet, V. Santucci** Preliminary report of tridactyl track morphotypes in the Brushy Basin Member of the Jurassic Morrison Formation, Curecanti National Recreation Area, Colorado
- B31 D. Fowler, E. Freedman Fowler, J. Wilson, D. Barrera Guevara, C. Woodruff** New dinosaur discoveries from the Judith River Formation of Montana: biostratigraphy, impacts on correlation, taxonomy, and hypotheses of biogeography and anagenesis
- B32 I.M. Matteson, D.J. Varricchio, K. Chin** Coprolite happens: analysis of specimens from Egg Mountain in the Cretaceous Two Medicine Formation of Montana
- B33 M.G. Thompson, K. Brink, C.M. Brown, P. Durkin** Geochemical fingerprinting of bentonite beds in the Dinosaur Park Formation, Alberta to reduce uncertainty regarding stratigraphic correlations and dinosaur biostratigraphy
- B34 H.B. Davis, M. Wilson** Examining Late Cretaceous (Maastrichtian) North American dinosaur teeth and their palaeoecological implications in the Hell Creek Formation of Carter County, Montana
- B35 K.L. Atkins-Weltman, E. Snively** Angular acceleration capability of *Tyrannosaurus rex* and contemporaneous dinosaurs reveals new implications for predator-prey interaction
- B36 C.H. Ummel, T. Luckau, J. Frewin, R. Scheetz, B. Britt** The taphonomy of a new *Gastonia* (Ankylosauria) site in the Yellow Cat Member of the Cedar Mountain Formation (Barremian, Early Cretaceous) of Utah
- B37 B. Green, J. Cavigelli, L.A. Vietti, A. Wroblewski** Taxonomy and paleobiogeographic implications of a nodosaurid sacral shield from the Late Maastrichtian Ferris Formation, Wyoming
- B38 J. Park, M. Son, Y. Lee, S. Lee, S. Kim, K. Tsogtbaatar** Redescription of the cranial anatomy of the holotype of *Pinacosaurus grangeri* (Ankylosauria: Ankylosauridae) and a revision of the genus
- B39 J. Haye, S. Siegler, A. Nabavizadeh, S.L. Booth, K. Voegelé** Examination of the prementary bone and lower jaw kinematics in *Euoplocephalus tutus* using multibody dynamic modeling
- B40 P.L. Godoy, J. Meachen, A. López-Arbarello, M.D. D'Emic** The reproducibility crisis in phylogenetic analysis
- B41 E.T. Saitta, T.G. Kaye** ‘Synthetic fossils’: experiments make taphonomy a better science
- B42 K.L. Whitman, L. Riddle, A. Mazza, S. Heritage, K. Neely, G.S. Yapuncich, M.R. Borths** Activating the paleontological research potential of life history data in living collections: a case study at the Duke Lemur Center
- B43 O. Regalado Fernandez, A. Sebralla, N. Bucker, S. Heidekorn, P. Marutschke, D. Mäurer, C. Uhe, F. Watz** Taxonomic resolution to compare taphonomic processes in bonebeds: an example on a bonebed from the Lance Formation (Maastrichtian)
- B44 P. Medina-González, V. Bernal-Fernández, R. Arancibia-Müller, P. Aburto-Valdevenito, M. Gómez-Jaramillo** Influence of anatomical layers on the range of motion in rabbit (*Oryctolagus cuniculus*) and pudú (*Pudu puda*): building an ex vivo database for morphofunctional inferences
- B45 R. Shonk, N. Eckstein, P.C. Sereno, T. Keillor, N. Connelly-Smolencic, M. Ciudad Real Ballesterio, E. Fitzgerald** The most posed burial in prehistory: Capturing and reconstructing its story in multiple dimensions

- B46 R.L. Luther, R.C. O'Neill** Teaching an old dog new tricks: The virtual goniometer as a novel tool for 3D molar segmentation and occlusal wear surface angle measurements
- B47 J. Sweder, E. Bamforth, M.J. Scott, A. Kerr** 3D scanning the Pipestone Creek Bonebed as a mapping technique during fossil excavation and preparation: preserving key context of fossil localities
- B48 D.J. Varricchio, S.A. Williams, M. Serio, L. Hall, E.T. Metz, M. Smith** Leveraging digital scanning and 3D printing technology to reveal new information and create the most accurate mount of the Late Cretaceous Dinosaur *Troodon formosus*.
- B49 L.L. Miller, E. Przybyszewski, J. Cozart, G. Scofield, J. Harvey** Bringing fossils to your fingertips: Photogrammetry techniques within paleontological exploration
- B50 N.A. Matthews, B.H. Breithaupt, P.C. Murphey** Rediscovering the lost tracks: Using modern photogrammetry to map the past at Dinosaur Ridge, Colorado
- B51 E. O'Callaghan, R. Abolt** Microphotography as a method to illustrate and highlight ultra-fine details preserved in microfossils
- B52 T. Sato** Ready-to-apply adhesive patches for efficient fossil preparation
- B53 M.L. Householder, C.A. Boyd** Reframing the question: are reversible adhesives also removable?
- B54 C. Lash** Tooth or consequence: case studies using dental impression putty, vinyl polysiloxane (VPS), as an alternative to conventional molding materials
- B55 B.P. Holbach** The use of hydrogels in fossil preparation, a novel material and method in cleaning and removing matrix from bone
- B56 L. Herzog, J. Anné, E. Lund, A. Knowles, L.E. Zanno** Evaluating the use of casting sand as a medium for large block stabilization
- B57 L.T. Yann, D.K. Butler** Mulberry paper and mammoths: A new, reversible method to prepare *Mammuthus columbi* specimens using archival, radiolucent materials at Waco Mammoth National Monument (Texas, USA)
- B58 R.R. Hummel, S.K. Swenson, L. Bird, N.A. McGee** Fresh ink and fresh perspectives: tattooing as a novel method of labeling silicone molds
- B59 M. Westfall, E. Johnson** Jackets, pedestals, and threats of disassociation: an analysis of tracking systems for unprocessed materials in museums
- B60 K. Lubbers** Managing mammoths and Ice Age collections expansion
- B61 K. Link, C.R. Cope, A. Landwehr, P. Black, I.J. Rivera-Molina, L.E. Wilson** Utilizing workflows to prioritize and rehouse unstable fossils for long-term storage
- B62 J.M. Koehn, R. McCord, G. McCulloughh, R.R. Hummel** Planning mounts for holotypes and fossils of significance for research access
- B63 A.G. Self, A.C. Berenyi-Tonesi** Expanding comparative collections at The Mammoth Site of Hot Springs, SD: overcoming constraints and constructing a comparative skeletal framework for use in vertebrate paleontology
- B64 C.A. Sullivan, M. Sims, S. Miceli** Curating the cave: It's a trap!
- B65 E. Tamez-Galvan, A. Polich, N.G. Toth, K. MacKenzie** Large-scale project management fit for a Jurassic giant
- B66 S. Hartman, S.N. McDavid** Best practices for fossil vertebrate skeletal diagrams
- B67 J. McHugh, S.K. Drumheller, J. Nestler** A novel method for estimating paleoecological modifications of vertebrate bone surfaces in the fossil record
- B68 R. Wilhite, B. Curtice** A proposed quantitative measurement system for describing distortion and completeness of appendicular and axial elements
- B69 L.S. Jackson, J.A. Wilson Mantilla** Tooth imbrication as an adaptation for herbivory in sauropodomorph dinosaurs
- B70 A. Moopen, K. Chapelle, R.B. Benson, P. Barrett, J. Botha, J. Choiniere** Paleobiology of the first bipedal lessemsaurid From the Late Triassic of South Africa

- B71 K. Chapelle, P. Barrett** New data on the postcranial anatomy of *Massospondylus carinatus* (Dinosauria: Sauropodomorpha) and implications for postcranial ontogeny
- B72 S. Jiang** Redescription and systematics of *Abrosaurus dongpoensis* (Dinosauria: Eusauropoda) from the early Middle Jurassic Lower Shaximiao Formation of China
- B73 A. Moore, P.D. Mannion** Critical reappraisal of a putative dicraeosaurid sauropod dinosaur from the Middle Jurassic of Gondwana and a revised view of diplodocoid evolutionary relationships
- B74 E. LaCount, M.T. Mossbrucker** Revising the timeline of discovery at the Lakes-Marsh “Atlantosaurus Beds” quarries at Morrison, Colorado
- B75 R. Higgins, P.D. Mannion, P. Barrett, P. Upchurch** A leg to stand on: a new sauropod dinosaur hindlimb from the Wessex Formation, Isle of Wight, UK
- B76 M. Ciudad Real Ballester, D. Vidal, A. Serrano Martínez, T. Keillor, P.C. Sereno** Comparative neuroanatomy of Jurassic sauropods from Niger: disparate sensory adaptations?
- B77 A. Reutter** *A priori* cladistic data comparison reveals the need for a revision of character data in macronarian evolution
- B78 R.S. Tykoski, T. Gabay, M. Slovacek, B. Smith, D. Contreras** Two new sauropod-bearing localities in the Antlers Formation (Trinity Group, Lower Cretaceous, Aptian-Albian) of north Texas
- B79 J. Fronimos, H. N. Woodward** Ontogenetic assessment from dorsal ribs in a mature titanosaur (Dinosauria, Sauropoda) from the Upper Cretaceous of Texas
- B80 K. Nguyen, P.R. Bell, B. Mainbayar, C. Woodruff, P.J. Currie** Digital preservation of titanosaur (Sauropoda) tracks with remarkable soft tissue anatomy from the latest Cretaceous of Mongolia using photogrammetry
- B81 A.A. Brink, D.W. Krause, S.L. Wick** A ferugliotheriid mammal from the Upper Cretaceous (Campanian) Aguja Formation of Texas, USA
- B82 I.R. Newbins, S.T. Lavin, P.R. Danosky, G. Wilson Mantilla** New samples of Late Cretaceous multituberculate mammals from the Judith River Formation of Hill County, Montana
- B83 D.A. Ausmus, J.S. Silviria, G. Wilson Mantilla** Earliest Paleocene multituberculate mammals from the Constenius Locality, Garfield County, Montana: A perspective from premolar morphometry
- B84 J.S. Silviria, D.A. Ausmus, P.R. Renne, A.J. Tholt, C. Sprain, G. Wilson Mantilla** An exceptional mammal locality from the first ~28 Kyr after the Cretaceous-Paleogene mass extinction in northeastern Montana with Lancian-aspect taxa
- B85 D.W. Krause, L.N. Weaver, R.R. Hummel, S.G. Chester, K. Weissenburger, T. Lyson** *Taeniolabis simmonsae* (Multituberculata, Taeniolabidae) from the early Paleocene of the Denver Basin, Colorado: implications for taeniolabidid systematics, Paleocene bio/geochronology, and paleoenvironmental reconstruction
- B86 F.S. Huang, E. Lindsey, R. Mohammed, A. Rincon, B.R. Peacock** Identification of the first fossil vertebrates described from Trinidad & Tobago: giant Ice Age armadillos (Chlamyphoridae: Glyptodontinae)
- B87 A. Grass, H.F. Smith, M.N. Muchlinski, A.D. Melin, C.C. Veilleux** Sloth unguals and claw sheaths: Comparisons between taxa and implications for xenarthran locomotor habits
- B88 T.K. Potter** Possible sexual dimorphism in the Pleistocene Shasta Ground Sloth (*Nothrotheriops shastense*)
- B89 A.W. Poust, R. Boessenecker** A giant sea cow from the early Pleistocene of northern California: persistence of *Hydrodamalis* throughout the Pliocene-Pleistocene in the eastern North Pacific
- B90 V.M. Jimenez Gonzalez, D.R. Prothero, A.C. Dooley** Variation in Columbian mammoth molars, and the issue of mammoth species in North America
- B91 K. Huff, C.M. Peredo** Wear and tear: Complexity of tooth renewal in manatees
- B92 R.C. Hulbert, J. Pirlo, R.E. Narducci, A. Woodruff, J.R. Bourque, C. Lockner, M. Riegler, A.M. Jukar, J.I. Bloch** Paleocology and taphonomy of megaherbivores (Mammalia: Proboscidea and Rhinocerotidae) from Stratum 3 of the late Hemphillian Montbrook Local Fauna, Florida
- B93 J. McCloskey, R. Secord** A biogeographic assessment of Columbian and woolly mammoths from the central Great Plains Region, U.S.A., using newly acquired fossil molars

- B94 C. Sylvester, J.E. Hargrave** Largest North American mastodon recovered in Acadia Parish, Louisiana: preliminary causes and paleoecology implications of mastodon size
- B95 J.A. Case** Early divergence of the four major clades of macropodiform (kangaroo-like) marsupials from the latest Oligocene of South Australia
- B96 N. Kaytor, P. Bishop, S.A. Hocknull, J. Bevitt, S.E. Pierce, M. Whitney** Ontogenetic changes in trabecular anatomy of the Carboniferous tetrapod *Ossinodus*
- B97 T. Herring, S. Brusatte, F. Elliott, T. Smithson, T. Challands** New tetrapod material from the Lower Pennsylvanian Scottish Coal Measures
- B98 A.F. Osterling Arias, J. Bevitt, R. Reisz** Taxonomic diversity of trematopid temnospondyls at Dolese in the Early Permian of Oklahoma
- B99 J. Andell, J. Patterson, A. Schwartz, M. Schwartz, M.F. Bonnan** A preliminary exploration of proximal ulna shape in extant mammals and reptiles: implications for fossil tetrapod posture
- B100 S.J. Norris, D.P. Temple** Histologic analysis of a large coprolite from the Permian period provides clues regarding the diet and eating habits of a large terrestrial predator

Thursday Morning, October 31, 2024
ROMER PRIZE SESSION
Meeting Room Nicollet B/C
Moderators: Sara Burch and Advait Jukar

- 8:00 L.N. Wilson** Avialan utilization of polar ecosystems traces back to Cretaceous ornithurines: key insights from the Campanian Prince Creek Formation of northern Alaska
- 8:15 A. Wilken** What good is a halfway ear? Biomechanical modeling of sound conduction in *Thrinaxodon*
- 8:30 K.E. Widrig** Paleobiology and evolution of early palaeognathous birds
- 8:45 J.D. van Zoelen** Southern giants: locomotory and sensory adaptations of diprotodontid marsupials from the late Cenozoic of Australia and New Guinea
- 9:00 J. Schap** Integrating paleobiological insights to evaluate climate impacts on small mammal communities
- 9:15 A.W. Peng** Multivariate analysis of ecological diversity in Asian Rodentia in the context of tectonism and environmental change
- 9:30 N.S. Ong** Ecophysiological influences on the metaplastic tissues of end-Cretaceous pan-trionychian turtle shells
- 9:45 D.T. Ledesma, M. Kemp** Lizards lost, lizard found, lessons learned: Changes in a Central Texas lizard community over the last 16,000 years
- 10:15 M. Lang** Tracing transformations: investigations into the evolution of brain shape in Primates and their kin
- 10:30 P. Kuo** Tracing macroevolutionary transformations of avian quadrate morphology
- 10:45 D.E. Korneisel** Estimating neck mobility in stem tetrapods: a novel method using the extant analogue *Acipenser fulvescens*
- 11:00 B. Igielman** The impact of taxonomic representation and “representative taxa”; a novel, comprehensive phylogenetic analysis of early amniotes
- 11:15 T.C. Hunt** Eco-sensory significance of crocodylian cranial morphology revealed through *in vivo* perimetry analysis with implications for visual field reconstruction in fossil taxa
- 11:30 C.A. Grand Pre** The hepatic piston in extant and extinct crocodylomorphs
- 11:45 O.E. Demuth** Wing movement and joint mobility within Ornithurae: Insights into the evolution of avian flight
- 12:00 Y. Asakura, T. Hirasawa** Evolution of the basal joint in the cranial skeleton from the evo-devo perspective

Thursday Morning, October 31, 2024
Technical Session 6: Ornithischia II
Meeting Room Nicollet A
Moderators: Emily Bamforth and Karen Poole

- 8:00 D.R. Dunfee, R. Ridgely, M. Lamanna, L.M. Witmer** Ontogenetic analysis of skull structure in *Dryosaurus elderae* (Dinosauria: Ornithopoda) from the Upper Jurassic Morrison Formation (Dinosaur National Monument, Utah, USA): new behavioral implications from the brain endocast and inner ear
- 8:15 Z. Hannebaum, D.J. Varricchio, R. Scheetz, C.M. Brown, H.M. Avrahami** The three species problem: a revised look at the systematics and phylogenetic relationships of neornithischian dinosaurs in the Upper Cretaceous Two Medicine Formation of northcentral Montana
- 8:30 G.M. Crow, P.C. Sereno** Functional specializations of the beak and tooth rows in the end-Cretaceous dinosaur *Thescelosaurus neglectus* (Ornithischia: Thescelosauridae)
- 8:45 K. Poole, E. Warner-Cowgill, D.D. DeBlieux, J.I. Kirkland** A new iguanodontian dinosaur from the Cedar Mountain Formation (Early Cretaceous) of Utah
- 9:00 L. Czepinski, D. Madzia** New insights into the lower jaw disparity in rhabdodontid ornithopods and their taxonomic implications
- 9:15 B. Cassiano, J.J. Sertich, M.S. Watkins, N.G. Toth, S. Bastien, A.L. Titus** Evidence for the earliest appearance of Brachylophosaurini (Hadrosauridae: Saurolophinae) from the lower Wahweap Formation of southern Utah, USA
- 9:30 T. Dudgeon, D. Evans** Finite element analysis supports the potential for niche partitioning between a contemporaneous lambeosaurine and hadrosaurine (Ornithopoda: Hadrosauridae)
- 9:45 D.A. Hoffman, A.A. Brink, G. Phillips, J. Starnes, N. Baghai-Riding, C. Hotton, O. Pharr, D. Hanes** Geometric morphometric analysis of the most complete dinosaur in Mississippi: a saurolophine hadrosaurid from an early-Campanian locality in the Coffee Formation, Prentiss County, MS.
- 10:15 T.L. Ford** *Edmontosaurus/Anatosaurus/Anatotitan*, one into three or three from one?
- 10:30 V.J. Radermacher, P. Makovicky** Quantifying wear in ornithopod and ceratopsian dental batteries
- 10:45 S. DeNarie** The complete royal flush: A fully-sampled phylogeny of Ceratopsia
- 11:00 M. Son, G.M. Erickson, C. Zhou, Y. Yin, P. Makovicky** Intra- and inter-specific variation in *Psittacosaurus* (Dinosauria; Ornithischia) and its implications for sympatry in early-diverging ceratopsians
- 11:15 D. Barrera Guevara, E. Freedman Fowler, D. Posada Martínez, C. de León Dávila, J. Flores Ventura, M. Aguilón Martínez, J. Guzmán Gutiérrez, H. Rivera Sylva, D. Fowler** A new juvenile bonebed of chasmosaurine ceratopsids from the Upper Campanian Cerro del Pueblo Formation, Coahuila, Mexico: affiliation to the *Pentaceratops*-lineage of southern Laramidia
- 11:30 S.M. Cajune, J. Scannella** A small juvenile *Triceratops* from the Hell Creek Formation, Montana, reveals details of early ontogeny
- 11:45 E. Bamforth, J. Sweder** Fifty years at Pipestone Creek: new discoveries and insights from Canada's densest dinosaur bonebed in the Late Cretaceous Wapiti Formation, northwest Alberta, Canada
- 12:00 J.A. Brennan, J.E. Alfano, D. Evans, P.J. Currie, C.A. Forster** Cranial redescription of *Stegoceras validum* gives first look into skull morphology in Pachycephalosauria (Dinosauria: Ornithischia) informed by X-ray computed tomography

Thursday Morning, October 31, 2024
Technical Session 7: Ungulates
Meeting Room Nicollet D
Moderators: Helen Machado and Margot Nelson

- 8:00 R.E. Sweedler, K.L. Rust, K. Beard** Revised biostratigraphic age of the late Paleocene *Titanoides* locality, Bison Basin, Wyoming, and its paleobiogeographic implications
- 8:15 C. Janis, S. Brown, M.J. Benton, S. Singh, D. Silvestro** Drivers of late Cenozoic equid evolution: The bull of the recent
- 8:30 A.F. Schwartz, L. DeSantis** Dental microwear texture analysis suggests differing responses to Paleocene-Eocene Thermal Maximum in phylogenetically dwarf basal ungulates

- 8:45 H. Machado** The La Brea horse, or how I learned to stop worrying and understand evolutionary stasis
- 9:00 Z. Landry, J.H. Miller, G. Zazula, C. Bataille, D. Fraser, L. Orlando, H. Tiffin** Check tooth morphology is not a reliable taxonomic indicator for Beringian *Equus*
- 9:15 D.A. Croft, M.A. Armella, S.W. Simpson** Diets of late Neogene notoungulates from northwestern Argentina based on enamel microwear
- 9:30 A.R. Kurre, L. DeSantis** Inferring the life histories of herbivorous megafauna from Rancho La Brea
- 9:45 J. Gallucci** Ecomorphologic trends in North American mammals across the Oligocene-Miocene boundary
- 10:15 E.G. Ekdale, J.J. ElAdli, M.R. Michael, T.A. Demere, A. Lanzetti, R. Boessenecker, J. Gatesy** Palatal foramina in artiodactyls and their relation to baleen
- 10:30 M.D. Uhen, N.A. Brand, C.M. Peredo, D. Taylor, J. Pollock** A new basal chaeomysticete from the Early Oligocene of Washington State
- 10:45 M.D. Nelson, O. Lambert** A new basal homodont odontocete from the Aquitanian of the Northeast Pacific, and reflections on the distribution and phylogeny of the putative “*Chilcacetus* clade”
- 11:00 A.S. Gohar, H. N. Woodward, M.S. Antar, S. El-Sayed, H. Sallam** Chewing the data: Insights into archaeocete whale tooth histology and feeding biomechanics
- 11:15 R.J. Strauch, C.M. Peredo** To fuse or not to fuse: drivers of symphyseal fusion in whales
- 11:30 R.M. Laker, R. Franseth, J.H. Miller** Shed antler age-frequency distribution reflects caribou (*Rangifer tarandus*) calving ground trends recorded by wildlife monitoring in Ivvavik National Park, Yukon, Canada
- 11:45 S. Robson, M.J. Mourlam, M.J. Orliac, I. Ruf, J. Gegner, J.A. Ludtke, O. Bertrand, T. Smith, J. Theodor** The good, the bad, and the weird: A new hypothesis of tylopod (Artiodactyla) relationships based on data from the auditory region
- 12:00 F.C. Hardy, A.E. Kort** Ecometric analysis of artiodactyls from the Miocene Dove Spring Formation reveals stability in functional traits over geologic time

Thursday Afternoon, October 31, 2024
Technical Session 8: Paleontological Practices: Management & Ethics
Meeting Room Nicollet B/C
Moderators: Amy Atwater and ReBecca Hunt-Foster

- 1:45 M.K. Macias, D. Oberg, C. Shi, A.L. Ollendorf** Using automation tools to streamline field-to-laboratory documentation
- 2:00 A.W. Kellner** One thousand fossils to restore the exhibition of the Museu Nacional/UFRJ, Brazil - results of the RECOMPOE donation campaign
- 2:15 B.H. Breithaupt, N.A. Matthews, P.C. Murphey** High-resolution track surface analysis for informing mitigation and resource preservation strategies at Dinosaur Ridge, Colorado
- 2:30 R.K. Hunt-Foster, A.L. Titus, C.A. Suarez, P.D. Polly, G. Knauss** Geochemical fingerprinting using portable X-Ray Fluorescence and Rare Earth Elements of Late Jurassic dinosaur fossils from the Colorado Plateau, USA
- 2:45 A.L. Atwater, R. Mason, A.S. Rea, R.A. Kleeb, E. LaCount** Identifying agents of deterioration and management strategies for paleontological resources at Dinosaur Ridge, Colorado, USA
- 3:00 V. Santucci, J. Tweet** Paleontological resource inventory strategies developed and implemented by the U.S. National Park Service
- 3:15 J. Tweet, V. Santucci** Paleontological resource monitoring strategies developed and implemented by the U.S. National Park Service
- 3:30 E.G. Flint, J.M. Hoffman** Can you dig it? A lawyer’s advice on securing permission to excavate fossils exemplified by a recent Miocene mysticete excavation in Santa Barbara County, California
- 3:45 A. Huynh** Global Fossil Crime: An initial investigation on the illicit world of fossil trafficking
- 4:00 G.A. Liggett, B. Schumacher** Make it a federal case! Comments on making federal fossil criminal cases, with a summary of pre- and post-Paleontology Resource Preservation Act (PRPA) prosecutions

Thursday Afternoon, October 31, 2024
Technical Session 9: Triassic Herpetology
Meeting Room Nicolle A
Moderators: Adam Fitch and Randall Irmis

- 1:45 **S. Spiekman, V. Rossi, C. Foth, T.S. Slater, O. Schuchert, S.D. Schuchert, M. Serafini, H. Sues, M.E. McNamara, R.R. Schoch** **-WITHDRAWN-** The first small-bodied diapsid reptiles from the Triassic of the Grès à Voltzia (Middle Triassic: lower Anisian) of northeastern France
- 2:00 **G. Mestriner, G.F. Funston, S.J. Nesbitt, J. Marsola, M.C. Langer, D. Evans, C.A. Sidor, A. LeBlanc** Ankylothecondonty in rhynchosaurs (Archosauromorpha) involves true tooth sockets formed by cementum, alveolar bone, and the mineralized periodontal ligament
- 2:15 **K.M. Melstrom, B.T. Kligman, A. Marsh, S.J. Nesbitt, M.R. Stocker, R. Irmis** Dental complexity disparity of Late Triassic reptiles resembles extant Sauria
- 2:30 **R. Irmis, A. Milner, E. Boeman, J. Diaz, A.W. Johnson, T. Birthisiel** The importance of resolution and scale in paleoecological inference: a case study from the Upper Triassic of western North America
- 2:45 **W. Reyes, M. Brown** Triassic babies? A cluster of small-bodied aetosaurs from the Upper Triassic Dockum Group (Otischalkian – latest Carnian?) of Texas
- 3:00 **B.M. Weiss, R.B. Benson, K. Chapelle, K. Dollman, P. Barrett, S.J. Nesbitt, M.R. Stocker, J. Botha, J. Choiniere** A new and large pseudosuchian from the mid-Norian (Late Triassic) lower Elliot Formation of South Africa
- 3:15 **E. Armour Smith, C.A. Sidor** Four legs good, two legs better? Investigating if limb allometry supports an ontogenetically driven locomotor mode shift in a skeletally immature assemblage of shuvosaurids (Paracrocodylomorpha: Poposaurioidea) from the Upper Triassic Chinle Formation of Petrified Forest National Park
- 3:30 **R. Piechowski, T. Szczygielski** Comparison of limb musculature of the Triassic turtles *Proterochersis* (Testudinata, Proterochersidae) and *Proganochelys* (Testudinata, Proganochelyidae) suggests different habitat adaptations
- 3:45 **A.J. Fitch** Pterosaur femoral anatomy elucidates the evolution of Lagerpetidae (Panaves: Pterosauroomorpha)
- 4:00 **A.C. Pritchard, B. Britt, B.C. Theurer, G. Engelmann, D. Chure** Extreme left-right asymmetry in the forelimb of a drepanosaur (Diapsida, Drepanosauroomorpha) from the Upper Triassic of Utah

Thursday Afternoon, October 31, 2024
Technical Session 10: Fishes
Meeting Room Nicolle D
Moderators: Alecandria Quinn and Lisa Schnetz

- 1:45 **T. Miyashita, P. Janvier, K. Tietjen, M. Coates** Evolution of extrinsic eye muscles in vertebrates
- 2:00 **L. Schnetz, A. Lanzetti, R. Dearden, A.S. Jones, S. Giles, Z. Johanson, S. Lautenschlager, E. Randle, I.J. Sansom** Feeding without jaws: diversity of heterostracan oral structures
- 2:15 **D.M. Leong, J. Liu** Comparison of the cephalic lateral line system across tetrapodomorphs from Red Hill, Nevada
- 2:30 **C.D. Wilson, C.F. Mansky, J. Anderson** Unexpected mosaic anatomy in a new genus and species of Early Carboniferous actinopterygian
- 2:45 **A. Caron, K. Tietjen, M. Coates** Reevaluating neural preservation in the Carboniferous actinopterygian *Trawdenia planti*
- 3:00 **J. Stack, S.J. Nesbitt, M.R. Stocker** A new occurrence of *Saurichthys* (Actinopterygii) from the Dockum Group of Texas (Late Triassic, Norian) highlights the uneven tempo of the appearance of specialized jaw morphologies in ray-finned fishes
- 3:15 **M. Kane, T.A. Gates** A comparison of molecular and morphological phylogenetics of Carcharhiniformes sharks from North Carolina since the Cretaceous
- 3:30 **B. Costa, K. Brink, R.L. Silva** New microvertebrate fossils from the Pierre Shale, Manitoba, Canada
- 3:45 **A.E. Quinn, A.B. Heckert** Analyzing reconstructions of the giant fossil shark *Otodus megalodon*, and proposing a new process behind "Megalodon" exhibit design

4:00 J. Liu, J. Zhang Revision of a Paleocene catfish from Sanshui Basin, South China

Thursday Afternoon, October 31, 2024

REGULAR POSTER SESSION 2

Meeting Room Exhibit Hall

Authors must be present from 4:30 – 6:30 p.m. on Thursday, October 31

- B101 A. Prieto-Marquez, B. Lenoir, J. Wagner** Comparative osteological re-evaluation of phylogenetically informative characters of the ornithomimid dinosaur scapula
- B102 N.A. Hornicak, M. Lamanna, E. Gorscak** Preliminary assessment of South American hadrosauroid dinosaur paleobiogeographical hypotheses using tip-dating Bayesian methods
- B103 T. van der Linden, D.K. Zelenitsky, R.H. Fraaije, X. Valentin, G. Garcia, F.M. Holwerda, A.S. Schulp** The first occurrence of hadrosauroid eggshells from Upper Cretaceous deposits of France
- B104 M.S. Watkins, A.L. Titus, K. Knoll, B. Cassiano, J.J. Sertich, G.T. Shimer, A. Harrington** Taphonomic, stratigraphic, and morphological analysis of hadrosauroids from the lower Wahweap Formation (early Campanian): insights into the early evolution and ecology of Hadrosauridae in North America
- B105 H.R. Caldwell, D.J. Varricchio** Variation in occlusal morphology among hadrosaurids: implications for ecologic diversity
- B106 R.E. Rossi, J.R. Horner, J. Scannella** A saurolophine hadrosaur (Dinosauria: Ornithischia) from the marine Claggett Formation (Campanian) of northern Montana
- B107 S.R. Clawson, D.J. Neff, D. Fowler** A new Hadrosaurid nesting site from the Upper Cretaceous (Campanian) Judith River Formation, North Central Montana, with crushed eggs, embryonic and partially articulated hatchling bone elements, and possible mineralized mammary tissues
- B108 K.D. Obuszewski, L.E. Zanno** Assessment of taxon and character sampling across neoceratopsian phylogenies
- B109 E. Freedman Fowler, D. Barrera Guevara, B. Espinosa Chávez, C. Serrano Brañas, D. Posada Martínez, C. de León Dávila, D. Fowler** Stratigraphic revision of *Coahuilaceratops magnacuerna* as the first dinosaur from the Lower Maastrichtian Cerro Huerta Formation
- B110 L.M. Kastroll, K.A. Beguesse, C. Sullivan** A novel pathology in the feeding apparatus of a *Pachyrhinosaurus lakustai* (Ceratopsia: Centrosaurinae) skull from the Pipestone Creek bonebed of the Upper Cretaceous Wapiti Formation in Alberta, Canada
- B111 B. Chinnery, J. Scannella** The clavicle of *Cerasinops* and a preliminary reassessment of pectoral girdle anatomy in ceratopsian dinosaurs
- B112 N.R. Carroll, S. Moore, J. Scannella** Testing evolutionary hypotheses with historically collected *Triceratops* from the Hell Creek Formation of Carter and Fallon County, Montana
- B113 C.K. Mezak, B. Chinnery, J. Scannella** A morphometric study of postcranial ontogeny in *Triceratops* from the Hell Creek Formation, Montana
- B114 A. Pöferl, A.K. Hastings** New record of a pachycephalosaurid partial dome from the lower Hell Creek Formation, Montana (USA)
- B115 F. Varriale, A. Maya-Romero** Dental wear facets in Pachycephalosauridae are more similar than previously thought
- B116 S.L. Booth, K. Synder, A. Chadwick, R. Ash, P. Ullmann** Rare earth elemental concentrations as a novel proxy for lateral continuity: an initial case study at the Hanson Ranch Bonebed, Cretaceous Lance Formation, Wyoming
- B117 K.D. Mulcahy, K. Beard, K. Constenius** The northernmost record of Uintatheriidae (Mammalia: Dinocerata) in North America: phylogenetic and biogeographic implications
- B118 G.W. Flora** Species taxonomy and biogeography of the Dinocerata (Mammalia)
- B119 S.L. Garcia-Lara, Z. Tseng** Exploring patterns of modularity and integration in the mandible of terrestrial artiodactyls
- B120 K.S. Chambers, C. Badgley, M. Zelditch** Fancy feet: An ecomorphological assessment of the terminal phalanx in Order Artiodactyla
- B121 R. Franseth, R.M. Laker, J.H. Miller** Quantifying bone weathering using surface texture modeling

- B122 S. Siarabi, D.S. Kostopoulos, S. G. Arranz, J.M. Robles, D. Alba** New craniodental remains of the suine *Propotamochoerus palaeochoerus* from the Late Miocene of Hostalets de Pierola (Vallès-Penedès Basin, NE Iberian Peninsula): biochronological implications

B123 A. Woodruff Demographic assessment of the *Mylohyus* (Artiodactyla: Tayassuidae) from the Cutler Hammock site of Dade County, Florida with comments on the faunal assemblage and paleoecology

B124 J.L. Scharpf, M. Wetherell Using modern variation to inform species-level taxonomy of *Brachycrus* (Family Merycoidodontidae)

B125 J.L. King, E.A. Ames Two-dimensional geometric morphometric analysis reveals a range of *Merycoidodon* skull morphospace

B126 D.R. Prothero, C. Cleaveland, E.T. Welsh, K. Marriott, D. Balassa, K.I. Watmore, S. Olson Systematics of the Late Oligocene-Miocene oreodonts (Mammalia: Artiodactyla: Merycoidodontidae)

B127 K.M. Ehler, B.R. Peacock, T.G. Kaye, M. Whitney The life history of the early camel *Poebrotherium* as inferred from paleohistology

B128 D. Balassa, D.R. Prothero What is a giraffe-like camel? A taxonomic revision of the Miocene camel, *Oxydactylus*

B129 K.I. Watmore, D.R. Prothero Systematics of the Stenomylini, the North American, Oligocene-Miocene, Gazelle-like Camels (Mammalia: Artiodactyla: Camelidae: Stenomylinae: Stenomylini)

B130 E. Froehlich The Miocene genus *Hemiauchenia* (Artiodactyla, Camelidae): a preliminary review suggests discrepancies across North America

B131 E. Medeiros, M.D. Uhen Comparisons between the hindlimb morphology of early cetaceans and modern semiaquatic mammals

B132 N.A. Brand, M.D. Uhen, C.M. Peredo Phylogenetic analysis of stem, toothed mysticetes and their relationships to archaeocetes and odontocetes

B133 W.E. Worrell, M.T. Clementz, B. Carrapa, C.S. Gutstein, S.T. Hasiotis, P.R. Martinez Marine mammal occurrences, distribution, and paleoenvironmental interpretation at Late Miocene sites of Cerro Ballena and Mina Fosforita, Bahía Inglesa Fm., Chile

B134 B. Leidy, W. Godwin, P.J. Lewis The inland cetaceans and other marine mammals of east Texas

B135 D.A. Hoppe Evidence of feeding by the macropredatory shark *Otodus megalodon* on a cetacean rib bone from the Middle Miocene Calvert Formation, Virginia, USA

B136 C.M. Peredo, R.J. Strauch, J. Berv, N.A. Brand, M.D. Uhen Back to the Future: Two case studies for applying AI techniques to fossil data

B137 J. Theodor, S. Robson, K.A. Nugent, S.T. Tucker Basal is better: a re-evaluation of *Syndyceras cooki* (Artiodactyla, Protoceratidae) petrosal morphology and the pitfalls of inferring evolutionary relationships based on derived morphologies

B138 O.R. Williams, J.X. Samuels, S. Maden, B.W. Schubert Description and morphometric comparison of early Pliocene deer (Cervidae) from the Gray Fossil Site of Northeast Tennessee to modern and fossil cervids

B139 E.R. Kuo, D.R. Prothero Allometric growth in the limbs of the Pleistocene "mountain deer" *Navahoceros fricki*

B140 B. Cragun, M. Wooller, P.S. Druckenmiller Investigating the foraging behavior of two eastern Beringian Quaternary moose species (*Alces alces* and *Cervalces* sp.) using stable isotopes

B141 S. Abbas, R. Croitor, M. Babar, M.A. Khan, A. Yasin First discovery of hog deer antler from the Pleistocene deposits of Panjan Sher Shahana, Punjab, Pakistan

B142 M.A. Khan, M. Asim *Miotragocerus* (Bovidae) from the Middle Miocene Chinji Formation of Pakistan

B143 M. Babar, S. Abbas, M.A. Khan, A. Yaseen, F. Jabar, M. Akhtar A supplementary report of bovids from the Middle Siwaliks (Late Miocene) deposits of Siwaliks of Pakistan

B144 S.M. Santos, D.R. Prothero Allometric change in the limbs of the Pliocene goat-like camel *Capricamelus gettyi*

B145 T.J. Anderson, J. Mead, R. Short, S.L. Swift, A. J. G. Rees, S. J. Martin Fossil bison (*Bison bison*) of the Snake River Site, Minnesota, demonstrate inconsistencies with the single species concept

- B146 L. Vetter, A. Kaur, K. Thirumalai, J.J. Saunders, N. Kerrison, B. Pobiner, A.K. Behrensmeyer, R. Patnaik, A.M. Jukar** Herbivore diets in the early Pleistocene Haro River Quarry of Pakistan
- B147 O.E. Wilson, P.A. Holroyd, A.K. Parker, A. Rincon, F. Pujos, M.C. Vallejo-Pareja, J. Saarinen** 80 years of the Chaparral Fauna, Colombia: Revisiting a pre-Laventan neotropical assemblage
- B148 J. Van Orman, F. Anaya, D.A. Croft** New Middle Miocene astrapothere remains from Quebrada Honda, Bolivia
- B149 L.T. Holbrook, B.L. Beatty, D.A. Croft, A. Wright** Reanalysis of the relationships among perissodactyls and certain South American native ungulates using an expanded matrix
- B150 R.E. Winter** Paleocology of Early Eocene *Homogalax* may have partly foreshadowed that of extant *Tapirus*
- B151 J. Orendorff, S.C. Wallace** Cranial ontogeny of the extinct dwarf tapir *Tapirus polkensis*; with comparison to that of the extant *Tapirus bairdii*
- B152 X. Lu, D. Tao** Reproduction of a fossil rhinoceros from 18 mya and origin of litter size in perissodactyls
- B153 S. Killingsworth** Harnessing machine learning to detect macroevolutionary transitions in Neogene fossil horses (family Equidae) in North America
- B154 L. Rieppel, L. Bradley** Morris Skinner and the dispossession of vertebrate fossils on Lakota Treaty Lands
- B155 J. Williams, M. Cradic, K.F. Emery, S. Goring, N. Hoffman, E. Kansa, M. LeFebvre, L. Lieberman, J. Blois** Advancing best practices in FAIR, CARE, and Ethical Open Science in paleocology and zooarchaeology: A case study with the Neotoma Paleocology Database, open context, and the Florida Museum of Natural History
- B156 M. Nohomovich, S.J. Nesbitt, Y. Haridy, N. Shubin, A.B. Heckert, P. Barrett, B.H. Lauer, R. Lauer, M.R. Stocker** New anuran material from the Dockum Group in the American Southwest provides insight into frog novelty, evolution, and biogeography in the Late Triassic
- B157 A. Lemierre, A. Logghe, T. Arbez** Unexpected discoveries: Postcranial elements and burrows within the skull of *Stanocephalosaurus amenasensis* (Amphibia, Temnospondyli), from the Lower-Middle Triassic of Algeria
- B158 Y. Bi, G. Li** A comparison of the gigantism of Mesozoic ichthyosaurs and Cenozoic whales
- B159 D. Jiang, R. Motani, A. Tintori, N. Fraser, O. Rieppel, M. Zhou** Two major evolutionary events for Triassic ichthyosauromorphs: origin in the Early Triassic and transition to an apex predator in the late Middle Triassic
- B160 A.E. Weeks, N. Klein, M. Sander, L. Schmitz** A case of hidden diversity: a new longirostrine ichthyosaur from the Anisian Fossil Hill Fauna of Nevada
- B161 G.A. McGaughey, N. Kelley, P. Noble, B.R. Peacock** In the fluke sweeps of giants: Ichthyosaurs in the Cedar Mountains of Nevada, USA fill gaps in the Norian ichthyosaur record
- B162 C.X. Su, S. Gu, D. Jiang, R. Motani, O. Rieppel, M. Zhou, Z. Sun** New anatomical information of *Glyphoderma kangi* (Placodontia, Sauropterygia, Reptilia) from the Middle Triassic of South China
- B163 D.M. Lovelace, H. Woznick, A. Hotchner, A.J. Fitch, H.R. Miller, C. So, A.M. Kufner** Late Triassic (Carnian) lower Popo Agie Formation, part I: faunal notes on the lower carbonate unit
- B164 A.M. Kufner, A.J. Fitch, H.R. Miller, M.E. Deckman, C. So, B.R. Price, D.M. Lovelace** Late Triassic (Carnian) lower Popo Agie Formation, part II: faunal notes on the purple unit
- B165 W.G. Parker, A. Marsh, J.W. Martz, D.E. Wagner, T.J. Allen** Redefining the Late Triassic Land Vertebrate Teilzones in the Chinle Formation of Petrified Forest National Park
- B166 D.D. DeBlieux, J.I. Kirkland, E. Warner-Cowgill, T.J. Thomson, A. Milner, V. Santucci** A paleontological resource inventory of Permian, Triassic, and Jurassic rocks at Canyonlands National Park: An update of significant vertebrate fossil discoveries
- B167 L.S. Freisem, G. Sobral** Morphometric diversity in early archosauromorph brains illuminates the origins of archosaurian sensory evolution
- B168 A.B. Heckert, J.P. Hancox, J. Choiniere** Tanystropheid (Diapsida, Archosauromorpha) occurrences from the Lower Triassic Burgersdorp Formation (*Cynognathus* Assemblage Zone: Early Triassic) of South Africa: A rare early Gondwanan record of the clade

- B169 A. Marsh, C.A. Sidor, E. Armour Smith** The hidden diversity of monodominant macrofossils bonebeds: a case study in allokotosaurian archosauromorphs from the Upper Triassic Chinle Formation
- B170 C. Carter, A.B. Heckert, B.H. Lauer, R. Lauer** Preliminary statistical study of Late Triassic archosauriform teeth from the Homestead Site, a microvertebrate assemblage in east-central New Mexico
- B171 E. O'Callaghan, R. Abolt** Pathological phytosaur teeth from the Triassic Chinle Formation, near St. Johns, Arizona
- B172 L. McCloskey, E.R. Goldsmith, M.R. Stocker** Osteohistology and bone microstructure of the phytosaur jaw
- B173 P.J. Byrne, N.D. Smith, J. Botha, A.A. Rytel, A. Huttenlocker** Using intertrabecular space to validate pneumatic bone: implications for assessing postcranial skeletal pneumaticity in stem archosaurs
- B174 E. Patellos, N.D. Smith, D. Bottjer** A survey of gain and loss of osteoderms in Archosauromorpha reveals complex patterns of evolutionary change
- B175 M.E. Jobbins, K. Brink** Early fish assemblages from the Middle Devonian of Lake Manitoba, Canada
- B176 A.I. Eliezer, E.B. Daeschler** Evidence of predation in vertebrate fossils from the Late Devonian (Famennian) Catskill Formation of Pennsylvania: further insight into the ecological context of the fin-to-limb transition
- B177 A.L. Hruska, S.Z. Gibson, R. Hilton, J. Bonde, P. Druschke** A new Mississippian fish from the Diamond Peak Formation of east-central Nevada, USA
- B178 A.L. Wurtz, J.M. Hodnet** A closer look into the Middle Mississippian Ste. Genevieve Formation microvertebrate chondrichthyan fossils of Mammoth Cave National Park
- B179 J.M. Hodnet, R. Bolden, R. Toomey, R. Olson, K. Tolleson, J. Tweet, V. Santucci** A partial skeleton of a Middle Mississippian (Viséan) ctenacanthiform shark (Chondrichthyes, Elasmobranchii, Ctenacanthiformes) from the Horse Cave Member of the St. Louis Formation at Mammoth Cave National Park, Kentucky, U.S.A.
- B180 W. Itano, D. Snyder** A new chondrichthyan genus and species from the Middle Pennsylvanian Minturn Formation of Colorado, USA, based on a tooth resembling those of *Venustodus*
- B181 T.B. Babcock, L. Tapanila** A review of the spiral-toothed sharks, the eugenodontids, show a complex biogeographical history of evolution, preservation, and diversification dependent on global sea levels.
- B182 M. Mateo, J.M. Hodnet, M. Bovis, R. Mateo, S. Timko, V. Santucci** New chondrichthyans from the Early Permian Phosphoria Formation from Grand Tetons National Park, Wyoming, U.S.A.
- B183 K. Plesh, A.B. Heckert, J. Stiegler** Filets of fish: segmenting computed tomography (CT) scans to morphologically describe ray-finned fish (Actinopterygii) from the Snyder quarry of the Upper Triassic (Revueltian) Petrified Forest Formation in northern New Mexico
- B184 S. Kim, Y. Lee, G. Nam, J. Park, S. Lee, M. Son** A new juvenile species of *Birgeria* (Osteichthyes, Actinopterygii) from the Upper Triassic freshwater deposits of South Korea
- B185 S.M. Ott, S.Z. Gibson** Advances in early Mesozoic paleoichthyology in the American southwest: New discoveries of ray-finned fishes from the Upper Triassic Dockum Group
- B186 L.J. Rose, J.P. Crothers, I. Pugh, A.B. Heckert, S.J. Nesbitt, M.R. Stocker, B.H. Lauer, R. Lauer** Microvertebrate ichthyofauna of the Upper Triassic (Norian) Homestead Site at Garita Creek in east-central New Mexico, USA
- B187 F. McDiarmid, E. Warner-Cowgill, G.W. Storr, M. Lamanna, Q. Hawkins, M. Affolter, L. Ashurst-Mcgee, K.C. Rayburn, L. Kosowatz, D. Anduza** First occurrence of the amiid fish *Melivius* from the Late Cretaceous Almond Formation of southern Wyoming: stratigraphic and taxonomic implications
- B188 C. Fielitz, H. Jackson, Z. DeWees** The phylogenetic relationships of *Stratodus*, *Prionolepis* (*Aspidopleurus*), and *Cimolichthys* among Late Cretaceous genera of the order Aulopiformes (Teleostei: Neoteleostei)
- B189 M.B. Soares, G.D. Freitas, J.M. Sayão, A.W. Kellner** The largest lamniform shark (Chondrichthyes: Neoselachii) from the Upper Cretaceous strata of the Antarctic Peninsula
- B190 J.P. Crothers, A.L. Wurtz, R.K. Hunt-Foster, J.R. Foster, J.J. Eberle, A.B. Heckert** A diverse microvertebrate site from the Late Cretaceous Williams Fork Formation (Campanian - Maastrichtian) of Colorado and its paleoecological implications for Laramidia

- B191 A.G. Armagno, K. Shimada** Fossil marine vertebrates from a new fossiliferous horizon in the upper-most part of the Upper Cretaceous Smoky Hill Chalk, western Kansas, USA
- B192 S.Z. Gibson, J.G. Westgaard, H.D. Hanks** Preliminary identification of fish species within the Late Cretaceous Coleraine Formation of Minnesota's Mesabi Iron Range
- B193 M. Fitzpatrick, K. Shimada** Late Cretaceous marine vertebrates from the uppermost Greenhorn Limestone in Russell County, Kansas, USA
- B194 O. Laser, K. Shimada** Late Cretaceous marine fishes from the middle part of the Jetmore Chalk (lower Turonian) in north-central Kansas, USA
- B195 M. Ballou** Evidence of sexual dimorphism in the Cretaceous actinopterygian, *Aethocephalichthys hyainarhinos*, of the Campanian Pierre Shale of western South Dakota
- B196 J.W. Krakora** Novel growth changes in neurovasculature correlates of the dentary in *Cyclurus fragosus* (Actinopterygii, Amiidae) of the Hell Creek Formation (67-66 mya) of Southeastern Montana
- B197 I.S. Zalmout, A.M. Memesh, A. Al-Masary, M.I. Najjar, A.A. Bahameem, M.L. Fadani, M. Haptari, M. Friedman** Early Paleogene skeletons of Cypriniformes and Siluriformes (Teleostei) from the Arabian Carbonate Platform, Northern Saudi Arabia
- B198 K. Shimada, J.J. Wood, P.C. Sternes, M. Siversson** How large was the Neogene megatooth shark, *Otodus megalodon* (Lamniformes: Otodontidae)?
- B199 Z. Johanson, M. Smith, M. Debais-Thibaud, E. Manzares, M.N. Dean, C. Underwood, A. LeBlanc** Diverse mineralized tissues of the buckler skin denticles in the ray *Raja clavata* (Batoidea, Chondrichthyes)
- B200 Z.J. Lyons-Weiler** Partnerships with avocational collectors, landowners, and regional groups catalyze paleontological discovery within the Pittsburgh area

Friday Morning, November 1, 2024
Technical Session 11: Theropoda I
Meeting Room Nicollet B/C
Moderators: Denise Maranga and Riley Sombathy

- 8:00 R.S. Sombathy, M.D. D'Emic, P.M. O'Connor** Investigating the relationship between annual growth rate and vascular organization in non-avian theropod dinosaurs using Bayesian threshold modeling
- 8:15 J.P. Kirmse, C. Foth, O. Rauhut** The largest Triassic neotheropod and the early evolution of Averostra
- 8:30 J. Choiniere, K. Chapelle** The skull of a new Early Jurassic theropod from the upper Elliot Formation of South Africa
- 8:45 P.C. Sereno, D. Vidal, N.P. Myhrvold, M. Ciudad Real Ballester, E.T. Saitta, N.S. Fontela, E.D. Johnson-Ransom, S.L. Baumgart, F. Gascó Lluna, Á. Simarro Cano** Scimitar-crested species of *Spinosaurus* discovered in riparian habitat in Niger (Farak Formation, Cenomanian)
- 9:00 A. Danison, H. N. Woodward, D.E. Barta, M. Wedel, A.H. Lee, H. Flora, E. Snively** Osteohistology, probable chimerism, and taxonomic revision of *Saurophaganax maximus*
- 9:15 Z.S. Morris, N.D. Smith, L.M. Chiappe** Osteological correlates of palatal soft tissues and choanae in extant birds and an assessment of the soft palate and nasopharynx in tyrannosaurs
- 9:30 J.C. Stock, M.J. Powers, C. Coppock, G.S. Raun, H.S. Sharpe, J.T. Voris, J.G. Napoli, P.J. Currie** New species of *Albertosaurus* from a distinct stratigraphic unit of the Horseshoe Canyon Formation corresponding to faunal and climatic changes
- 9:45 C. Coppock, M.J. Powers, P.J. Currie** Taxonomic assessment and stratigraphic distribution of *Daspletosaurus* specimens from the Dinosaur Park Formation
- 10:15 Y. Lee, T. Kim, Y. Lee, J. Bevirt, Y. Kobayashi, L. Jacobs, R. Barsbold, D.K. Zelenitsky, A. Paulina-Carabajal** Stomach contents of a juvenile *Tarbosaurus* (Dinosauria: Tyrannosaurinae)
- 10:30 T. Carr** Growth series of *Tyrannosaurus rex* and *T. bataar* (Dinosauria, Theropoda, Tyrannosauridae) share the same order of character changes, weakening the "Nanotyrannus" hypothesis
- 10:45 W.J. Freimuth, G.M. Erickson, L.E. Zanno** Population-level variation in osteohistology and growth trajectories in the therizinosaurian theropod *Falcarius utahensis*

- 11:00 L.T. Dickson** Reassessment of tetradactyl theropod ichnotaxa and a new large ichnospecies from the Early Cretaceous Gething Formation of northeastern British Columbia
- 11:15 M. Hao, Z. Li, Z. Wang, S. Wang, F. Ma, Q. Qinggele, L. King, R. Pei, Q. Zhao, X. Xu** A new early-diverging oviraptorosaur from the Lower Cretaceous Miaogou Formation of western Inner Mongolia, China
- 11:30 J. Hedge** Hierarchical variation in eggshell ornamentation elucidates unique oviraptorosaur nesting biology
- 11:45 F. Therrien, D.K. Zelenitsky, K. Tanaka, J.T. Voris** Life in the fast lane: comparative anatomy and histology of hindlimbs preserved in the stomach of a tyrannosaurid reveal cursorial adaptations and rapid growth in *Citipes elegans* (Oviraptorosauria: Caenagnathidae) possibly as a means of escaping predation
- 12:00 D. Maranga, G.F. Funston, M. Jargalsaikhan, P.J. Currie** Age-segregated assemblage of a new species of oviraptorid (Theropoda: Oviraptoridae) from the Late Cretaceous of southern Mongolia

Friday Morning, November 1, 2024
Technical Session 12: Euarchontoglires
Meeting Room Nicolle A
Moderators: Darrin Pagnac and Francesca Socki

- 8:00 R. Kumar, M. Bansal, C. Gilbert, B. Patel, R. Patnaik** Fossil-calibrated molecular phylogeny sheds light on the evolutionary radiations and biogeography of old-world rats and mice (Muridae: Murinae)
- 8:15 M. Gaetano, J.H. Miller, E. Wald, P.S. Druckenmiller** Whodunit? Partitioning of bone nutrients by Arctic rodents
- 8:30 D.C. Pagnac, N. Fox, S. Wright, S. Keenan** Winter is coming: The Richmond Hill Local Fauna and the Pliocene/Pleistocene transition in the Black Hills of South Dakota
- 8:45 L. Hall, A. Weil, E. Snively** Effects on FEA-simulated stresses in feeding rodents when teeth are modeled and implanted as separate structures
- 9:00 J.W. Crowell, J.I. Bloch, M.T. Silcox, S.G. Chester** The auditory bulla of the Paleocene plesiadapiform *Carpolestes simpsoni* (Euarchonta, Carpolestidae) differs in composition from that of crown Primates
- 9:15 J.I. Bloch, J.W. Crowell, D. Boyer, D.S. Gawlak, P. Houde, M.T. Silcox** Cranial anatomy of *Phenacolemur pagei* (Paromomyidae, Euarchonta, Mammalia) from the late Paleocene of northwestern Wyoming
- 9:30 H.E. Anderson, I.K. Lundeen, M.T. Silcox, S. López-Torres** Virtual sensory reconstruction of the early Miocene lorised *Mioeuoticus* (Strepsirrhini, Primates): implications for behavioural and evolutionary history
- 9:45 A. Bakhia, M. Tallavaara, J. Saarinen, A.K. Parker, M. Bukhsianidze, D. Lordkipanidze** Reassessing out-of-Africa I: Ecometric insights from Dmanisi herbivores challenge prevailing grassland hypotheses
- 10:15 S. G. Arranz, M. Mias-Alcántara, P. Comes, Y. Kimura, J. Villanueva, L. Flynn, D. Alba, I. Casanovas-Vilar** Paleoenvironmental reconstruction of the Late Miocene primate-bearing site of Can Llobateres (NE Iberian Peninsula) based on carbon and oxygen stable isotopes from herbivorous mammal teeth
- 10:30 M. Ioannidou, G. Koufos, L. de Bonis, K. Harvati** 3D investigation of the mandibular post-canine dentition of the Eurasian Miocene hominoid *Ouranopithecus macedoniensis* (Greece)
- 10:45 D.L. Fox, W. Lukens, R. Nockerts** Quantitative reassessment of the carbon isotope record of Neogene and Quaternary paleoecology and environments in eastern Africa
- 11:00 A.S. Hall, K. Jenkins, T. Lehmann, L. Michel, S. Muteti, D.J. Peppe, K.P. McNulty** Catarrhine distribution throughout the Early Miocene Kisingiri Sequence on Rusinga Island, Kenya
- 11:15 K.P. McNulty, A.S. Hall, T. Lehmann, S. Muteti** New fossils and biostratigraphic implications from Miocene sites on the Uyoma Peninsula, Kenya
- 11:30 J. Gardner, S. Humphries, G. Ruxton, C. Venditti** The costs of bipedal locomotion through time in hominins
- 11:45 J. Kingston, L.M. MacLachy** Paleocology of the Pliocene Panshan site, Tugen Hills Succession, Kenya **-WITHDRAWN-**
- 12:00 J. Sun, F. Bibi, I. de la Torre** Biogeography and evolution of Asian and African large mammals from the Late Miocene to the present: continental-scale turnover, functional stability, and no wave of dispersal associated with *Homo* Out of Africa **-WITHDRAWN-**

Friday Morning, November 1, 2024
Technical Session 13: Synapsida
Meeting Room Nicollet D
Moderators: Caroline Abbott and Alexander Acker

- 8:00 K.D. Angielczyk** Changing perspectives on the synapsid evolutionary radiation and the evolution of mammals
- 8:15 N. Cochran, J. Anderson** Reexamination of hypothesized sexual dimorphism in the Early Permian non-mammalian synapsid *Dimetrodon limbatus*
- 8:30 M.M. Mercado, R.B. Benson, K.D. Angielczyk** A Micro-CT based reconstruction of *Tetraceratops insignis* (Synapsida; Eupelycosauria) and new insights into its taxonomy and biology
- 8:45 A. Duhamel, B. Wynd, A. Wright, A. Moopen, J. Benoit, B.S. Rubidge** Rethinking therapsid phylogeny: Bayesian and cladistic analyses of early-diverging Therapsida
- 9:00 E.A. Warshaw** Constraints and drivers of the ecomorphological evolution of Permian synapsid carnivores
- 9:15 J. Pardo, K.D. Angielczyk** Tradeoffs between the secondary palate and vomeronasal organ in dicynodonts
- 9:30 H.N. Thomas, B.R. Peacock** Lawless teeth indeed: repeated reversals of edentulousness in dicynodont therapsids
- 9:45 C.F. Kammerer, R.M. Araújo, B.S. Rubidge, Z. Macungu, N. Chambule, A. Massingue, K.D. Angielczyk** A new emydopoid dicynodont from the middle Permian of the Karoo Basin and the systematics of the Kingoriidae
- 10:15 B. Shipps, C.A. Sidor, K.D. Angielczyk** A new, large-bodied species of *Dicynodontoides* (Synapsida: Anomodontia: Emydopoidea) from the base of the Usili Formation (Ruhuhu Basin, Tanzania) with comments on tetrapod biozonation in the formation
- 10:30 A. Brant, C.A. Sidor** Cross-sectional area of the maxillary canal suggests acutely developed facial sensation in gorgonopsians.
- 10:45 A.L. Acker, M. Whitney, B.R. Peacock, C.A. Sidor** The first occurrence of *Cyonosaurus* (Gorgonopsia) from the Luangwa Basin of Zambia
- 11:00 C.A. Sidor, A. Mann** A new species of *Arctops* (Therapsida: Gorgonopsia) from the upper Madumabisa Mudstone Formation of Zambia, with new information on gorgonopsian postcranial anatomy
- 11:15 C.P. Abbott, K.D. Angielczyk** A bottom-up revision of *Lystrosaurus* (Therapsida, Dicynodontia) species in the Karoo Basin, South Africa
- 11:30 P.A. Viglietti, K.D. Angielczyk, A. Huttenlocker, J. Botha, R.M. Smith, J. Crowley, C. Browning, T. Seerane, C.P. Abbott** Testing models of biotic survival and recovery from the Permo-Triassic mass extinction and climate crisis
- 11:45 B.P. Stuart, A. Huttenlocker, F.P. Wolvaardt, V. Fernandez, J. Botha** New exceptionally-preserved specimens of *Microgomphodon oligocynus* offer novel insights into the ecomorphology of the most derived therocephalian (Synapsida: Therapsida)
- 12:00 J. Ren, F. Mao** New tritylodontid specimen from Wucuiwan area of Xinjiang, China, and the revised phylogeny of Tritylodontidae

Friday Afternoon, November 1, 2024
Technical Session 14: Paleobiology: evolution, ecosystems, taphonomy, & traces
Meeting Room Nicollet B/C
Moderators: Chandelé Montgomery and Sadie Sherman

- 1:45 T.R. Simoes** The pervasiveness of constructive radiations during evolutionary transitions across deep time and space
- 2:00 P.E. Olsen, Y. Fang, J. Sha, B. Slibeck, C. Chang, B. Wang** Paleoarctic vertebrate and invertebrate assemblages from lakes with winter ice from the Late Triassic-Early Jurassic Junggar Basin of northwestern China
- 2:15 C. Montgomery, K. Dollman, A.B. Heckert, J.P. Hancox, J. Choiniere** Comparative morphology and composition of Olenekian coprolites using 3D X-ray imaging
- 2:30 G. Freeman Peters, J.C. Stock, G.S. Raun, N.E. Morley, D. Brinkman, L.R. Leighton** Methods for describing paleoecological change in the Late Cretaceous Oldman, Dinosaur Park, and Horseshoe Canyon Formations of Alberta, Canada.

- 2:45 **L. Zugschwert, M. Luft, K. Curry Rogers, R. Rogers** Documenting tiny feeding traces on small bones from vertebrate microfossil bonebeds, Upper Cretaceous Judith River Formation, Montana
- 3:00 **S.M. Sherman, H. Petermann, T. Lyson** Relative abundance of macrovertebrates from the early Danian of Colorado shows evidence for niche partitioning just after the end-Cretaceous mass extinction
- 3:15 **T.W. LaBarge, J.K. Njau** The neoichnology of *Nihilichnus* in the Serengeti
- 3:30 **P. Ullmann, A. Drewicz, E.R. Goldsmith, J. Gallucci, A. Tumarkin-Deratzian, D. Terry, R. Ash, D. Grandstaff** Illuminating the variability, utility, and limitations of diffusion modeling of trace element concentration profiles in fossil bones
- 3:45 **A. Ovando, B.W. Schubert** The Pleistocene vertebrate paleontology of Belize: Results from the first paleontological resource assessment in Belize
- 4:00 **J.R. Moore, C.M. Redman, R. Souberlich, Y. Sarubbi Jacks, C. Colman, I.S. Hutchinson, A.D. Apgar, K. Bosch** Future fossils on fans: The taphonomy of modern remains on the Pilcomayo fan, Paraguay, with insights into temporal and spatial averaging and environmental fidelity

Friday Afternoon, November 1, 2024
Technical Session 15: Jurassic & Cretaceous Herpetology
Meeting Room Nicollet A
Moderators: John Fortner and Eric Wilberg

- 1:45 **J. Atterholt, M. Wedel, J. Benito, D.J. Field** Evidence of paramedullary diverticula in extinct ornithomirans
- 2:00 **H. Chen, S. Jiang, A.W. Kellner, X. Wang** New insights into pterosaur cranial anatomy: X-ray imaging reveals palatal structure and evolutionary trends
- 2:15 **S.L. Baumgart, M.B. Habib, M. Brown, E.R. Schachner** How special are pterosaurs? Comparing cross-sectional structure of pterosaur humeri to that of birds
- 2:30 **C. Caputo, T. Cullen, Z. Haibo** Applying isotopes to the pterosaur fossil record (Ornithocheiridae) to understand their movement patterns
- 2:45 **F.R. O'Keefe, E. Armour Smith, R.A. Otero, P. Trask** A new genus of elasmosaur from the Santonian Haslam Formation of Vancouver Island, British Columbia, with aristonectine-like postcranial adaptations
- 3:00 **E. Wilberg, R.V. Hill, E.M. Roberts, M.A. O'Leary** A new pepesuchine peirosaurid (Crocodyliformes, Notosuchia) from the Early Cretaceous of Mali
- 3:15 **B.S. Salem, S. Saber, K. Ouda, A.S. Gohar, S. El-Sayed, H. Sallam** A new long-snouted dyrosaurid (Crocodyliformes, Mesoeucrocodylia) from the Campanian of Egypt
- 3:30 **H.J. Allen, E. Wilberg, A.H. Turner** An intriguing new neosuchian crocodyliform from the Upper Cretaceous (Maastrichtian) Maevarano Formation of Madagascar
- 3:45 **J.D. Fortner, K. Middleton, C. Holliday** Comparative functional morphology and intramandibular biomechanics of *Alligator*, *Majungasaurus*, and *Tyrannosaurus*
- 4:00 **F.E. Novas, F. Agnolin, S. Rozadilla, A. Aranciaga-Rolando, N. Chimento, M. Motta, M. Manabe, T. Tsuihiji, M. Isasi, D. Pol** Paleontological discoveries in SW Argentina: New insights into the end of the Dinosaur Era in South America

Friday Afternoon, November 1, 2024
Technical Session 16: Mammal Evolution
Meeting Room Nicollet D
Moderators: David Grossnickle and Nick Thurber

- 1:45 **S.S. Strassberg** Clade-specific relationships and cranial suture complexity in mammals **-WITHDRAWN-**
- 2:00 **A. Breyak, H.C. Fricke, J. Wainwright, S. Blumenthal, K. Chritz, T. Lyson, D.W. Krause, S.G. Chester** A stable isotope-based investigation of mammalian paleoecology across the Cretaceous/Paleogene boundary in the Denver Basin, Colorado, U.S.A.
- 2:15 **N. Thurber, R. Motani** The efficiency of three forelimb joints and its correlation with habit specialization in extant mammals

- 2:30 C. Badgley, M.E. Morgan, D. Pilbeam, L. Flynn, A.K. Behrensmeyer** Does global warming past or present create uninhabitable regions for mammals?
- 2:45 D. Fraser, B. Hunter-Moffatt** Mammal dispersal among tectonically active and quiescent regions of North America
- 3:00 K. Beard, R.L. Anemone, M.F. Jones** Later Clarkforkian (latest Paleocene) mammals from the Great Divide Basin (southwestern Wyoming) and a revised biozonation scheme for the Clarkforkian NALMA
- 3:15 D. Grossnickle, R. Ely, S. Santana, G. Slater** Early burst radiations are more commonly observed in comparative studies that sample fossils, are phylogenetically broad, and use ecomorphological traits
- 3:30 R. Secord, A.E. Chew, C.C. Gilbert, S.G. Chester, K.D. Rose** Paleoenvironments across the onset of the Early Eocene Climatic Optimum in the Wind River and Bighorn basins, Wyoming, USA – inferences from stable carbon isotopes in fossil mammals
- 3:45 A.K. Behrensmeyer, N. Roach, K.G. Hatala** Body fossils versus footprints – Investigating the taphonomy and paleoecology of contrasting records of a Pleistocene vertebrate community in the Turkana Basin, Kenya
- 4:00 P.Z. Barrett, J. Rowan, T.M. Smiley** Functional and taxonomic turnover are decoupled across the Neogene mammalian record of eastern Africa

Friday Afternoon, November 1, 2024

REGULAR POSTER SESSION 3

Meeting Room Exhibit Hall

Authors must be present from 4:30 – 6:30 p.m. on Friday, November 1

- B201 M.M. Candlen, F.S. Wilhelm** The *Podokesaurus* Project: Rediscovering Holyoke's swift-footed lizard
- B202 E.D. Johnson-Ransom, A. Lopez-Vaca, T.C. Wyenberg-Henzler, E. Snively, P.C. Sereno** Craniocervical morphology and feeding function in Spinosauridae (Dinosauria: Theropoda)
- B203 A. González Pérez, D. Vidal, M. Ciudad Real Ballester, Á. Simarro Cano, P.C. Sereno** Three-dimensional skeletal reconstruction of *Afrovenator abakensis* (Theropoda: Megalosauroidea) from Niger, West Africa
- B204 L.A. Maddox, M. Loewen** Pathologic and taphonomic history of the largest known specimen of *Allosaurus jimmdseni* from the Upper Jurassic Morrison Formation of Wyoming
- B205 K.L. Durrant, J.E. Diepenbrock, L.A. Vietti** A re-analysis of Reeds Allosaur, applying new methods to a historic specimen
- B206 C. Griffin, A.W. Poust, J.E. Bugos, Z.S. Morris, H. Petermann, M. Fabbri, C. Colleary** Assessing the ontogenetic maturity of the '*Nanotyrannus lancensis*' holotype with hyoid osteohistology
- B207 T.C. Wyenberg-Henzler, J. Scannella** Behavioral implications of a tyrannosaurid tooth embedded in an articulated skull of *Edmontosaurus* from the Hell Creek Formation, Montana
- B208 A. Lopez-Vaca, E.D. Johnson-Ransom, E. Snively** FEBio: Free Finite Element Analysis software for biomechanical analysis tested using megatheropods analysis replications and multi-step analysis of the puncture-pull feeding strategy of *Tyrannosaurus rex*
- B209 J. Slowiak, T. Szczygielski** Skull ontogeny of *Tarbosaurus bataar*
- B210 K.W. Schirmacher, A. Scotti, P. Makovicky, J.R. Hutchinson, X. Yao, X. Xu, S.H. Burch** Use of musculoskeletal models to estimate optimal postures and potential functions of tyrannosaur forelimbs
- B211 J.T. Voris, F. Therrien, C. Coppock, D.K. Zelenitsky** New tyrannosaurid material from the marine Bearpaw Formation of Alberta sheds light on the turnover between Judithian and Edmontonian faunas in northern Laramidia
- B212 L.A. Rooney, J. Anné, K.B. Donnelly** Unique pathology on a pedal claw of *Gorgosaurus* sp. (TCM 2001.89.1)
- B213 C.W. Garros, J.T. Voris, H.S. Sharpe, F. Therrien** A myriad of maladies: costal, vertebral, appendicular, and severe cranial pathologies in a large individual of *Gorgosaurus* (Theropoda: Tyrannosauridae) from the Upper Cretaceous Dinosaur Park Formation of Alberta, Canada
- B214 K. Tanaka, T. van der Linden, F. Therrien, D.K. Zelenitsky** An unusual adaptation in the eggshell of a non-avian maniraptoran dinosaur

- B215 A.K. Hastings, J.G. Westgaard, H.D. Hanks, J. Korf, P. Makovicky** First record of non-avian Maniraptora (Theropoda) from Minnesota (USA)
- B216 C.M. Brown** Dromaeosaurid feeding traces on multiple ornithomimid skeletons and isolated bones from the Dinosaur Park Formation (Campanian) of Alberta, Canada.
- B217 R. Jorgensen, M. Loewen, J.I. Kirkland, D.D. DeBlieux, L.E. Zanno** Reassessment of *Yurgovuchia* pelvic material and Theropod diversity in the lower Yellow Cat Member of the Cedar Mountain Formation of Central Utah
- B218 K.A. Beguesse, W.J. Freimuth, L. Herzog, L.E. Zanno** A survey of paleopathologies in the Early Cretaceous therizinosaurian *Falcarius utahensis* from the Crystal Geyser Quarry, Utah, USA
- B219 Y. Kobayashi, T. Chinzorig, A. Fiorillo, K. Tsogtbaatar, R. Barsbold** Functional morphology and adaptive implications of manual unguals in a therizinosaur with didactyl hand from southern Mongolia
- B220 D.K. Smith** Forelimb biomechanics of the derived therizinosaur *Nothronychus* from the Upper Cretaceous of Southern Utah
- B221 A.N. Naskov, J. Scannella** A partial caenagnathid (Theropoda: Oviraptorosauria) hindlimb from the uppermost Cretaceous Hell Creek Formation, Montana, suggests ontogenetic changes in cursoriality
- B222 M.T. Silcox, D.S. Gawlak, M. Lang, I. Ruf** Revisions to our understanding of the endocranial anatomy of *Carcinella sigei* (Apatemyidae, Euarchontoglires)
- B223 I.K. Lundeen, E.C. Kirk, B. Rodwell** Renewed vertebrate fossil collection in the Aycross Formation, Hot Springs Co., WY
- B224 K.O. Malmberg, W.E. Worrell, L.A. Vietti** A collections-based survey of the distribution and occurrence rates of *Microsypops* sp. dental caries in Wyoming
- B225 P.D. Rhinehart, K. Beard, R.L. Anemone** An anachronistic assemblage of omomyid primates from the early Eocene Wasatch Formation, Great Divide Basin, Wyoming, U.S.A.
- B226 K.L. Rust, K. Tietjen, K. Beard** Quantitative and qualitative analyses of dental morphology in an anaptomorphine (Omomyidae) lineage reveal patterns of mosaic evolution in early primates
- B227 M.R. Walker, R. Nockerts, D.L. Fox, K.P. McNulty** Using stable isotopes to deduce context clues and evaluate dietary ecology from a collection of historic cercopithecoid skeletons from Lake Victoria
- B228 C. McCraw, D. Flores, S. Hopkins** Reevaluating species level variation in 2-Dimensional morphometric analysis of the first molars of cricetid rodents
- B229 F.T. Mullally, D. Flores, S. Hopkins** 2D morphological analysis of squirrel molars and the implications on taxonomy
- B230 D.C. Kalthoff, V. Winkler, G. Daxner-Höck** Unveiling the oldest *Hystrix*: a comprehensive study of *Hystrix parvae* from Kohfidisch, Austria
- B231 B. Rodwell, E.C. Kirk** A new genus of cylindrodontid rodent from the Middle Eocene Devil's Graveyard and Laredo Formations in Texas
- B232 M.R. Wyatt, J.J. Calède, T.M. Smiley** Evidence for a spatial range expansion of the Miocene-aged heteromyid *Schizodontomys harkseni*: implications for the biogeographic ranges of Heteromyidae (Rodentia)
- B233 A. Chao, A. Brant, C.A. Sidor** Novel aspects of maxillary canal anatomy in a Zambian gorgonopsian revealed by high-resolution CT scanning
- B234 Y. Tse, L.A. Norton, B.P. Stuart, A. Huttenlocker** Ontogenetic changes in the structural performance and morphology of the mandible of *Theriognathus microps* (Therapsida: Therocephalia)
- B235 C. Schulte, N.J. Tabor, C. Flis** Isotope-based assessment of trophic relationships amongst Early Permian vertebrate fauna from Baylor County, Texas
- B236 M.L. Gold, T. Vasquez, P.M. Gignac** Using a novel imaging pipeline to assess cause of death in a zoo budgerigar (*Melopsittacus undulatus*), with implications for image analyses in preserved specimens
- B237 Z. Perry, D.A. Orme, E.G. Hyland, L. Hall, S.A. Williams, M. Schweitzer, J. Scannella** Taphonomy and taxonomic diversity of "Happy Mary," a polytypic bonebed from the Cretaceous Judith River Formation of Montana, USA

- B238 Z.D. Tenney, W.E. Worrell, J. Slattery, J. Cavigelli** Diversity and taphonomy of the Upper Cretaceous Mesaverde and Lance formation's vertebrate faunas in Wyoming: A collection-based analysis of the University of Wyoming Geological Museum and Tate Geological Museum vertebrate paleontology collections
- B239 A.D. Apgar, I.S. Hutchinson, C.M. Redman, R. Souberlich, Y. Sarubbi Jacks, C. Colman, K. Bosch, J.R. Moore** Where have all the good bones gone? Comparing modern and fossil vertebrate preservation under the fluvial Megafan Model
- B240 R. Dunn, A.B. Heckert, J.R. Foster, R.K. Hunt-Foster** Super Charger Heaven: A freshwater microvertebrate assemblage from the Upper Cretaceous (Edmontonian), Williams Fork Formation of northwestern Colorado
- B241 J.S. Mitchell, A. Morse, C. Gabriel, P. Makovicky, L.E. Zanno, J. Hedge** A New Microsite from the Mussentuchit Member of the Cedar Mountain Formation, Utah
- B242 B.H. Lauer, C.J. Duffin, D.J. Ward, R. Lauer** Vertebrate coprolites from the Maastrichtian phosphates (Late Cretaceous) of Morocco
- B243 I.S. Hutchinson, C.M. Redman, R. Souberlich, Y. Sarubbi Jacks, C. Colman, A.D. Apgar, K. Bosch, J.R. Moore** The trace assemblage of the Pilcomayo megafan and insights into the terrestrial trace fossil record
- B244 J. Korf, J.G. Westgaard, A.K. Hastings, H.D. Hanks** Vertebrate trace fossils of the Coleraine Formation at Hill Annex Mine State Park, Calumet, Minnesota (USA)
- B245 J.N. Crouch, A.B. Heckert, B.H. Lauer, R. Lauer** Coprolite ichnotaxa from the Revueltian (Upper Triassic: Norian) age Homestead Site, Garita Creek Formation, east-central New Mexico, U.S.A.
- B246 H. Inaba, K. Chiba, M. Saneyoshi, T. Miyaji, A. Kawakami, M. Eda, M. Tanaka, Y. Kobayashi, K. Tsogtbaatar, H. Tsujigiwa** Potential taxonomic implications of endogenous ancient proteins in vertebrate fossils from the Paleogene Ergilin Dzo Formation, Mongolia
- B247 J.M. Christensen, T. Bown, K. Nichols** An unusual occurrence of fossil vertebrate remains in the lower Eocene Willwood formation of NW Wyoming, USA
- B248 M.R. Kringstad, P. Ullmann, D. Terry, N.A. Famoso** Soft tissue preservation in Cenozoic fossils from John Day Fossil Beds National Monument, Oregon
- B249 G. DeVault, A.K. Hastings, C. Iverson, M.G. Brandel** Let it snow: A deep dive into Minnesota's Pleistocene-Holocene Transition faunal assemblage
- B250 A. Boville, J. Jacisin, M. Kemp** The state of Quaternary vertebrate paleontology research in the Caribbean: areas of rigor and opportunities for growth
- B251 G. Panasci, D.J. Varricchio, J. Prall** The Frontier Formation of southwestern Montana: a new paradigm to understand the middle Cretaceous transition and faunal provincialism of North America
- B252 D.M. Peltier** Volcanism and vertebrate evolution: insights from multi-agent based modeling
- B253 J. Robinson** Ouchies and boo boos: A survey of northern Laramidian pathologies using differential diagnoses for a quantitative dataset
- B254 J.R. Milligan, Y. Wu, E. Bamforth, R.L. Sissons, J. Sweder, N. Campione, P.R. Bell, C. Sullivan** New *Champsosaurus* sp. (Diapsida: Choristodera) material from the Campanian Wapiti Formation of northern Alberta, Canada
- B255 H.D. Hanks, J.G. Westgaard, A.K. Hastings, J. Korf** Early insights into new additions to the Marine Reptile fauna of Late Cretaceous deposits within the Coleraine and Windrow Formations of Minnesota
- B256 R.O. Clark, F.R. O'Keefe** Predatory ecomorphology of *Unktaheela specta*, smallest polycotyloid of the Western Interior Seaway
- B257 V. Singh, M. DeBlois** Phylogeny constrains distal propodial cross-sectional shape in plesiosaurs
- B258 M. Marx, R. Szász, M.E. Eriksson, B. Kear, S. Sachs, J. Lindgren** Assessing the hydro- and thermodynamic capabilities of long-necked plesiosaurs using computational fluid dynamics
- B259 B.A. Clark, Z. Hannebaum, D.J. Varricchio** Digital rendering of a unique turtle specimen from the Blackleaf Formation, Montana
- B260 D. Ehret, C. Langel, D.G. DeMar, R.K. Denton, M.T. Carrano** A Late Cretaceous (Campanian) chelydroid turtle from the Ellisdale Fossil Site, New Jersey, USA

- B261 R. Buchmann, T. Rodrigues** The location of pneumatic foramina in pterosaur vertebrae is constrained by biomechanical stresses
- B262 K. Miller, N. Zoller, M.B. Habib, H.C. Larsson, T.A. Dececchi** Terror from the skies? Investigating the energetics and feeding ecology of the largest pterosaurs *Quetzalcoatlus*
- B263 M. McKeown, M. Young, S. Brusatte, E. Wilberg** The evolution of aquatic adaptations in metriorhynchoid skulls (Crocodylomorpha, Thalattosuchia)
- B264 Z.G. Cooper, D. Fowler, J. Scannella** A new, large specimen of *Brachychampsia* (Archosauria: Crocodilia) from the uppermost Cretaceous Hell Creek Formation, Montana
- B265 T. Nolan** A seasick crocodile: Goniopholidid postcrania from the marine Austin Group of north Texas
- B266 B. Rakotozafy, P.M. O'Connor, J. Groenke, A. M. M. Nivoharimanana** Ecomorphology and paleoecology of notosuchian crocodyliforms from the Late Cretaceous (Maastrichtian) Maevarano Formation, Madagascar
- WITHDRAWN-**
- B267 J.R. Lively, M. Toscanini** New vertebrate body and trace fossils from the Upper Cretaceous (Campanian) Neslen Formation, Utah, USA
- B268 S. Hopkins** Exploring the macroevolutionary ratchet in burrowing mammals using phylogenetic and paleontological approaches
- B269 K.E. Samonds, N.B. Simmons, S.M. Goodman, J.L. Alumbaugh, S.J. Hand, M.T. Irwin, N. Rasolofomanana, G.F. Gunnell** Oldest record of Cenozoic terrestrial vertebrates (Chiroptera) from Madagascar
- B270 M.F. Jones, J.R. Baez** The early middle Eocene bat fauna of Powder Wash, Utah, USA
- B271 A. Vohs, L.N. Weaver, S.G. Chester, T. Lyson** A perplexing new peripitychid mammal specimen from the lower Paleocene D1 sequence of the Denver Formation of Colorado (Corral Bluffs, El Paso County)
- B272 S. Reynolds, B.Z. Foreman** Paleoenvironmental patterns in mammal fossil localities of the Fort Union and Willwood Formations, Bighorn Basin, Wyoming, USA
- B273 J.C. Johnson, R. Secord** Taxonomy and biostratigraphy of the tillodont *Esthonyx* (Mammalia) from the lower Eocene of the Bighorn Basin, Wyoming, U.S.A.
- B274 S.V. Olson, E.C. Kirk** A new zambodont apternodontid from the early Chadronian of Trans-Pecos Texas
- B275 A.A. Rock, W. Godwin, P.J. Lewis** A comparison of Miocene faunas from East Texas
- B276 M. Ameen, S.G. Abbas, A. Khan** New fossil remains of the Lower Siwalik (Middle Miocene) mammals from northern Pakistan
- B277 O. Ksila, F. Lihoreau, K. Aridh, F. Melki** A typical pre-evaporitic Messinian fauna in southeast Tunisia
- B278 A. Shupinski, M. Craffey, F.A. Smith, K. Lyons** Different mammals, same structure: co-occurrence structure of North American mammal paleocommunities across the Plio-Pleistocene transition
- B279 J. Glöggler, R.M. Muriuki, A.K. Parker, D. Burgas Riera, J. Saarinen, M. Cabeza Jaimejuan, R. Kinyanjui, I. Zliobaite** Associations between mammal and plant communities in the Plio-Pleistocene of the Omo-Turkana Basin and their evolution through time
- B280 K. Marano, A.W. Haveles, D.L. Fox** Reconstructing Late Pliocene and Pleistocene paleoenvironments using taphonomy
- B281 M.G. Brandel, A.K. Hastings, G. DeVault, R. White** Lost bones: Rediscovering county museum specimens to enrich Minnesota's Quaternary fossil record
- B282 C.J. Hohman, A.C. Dooley, E. Scott, B.L. Beatty** Late Pleistocene fauna of Lake Elsinore (Riverside County, California) and observations on the timing of Pleistocene faunal extirpations
- B283 J.R. Dallmer, P. Lopez de Cardenas, J.E. Cohen, W. Binder** Pit wear and tear: unearthing taphonomic trends at Rancho La Brea Tar Pits
- B284 D. Flores, N.A. Famoso, S. Hopkins** Screenwashed vertebrate assemblage from Campbell Ranch, Oregon, reveals additional small mammal diversity

Saturday Morning, November 2, 2024
Technical Session 17: Theropoda II
Meeting Room Nicollet B/C
Moderators: Chinzorig Tsogtbaatar and Charles Woolley

- 8:00 R. Pei, X. Xu** Quantitative analyses reveal divergence and convergence of ecomorphological features in non-avian paravian dinosaurs
- 8:15 C. Morrison, J. Gregory, C. Jackson, K. Schroeder, J. Bestwick, S. Gascoigne, P.D. Mannion, L.B. Porro, P. Bills, P. Barrett** Dental microwear analysis suggests inter- and intraspecific dietary partitioning as ecological mechanisms for high sympatric theropod dinosaur diversity and subsequent decline in the Late Cretaceous
- 8:30 D.J. Varricchio, H.J. Allen, J. Scannella** A new double clutch of *Prismatoolithus* eggs from the Cretaceous Two Medicine Formation of Montana and nesting site fidelity in non-avian dinosaurs
- 8:45 S. Wang, N. Ding, R. Yang** Insight into troodontid tooth attachment and replacement from a new *Urbacodon* (Theropoda, Troodontidae) from the Upper Cretaceous Iren Dabasu Formation, China
- 9:00 T. Chinzorig, Y. Kobayashi, J.G. Napoli, P.J. Currie, K. Tsogtbaatar, R. Barsbold, L.E. Zanno** New dromaeosaurid material from the Upper Cretaceous Nemegt Formation, Mongolia, reveals hidden diversity in the Nemegt Basin
- 9:15 J.G. Napoli, M. Fabbri, A.A. Ruebenstahl, J. O'Connor, B.S. Bhullar, M.A. Norell** Reorganization of the theropod wrist facilitated the origin of avian flight
- 9:30 J. O'Connor, H. Hu, M. Fabbri, P. Kuo, A. Clark, A. Shinya, C. Van Beek, M. Wang** Chicago *Archaeopteryx* reveals early transformations in the avian skull
- 9:45 Y. Uno, T. Hirasawa** The developmental origin of the propatagial muscle and its implication for the evolutionary process of the wing musculoskeletal system in theropods
- 10:15 A. Clark, J. Atterholt, N.R. Carroll, T. Carr, J. Scannella, J. O'Connor** New enantiornithine diversity in the Hell Creek and the functional morphology of the avosaurid tarsometatarsus
- 10:30 A. Chen, E. Steell, R.B. Benson, D.J. Field** Assessing phylogenetic congruence with a high-homoplasy phenotypic dataset: a case study using the avian pectoral girdle and forelimb skeleton
- 10:45 C.M. Early, S. Giles, D. Ksepka, D.J. Field** The Late Cretaceous neornithine *Asteriornis maastrichtensis* and avian olfactory bulb evolution
- 11:00 G. Musser, J. Clarke** A new Paleogene fossil and a new dataset for waterfowl (Aves: Anseriformes) clarify phylogeny, ecological evolution, and avian evolution at the K-Pg Boundary
- 11:15 M. Hanson, H.F. James** An ontogenetic study of the skeleton in Hawai'i's large extinct Quaternary waterfowl: Investigating the roles of paedomorphosis and selection for hindgut fermentation in the evolution of large, secondarily flightless island birds
- 11:30 C. Sullivan, K. Hatch, A. Katerenchuk, Y. Wang, J. Wong** Physical 3D model of partial ribcage confirms that avian uncinate processes act as levers for the appendicocostalis musculature
- 11:45 B.M. Rothschild, E. Mayle, G.C. Argyros** Eye of the beholder: Role of vascular plexuses in ocular thermoregulation in upper level vertebrates
- 12:00 C.H. Woolley, M. Cusack-Mercedez, N.D. Smith** Quantifying skeletal representation in the fossil record of birds and beyond: implications for using incomplete fossils in phylogenetic analyses

Saturday Morning, November 2, 2024
Technical Session 18: Carnivora & Co
Meeting Room Nicollet A
Moderators: Emily Bogner and Narimane Chatar

- 8:00 N. Chatar, M. Michaud, D. Tamagnini, V. Fischer** Evolutionary patterns of cat-like carnivorans
- 8:15 J. Hoefflich, J. Liu** Ears of an enigma: Reconstructing the hearing characteristics of the extinct American Cheetah, †*Miracinonyx trumani*, using dynamic finite element methods
- 8:30 G.J. Parker, R. Dunn, A. Farrell, E. Ghezzi, E. Lindsey** Size doesn't matter (as much as we thought): new discoveries from paleoproteomics demonstrate that morphometric analyses are not a reliable estimator of sex in extinct lions

- 8:45 **E. Ghezze, D. Cooper, A. Marciszak, R. Zomer, A.C. Kitchener, S. Malavasi, A. Trabucco, E.B. Davis** Probability distribution and palaeoecological preference of cave lions (*Panthera spelaea*) in Europe during MIS5-3
- 9:00 **A. Berger, R. Brown, A. Deutsch, A. Hartstone-Rose** Bite force and gape reconstruction of South African sabertooth and non-sabertooth felids
- 9:15 **B.R. Witt, A. Berger, A. Deutsch, A. Hartstone-Rose** Comparison of fossil coyotes of Rancho La Brea to modern coyotes reveals differences in dental morphology
- 9:30 **C.J. Salcido** Evolutionary lag between changes in diet and changes in jaw function in Cenozoic carnivores
- 9:45 **A.M. Pamfilie, N.S. Vitek** Comparisons among morphologies from modern and quaternary collections in a widespread mustelid (*Neogale vison*)
- 10:15 **E. Bogner, A. Savani, Z. Tseng** Hunting for an answer: new insights on the predatory ecomorphology of *Borophagus*
- 10:30 **A.A. Burt, N. Adams, F.F. Pigiere, D. Schreve** Dental microwear texture analysis reveals temporal and geographical variation in the dietary behaviour of grey wolves
- 10:45 **A. Deutsch, A. Berger, L. Martens, R. Smith, A. Hartstone-Rose** Myological and osteological approaches to gape and bite force reconstruction in *Smilodon fatalis*
- 11:00 **S.F. Al-Ashqar, M.R. Borths, H. El-Desouky, S. Heritage, M. Abed, E. Sieffert, S. El-Sayed, H. Sallam** Reevaluation of *Pterodon* in Africa
- 11:15 **A.E. Nelson** Mexican wolves are significantly different from all but one group of grey wolves (Eastern grey wolves) and have changed significantly morphologically in captivity
- 11:30 **F.F. Pigiere, D. Bista, A.A. Burt, A. Lamb, D. Schreve** Nature of the beast? Identifying drivers of prey choice, competition and resilience in wolves: a stable isotope approach
- 11:45 **A.R. Evans, W.J. Deakin, N. Chatar, P. Milla Carmona, D. Rovinsky, W. Parker, J.W. Adams, P. Donoghue, E. Rayfield, T. Pollock** Getting to the point of sabre teeth: functional optimality underpins the repeated evolution of extreme 'sabre-tooth' morphology
- 12:00 **L. DeSantis** Comparing dental microwear textures: prioritizing functional similarity over phylogenetic relatedness

Saturday Morning, November 2, 2024
Technical Session 19: Squamata & Co
Meeting Room Nicolle D
Moderators: Meghan Forcellati and John Jacisin

- 8:00 **G. Sobral, R.R. Schoch** Early lepidosauromorph diversity of southwestern Germany
- 8:15 **B.T. Kligman, A. Marsh, K.M. Melstrom, M.R. Stocker** Exceptionally diverse lepidosaur assemblage from the Late Triassic of equatorial Pangaea fills gap in squamate origins
- 8:30 **R.B. Benson, D. Ford, E. Griffiths, S. Evans** Evidence for clinging scansoriality in a stem lepidosaur from the Middle Jurassic of Scotland
- 8:45 **S.L. Olroyd, S. Singh, A. Huttenlocker, B.S. R** **WITHDRAWN** Degree of heterodonty among squamates and a morphometric approach to its underlying mechanisms
- 9:00 **I. Wilenzik, T.R. Simoes** Phylogenetic and biogeographic analysis of the Cretaceous squamate clade Polyglyphanodontia
- 9:15 **M.J. Scott, K. Brink, C.M. Brown** Cretaceous combat: Identifying trends in mosasaur cranial injury pathologies
- 9:30 **A.S. Schulp, M. Polcyn, J. Robbins, L. Jacobs** The ¹³C isotope record of 30 million years of mosasaur evolution
- 9:45 **A.R. Zietlow** Tylosaurine diversity informed by morphological variation in extant *Varanus*
- 10:15 **M.J. Powers, F. Garberoglio, M.W. Caldwell** Madtsoiidae revisited: review of putative synapomorphies and their distribution to redefine the clade
- 10:30 **J. Head, M. Lawing, F. Manthi, A.K. Parker, J. Boisserie, L.E. Roberts, K.P. McNulty, S. Cote, J. Müller** Younger giants: Reconstructing the evolutionary and ecological histories of *Python* (Serpentes: Pythonidae) in Africa

- 10:45 G. Georgalis, B. Mennecart** New squamate faunas from the late Paleocene and early Eocene of France reveal fascinating patterns of endemism, dispersals, and extinctions
- 11:00 M. Riegler, P.E. Morse, N.S. Vitek, P. Houde, J.I. Bloch** The fossil record of worm-lizards (Squamata, Amphisbaenia) across the Paleocene-Eocene Thermal Maximum of the Bighorn Basin, Wyoming
- 11:15 D. Rourke, M.J. Powers, M.W. Caldwell** Redescription of a Miocene Colubrid from West-Central Nevada using Micro-CT
- 11:30 J. Jacisin, C. Urban, T. Xu, A. Meza, A. Boville, C. Lawrence, M. Kemp** Cranioskeletal elements elucidate the tempo and mode of ecomorphological adaptive radiation in Greater Antillean *Anolis* lizards
- 11:45 M.R. Forcellati, A.T. Salis, R.B. Benson, C. Raxworthy** Using palaeogenomics to identify chameleon subfossils to species and determine community turnover in Madagascar
- 12:00 A. Howard, M.A. Hurtado Materon, J.A. Rivera, J. Zúñiga-Vega, E. Martins, M. Lawing** The evolution of climate tolerances and the shifting community composition of sympatric congeners of *Sceloporus* spiny lizards

Saturday Afternoon, November 2, 2024
Technical Session 20: SVP Saturday Spectacular
Meeting Room Nicollet B/C
Moderators: Erika Goldsmith and Emily Keeble

- 1:45 L.Y. Florsheim, N. Klein, K. Gelatt, J. Cox, M. Sander, L. Schmitz** Osteological evidence for supraorbital salt gland fossae in a new Middle Triassic cymbospondylid ichthyosaur from the Anisian Fossil Hill Fauna of Nevada
- 2:00 E.R. Goldsmith, D.E. Barta, B.T. Kligman, S.J. Nesbitt, A. Marsh, W.G. Parker, M.R. Stocker** Histology of a tiny phytosaur femur reveals unexpected growth patterns near the base of Archosauria
- 2:15 I. Pugh, M.R. Stocker, S.J. Nesbitt** A tale of loose teeth: using quantitative analyses for reconstructing phytosaur dentition
- 2:30 E. Keeble, S.J. Nesbitt** Tools for distinguishing the isolated and undistinguishable: a new digital protocol for identifying isolated teeth using Late Triassic Archosauriformes as case study
- 2:45 N.S. Whalen, T. Grejtak, T.C. Hunt, B. Krick, G.M. Erickson** Feeding habits of *Diplodocus* revealed through dental tribological analyses
- 3:00 J.E. D'Angelo** How to tell a tail: a review of the taxonomic utility of *Diplodocus* caudal vertebrae
- 3:15 D.J. den Ouden, J.X. Samuels** Inferring the dietary ecology of extinct shrews using a multifaceted approach

Saturday Afternoon, November 2, 2024
Technical Session 21: Cenozoic & Modern Herpetology
Meeting Room Nicollet A
Moderators: Adam Cossette and Laura Porro

- 1:45 M. Schaberg, A.K. Hastings, G. DeVault** Paleopathologic examination of the eusuchian crocodyliforms *Borealosuchus formidabilis* and *Wannaganosuchus brachymanus*, as well as the choristodere *Champsosaurus gigas*, from the Paleocene Wannagan Creek Site in western North Dakota (USA)
- 2:00 K. Lindblad, E. Bamforth, M.G. Mangano** Crocodiles of Pierced Rock: a rediscovered mid-late Paleocene fossil site in south-east Saskatchewan, Canada
- 2:15 A.P. Cossette, D.A. Tarailo** Crocodylian hyperdiversity during the early Eocene in the Golden Valley Formation of North Dakota, U.S.A.
- 2:30 D. Hoffman, R. Felice, E.R. Goldsmith, A. Houssaye, S. Maidment, P.D. Mannion** Osteohistology of the Eocene alligatoroid *Diplocynodon hantoniensis* informs growth in alligators and caimans
- 2:45 BREAK**
- 3:00 C.A. Brochu, A. Adams Tarailo** Disparate regional responses to climate change across the East African Rift Valley System: Insights from the late Miocene and Pliocene of Uganda
- 3:15 L.B. Porro, E. Galvez-Lopez, K. Sellers, C. Ross** The impact of sutures and ontogeny on mandibular mechanics in *Alligator mississippiensis*: implications for finite element modelling of fossil archosaurs

- 3:30 D. Hill, H.P. Tsai** Qualitative XROMM analysis of hip joint kinematics and soft tissue interactions in *Alligator mississippiensis* during low-walk locomotor behaviors
- 3:45 M. Pereyra, A. Chinsamy** Postcranial osteohistology and bone appositional rates of *Crocodylus niloticus* Laurenti, 1768
- 4:00 D.G. Cerio, G.S. Bever** The ancestral blink: assessment of abducens muscles and nictitating apparatus sheds light on turtle eye evolution

Saturday Afternoon, November 2, 2024
Technical Session 22: Paleontological Practices: Education & Outreach
Meeting Room Nicollet D
Moderators: Adam Hartstone-Rose and Veronica Waweru

- 1:45 E.D. Jones, J. Kanipe, H.M. Avrahami, T. Cullen, L.E. Zanno** Evaluating the efficacy of a public science project (Cretaceous Creatures) to educate and engage students in identifying vertebrate microfossils from the Upper Cretaceous Hell Creek Formation
- 2:00 E. Boll** Depictions of paleontology in three major American newspapers in the 1990s, a key period in the history of paleontological portrayals in the media
- 2:15 S.M. Lukowski, K. Greer, M. Thaler** Conducting learning assessments in an informal education setting to improve pedagogy and learning outcomes
- 2:30 V. Waweru, F.M. Kirera, A. Grossman, N.R. Malit, R. Kinyanjui, R. Kinyua** Paleoanthropology in the Central Highlands of Kenya: Education, indigene agency and knowledge co-production
- 2:45 J. Kanipe, E.D. Jones, H.M. Avrahami, T. Cullen, L.E. Zanno** Public involvement in the production of microfossil datasets: A case study of the biodiversity and methodology of the public science project Cretaceous Creatures
- 3:00 B.L. Matzen, D. Levering, N. da Silva, A. Smith** Change in student perception of science as a practice: an initial study from the Sternberg Museum of Natural History Paleontology Academy: Kansas summer program
- 3:15 A. Hartstone-Rose, J. Cerda-Smith, A. Deutsch** Paleontology in Cuvier's Paris: an international research experience for historically minoritized undergraduates aimed at broadening participation
- 3:30 D. Levering, L.E. Wilson, K. Schmelmer, P. Coelho, T. Finnegan** Rethinking the paleontology virtual fieldtrip with AI and metaverse technologies
- 3:45 L. Jones, M. Westfall** Conservation Academy: Digging Deeper, an introduction to museum conservation methods for 11-12 year-olds at the Lubbock Lake Landmark
- 4:00 E.M. Simpson, S. Bornheim, D. Levering, I. Trevethan** Changing expectations and perceptions in emerging paleontologists: introducing high schoolers to scientific excavation

Saturday Afternoon, November 2, 2024
REGULAR POSTER SESSION 4
Meeting Room Exhibit Hall
Authors must be present from 4:30 – 6:30 p.m. on Saturday, November 2

- B285 S. Lee, Y. Lee, J. Park, S. Kim** Bite marks on a small dromaeosaurid: intraspecific aggression?
- B286 K. Kubota, Y. Kobayashi, T. Ikeda** Early Cretaceous troodontine troodontid (Dinosauria: Theropoda) from the Ohyamashimo Formation of Japan reveals the early evolution of Troodontinae
- B287 G.A. Martínez-Ruiz, D. Fowler** An unusual ungual from the Hell Creek Formation, Montana: is the enigmatic theropod *Richardoestesia* a unenlagiine (Theropoda: Dromaeosauridae)?
- B288 T.A. Dececchi, H.C. Larsson, M.B. Habib, S. Hartman, M. Pittman** It's habit forming: examining the origins of prolonged and habitual use of powered flight in non-avian theropods
- B289 N. Zoller, K. Miller, M.B. Habib, H.C. Larsson, T.A. Dececchi** Flying through the air with the greatest of ease? Evaluation of glide capability in basal maniraptoran theropods
- B290 C. Woodruff, D. Hone, J. Simon, D. Evans** Heterocoely and the advent of preening in non-avian theropods: how a behavior contributed towards sexually selected feathers and the avian airfoil

- B291 G. Kinney-Broderick, G. Navalon, D.J. Field** Reinvestigating the appendicular skeletal morphology of *Confuciusornis* using high-resolution μ CT scanning
- B292 J.T. Deckhut, J.A. Case** Addition of morphospaces on the polar section modulus plot to determine the niche of *Antarcticavis capelambensis*
- B293 M.C. Dickson** Filling in the gaps: determining ranges of fossil birds with machine learning
- B294 I.J. Rivera-Molina, D.J. Field, D.A. Tarailo, L.E. Wilson** A new species of zygodactylid bird from the late Eocene Florissant Formation, Colorado
- B295 M. Jargalsaikhan, B. Munkh-Ochir, B. Minjin** Additional avian remains, including the first carpometacarpus, from the late Eocene Khoer Dzan locality of Eastern Mongolia.
- B296 R. Evenden, F. Anaya, D.A. Croft** Domain expansion: New occurrences of phorusrhacids, cariamids, and rheiformes (Aves) in the late Middle Miocene of Bolivia
- B297 L.N. Coultley, J. Clarke, P. Ward, E.B. Davis** Take to the skies: A new type species pushes back the origination of crown group albatrosses (Aves, Diomedidae)
- B298 S. Bornheim, S. Gatesy, M. López Martínez, M. Haber Uriarte, A. López Jiménez, G. Linares Matás, M. Walker** Inferring environmental conditions at a late Early Pleistocene site using avifauna
- B299 S.N. Davis, K.S. Bader** The Late Pleistocene avifauna of coastal Texas, USA
- B300 Q. Wu** Evolution and development of the furcular epicleidium and acrocoracoclavicular joint of birds
- B301 Y. Yamazaki, T. Yamasaki** Why do some flightless birds maintain feathers adapted for flight?
- B302 X. Zhang, B. Bai, Y. Wang, Z. Tseng** New materials of *Propterodon* (Hyaenodonta: Hyaenodontidae) from the middle Eocene of the Erlian Basin of Inner Mongolia, China
- B303 A.E. Kort** Finding ecological analogues for an extinct clade: The pelvic anatomy of hyaenodonts in comparison to extant mammals
- B304 J.A. Kapornekas, K. Nichols, T. Bown** Occurrences of fossil Carnivora and Creodonta in localities of the Lower Eocene Willwood Formation (~56-53 Ma), Bighorn Basin, Wyoming, USA
- B305 G.S. Raun, L.J. Cotton** An unusually complete *Cynodictis lacustris* from the Quercy Phosphorites and historical specimens of the Natural History Museum Denmark
- B306 A. Friscia, A.W. Poust, S. Tomiya** The *Miocyon* species complex and the first evolution of a large omnivore morphotype in carnivorous mammals
- B307 A. Littleton, S.K. Drumheller, C.A. Boyd** Middle and inner ear anatomy of the 32 Myo canid *Mesocyon* including the oldest known carnivoran ear ossicles
- B308 B. Hoole, B.W. Schubert** Evaluating morphological characters used to distinguish dire wolves from other canids
- B309 A. Hotchner, J. Meachen, R.H. Dunn** Bears will be bears: the scapholunar reflects phylogeny and function in the Ursidae
- B310 L. Koper, M.G. Crowell, S.J. Rahmat** Hear today, gone tomorrow: first record of ossicle descriptions from a fossil seal (*Leptophoca proxima*) using micro-CT technology
- B311 E. Restrepo-Cortes, J.S. Keller, F.A. Smith** From bobcats to sabercats: Dental (dis)similarity among modern and fossil felids in the Americas
- B312 J.E. Hargrave, J.E. Martin** A Pleistocene jaguar skeleton from Acadia Parish, Louisiana
- B313 M.H. Haji-Sheikh, V.L. Naples** Was *Smilodon fatalis* a gang member? Solitary ambush or social pursuit predator
- B314 J. Parham, J.X. Samuels** Geographic variation in carnivoran dentition in relation to environment
- B315 G.C. Argyros, S.A. Pepevnik, C. Jones** Skeletal pathologies in carnivores (Mammalia, Carnivora): A systematic survey of prevalence of skeletal disease and injury based on an analysis of museum specimens
- B316 J.A. Whitlock** Extrinsic eye musculature in the green Iguana (*Iguana iguana*): an exploratory study

- B317 F. Iftikhar, A. LeBlanc, M.W. Caldwell** Tooth development and resorption in squamates: a comparison of living Teiidae and fossil Mosasauridae
- B318 B. Faulkner, R. Motani** Morphological correlates for herbivory in extant lizard skeletons
- B319 C. Lawrence, J. Jacisin, A. Meza, M. Kemp** Using maxillary morphology to identify ecomorphological affinities in Jamaican *Anolis* lizards
- B320 E.D. Howerton, R. Leard, E. Sherratt, A. Bauer, J. Daza** Using the osteological postnatal development of *Sphaerodactylus townsendi* (Sphaerodactylidae: Gekkota) to evaluate variation in the Dominican Amber gecko *S. dommeli*
- B321 A. Steele, C.P. Bohus, A. Stroup, A. Clark, N. Carroll, J. O'Connor** Pronounced morphological diversity of squamates in a Hell Creek (Montana, USA) microsite
- B322 A.A. Cameron, T. Konishi, M.W. Caldwell** Description of a near-complete specimen belonging to the Late Cretaceous mosasaur subfamily Plioplatecarpinae (Squamata, Mosasauridae)
- B323 L. Chilver, J. Head** Osteological evidence for a re-entrant periotic system in the inner ear of the stem snake *Dinilysia patagonica* and the evolution of the crista circumfenestralis in snakes
- B324 H. Petermann, T. Lyson** A squamate fauna from the Early Danian of the Denver Formation of Colorado, USA, highlights ecosystem-disruption after the end Cretaceous mass extinction
- B325 H.A. El-Saka, M.S. Antar, A.S. Gohar, S. El-Sayed, H. Sallam** New materials of the family Palaeophiidae (Order Squamata) from the Eocene of the Fayum Depression, Egypt
- B326 K. Moon, I. Morales, I. Chen, K.B. Townsend, L. Stroik, P.C. Murphey, A. Friscia** Large varanid of the Uinta Formation, Utah and their place in the Uintan carnivore niche
- B327 M.F. Greaves, J. Head** A partial braincase from the Brule Formation (Orellan, Oligocene) of South Dakota reveals the presence of charinaiid snakes in North American Paleogene small booid faunas
- B328 H.E. Burch, D. Foffa, S.J. Nesbitt** Pulling teeth: Modeling correlations between crown height and body mass for determination of a functional trait from microfossils
- B329 H.M. Maddox, O.J. Singleton, S.K. Drumheller** Reptile taphonomy: decay, disarticulation, and paleontological implications
- B330 O.J. Singleton, H.M. Maddox, S.K. Drumheller** Seasonal variation effect on *Salvator merianae* decomposition and implication for reptilian mummification
- B331 J. Knoff, K.D. Mulcahy, K. Beard, G. Georgalis** The herpetological fauna of Eocene Balkanatolia
- B332 M. Wosik, M.L. Householder, C.A. Boyd** Osteohistological assessment of Cretaceous-Paleogene crocodylomorphs
- B333 S. Newsom, M. Riegler, C. Suarez, M.C. Vallejo-Pareja, J.R. Bourque, J.I. Bloch** Isolated ziphodont crocodyliform teeth from the Paleocene-Eocene of tropical South America
- B334 J. Nguyen, C.A. Brochu** A reassessment of the Eocene crocodylid *Asiatosuchus grangeri* and its implications on the phylogenetic relationships and evolution of Paleogene crocodiles
- B335 B.W. Nienaber, A.K. Hastings** Investigating fossil preservation in Alligator from the Miocene of Florida (USA)
- B336 Y. Cho, C. Tsai** Miocene crocodylians from Taiwan
- B337 M. Turala, B.W. Schubert, D. Gunnin, J.X. Samuels** Estimating *Alligator* body size based on skeletal remains, with application to the Gray Fossil Site of Northeastern Tennessee
- B338 K. Salih, J. Müller, A. Eisawi, F. Bibi** A new late Pleistocene fossil *Crocodylus* from Sudan
- B339 B.X. Jackson** Quantitative osteological ontogeny of alligatoroids
- B340 W.J. Hart, R.V. Hill, J.B. Bennington** A caudal vertebra from *Thecachamps* sp. (Crocodylia: Tomistominae) with comments on systematics
- B341 T.J. Stock, J. Parham** A well-preserved specimen of the stem-cheloniid *Pacificchelys urbinai* from the Upper Miocene Monterey Formation of California (USA) and the evolution of Pacific marine tetrapod dispersals during the Miocene

- B342 A. Gentry, M. Burns, J. Ebersole, K. Gregson, J. Parham** A leatherback marine turtle (Chelonioidea, Dermochelyidae) from the Lower Oligocene of the Gulf Coastal Plain of North America
- B343 M. Bhat, T. Cullen** Bone histology and life history of freshwater turtles (Testudines: Cryptodira)
- B344 A.M. Glass, C.A. Boyd** A morphological assessment of Paleocene champsosaurs from North Dakota, USA
- B345 D. Marjanović, S.N. Auste, F. Witzmann, N.B. Fröbisch** The Messel salamander, ?*Chelotriton robustus*
- B346 A.S. Fogelson, R.J. Gay** Jurassic Park and its consequences: the impacts of popular media on science communication and paleoart
- B347 J. McHugh** 30 years of insights from hands-on dinosaur digs and informal paleontology education at the Museums of Western Colorado
- B348 M.J. Benton** At the feet of the dinosaurs: undergraduate projects lead to more than 20 publications
- B349 B. Haiar** Immersive connections in geosciences: Paleontological field experiences and bridges to robust career training opportunities
- B350 R. Schmeisser McKean** Multi-level paleontology outreach: Instilling the value of science outreach at the undergraduate level
- B351 M.R. Acosta, O.H. Blomberg, L. Henn, J. Gardner, T. Hampton, D.M. Lovelace, F. Working Group** Citizen science: empowering Native youth through collegiate collaboration
- B352 M.L. Gold, B.A. Garner** A novel, scaffolded, station-based approach to learning anatomy and physiology
- B353 T. Keillor, P.C. Sereno, E. Fitzgerald, J. Schwartz** Fossil lab in a neighborhood: new connections, future visions
- B354 D. Anduza** Livestreaming as paleontological outreach: lessons from four years of real-time fossil science broadcasting
- B355 E. Apostolidis, E. Ghezzi, M. Peloso, E. Kustacher, A. Scarpa, M. Ferri, A. Santorello, F. Zaghis** Captivating young minds: How a comic book fosters children's interest in paleontology in Italy
- B356 T.A. Gates, A. Hurlbert, H. Vance-Chalcraft** Bringing paleontology citizen science into higher education
- B357 R.J. Gay, D. Barclay, A.S. Fogelson** Assessing educational outcomes with single-interaction outreach: towards a natural history outreach evaluation model
- B358 J. Person, C.A. Boyd, B. Barnes** The scientific and economic impacts of 25 years of public fossil digs at the North Dakota Geological Survey
- B359 A.S. Rea, E. LaCount, A.L. Atwater** Day Camp based education of geological and paleontological sites of the Dinosaur Ridge Fossil Area
- B360 E. Bamforth, J. Sweder** April Archosaur Absurdity: a seasonal online program featuring science, paleoart, school programming, and public outreach
- B361 O.H. Blomberg, D.M. Lovelace, S. Hartman, A.M. Kufner** Advantages of 3D models in science education and outreach: example from the Popo Agie Formation
- B362 M.A. Chiappone, V.J. Radermacher, M. Son, C. Scotese, P. Makovicky** Using 3D paleotopographic maps to explore tectonics and sea level change in museum and classroom settings
- B363 D. Vital** Paleontology at the junior level: engaging adults in paleontological thinking in professional learning focused on inclusion, diversity, equity, and access, in formal and informal educational contexts
- B364 A.K. Hastings, J. Holm, E. Stallnick, J. Groenert, B. Rohde, N. Dzenowski, G. DeVault** Assembling a dinosaur assembly: Development of dinosaur-themed STEM content for grades 3–5
- B365 C. Hogan, A.E. Hall, L. Hall, J. Scannella, K. Kuhn** MOR than puppets: Best practices in creating dynamic dinosaur ambassadors
- B366 L. DeSantis, D. Weintraub** Inspiring young minds through STEM: The “Who Me?” Project
- B367 F.J. Shuster, C. Visaggi, R. Spears** Victims of the “Big 5” and modeling threats of the sixth extinction: Science communication by upcycling waste into art

- B368 S.C. Hurrell, L.A. Vietti** New material of '*Crocodylus*' *affinis* (Crocodyloidea) from the Eocene Bridger Formation of Wyoming

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

First discovery of hog deer antler from the Pleistocene deposits of Panjan Sher Shahana, Punjab, Pakistan

Aabbas, Sayyed Ghyour¹, Croitor, Roman², Babar, Muhammad Adeeb³, Khan, Muhammad A.⁴, Yasin, Aamir⁵

¹Zoology, University of Sialkot, Sialkot, Punjab, Pakistan, ²Ministry of Culture, Education, and Research, Chisinau, Moldova (the Republic of), ³Zoology, University of Okara, Okara, Punjab, Pakistan, ⁴Zoology, University of the Punjab, Lahore, Punjab, Pakistan, ⁵Pakistan Museum of Natural History, Islamabad, Federal, Pakistan

The Pleistocene deposits of the Siwalik Group offer remains of life forms that can be directly compared with the present-day species of the Indian subcontinent either as extant member or their extinct relatives. We are describing a newly discovered shed antler, found from the Pleistocene deposits of Panjan Sher Shahana Pabbi Hills, Pakistan, that afford similarity with the extant deer species hog deer (*Hyelaphus porcinus*). This represents the first ever discovery of a hog deer antler from the Siwalik Group of the Indian subcontinent. This discovery of the antler offers new insight in the evolutionary history of this particular representative of the Indian subcontinent fauna. The morphological peculiarities of the antler allowed us to describe it as *Hyelaphus porcinus*, supported by cluster analysis. The discovery of this deer species new to the Siwaliks reveals the paleobiogeographic connection of the Indian Subcontinent with Sundaland. Also, we provide a brief history and paleobiogeography of this species with the help of the described antler and published literature.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

A bottom-up revision of *Lystrosaurus* (Therapsida, Dicynodontia) species in the Karoo Basin, South Africa

Abbott, Caroline P.¹, Angielczyk, Kenneth D.²

¹Committee on Evolutionary Biology, The University of Chicago, Chicago, Illinois, United States, ²Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Lystrosaurus is among the most iconic survivors of the End Permian Mass Extinction (EPME) due to its broad geographic distribution and abundance. Thousands of *Lystrosaurus* specimens have been collected over the past 150 years, sampling across taxonomy, ontogeny, and taphonomy. Its fossil record is especially rich in the Karoo Basin, South Africa, where it has used to investigate a variety of questions related to biostratigraphy, biogeography, paleoecology, and life history in the context of the EPME. However, this work is complicated by unresolved issues in *Lystrosaurus* taxonomy. Over 27 species were named in the Karoo Basin alone, largely based on deformation mode, ontogeny, and locality. Today, four species are recognized: *L. curvatus*, *L. maccaigi*, *L. declivis*, and *L. murrayi*, yet they also suffer from bias due to deformation and ontogenetic stage. Here we present a new bottom-up approach to remedy issues of *Lystrosaurus* taxonomy. We surface scanned roughly 140 *Lystrosaurus* crania and measured 19 characters for each. To quantify taphonomic effects, we scored four deformation metrics on a numerical scale, and three discrete characters commonly used to diagnose species, but are highly subject to deformation. We used basal skull length and bone histology (when available) as additional measures of ontogenetic stage. We ordinated these data to visualize taphonomic, ontogenetic, and taxonomic groupings among

specimens. Our results highlight the need for taxonomic revision in Karoo *Lystrosaurus*. There is relatively low variation between specimens attributed to *L. declivis* and *L. murrayi*, aside from size and deformation mode, indicating that these taxa may be synonyms. Without added information, such as body size, *L. curvatus* specimens group with juveniles of the other three species because *L. curvatus* lacks features that change over ontogeny in other species. *Lystrosaurus maccaigi* adults are the most distinctive group, due to their apomorphic character states. Large *L. maccaigi* skulls are highly deformed, likely due to their size, but the characters they share make them easy to identify. We plan to extend this work by using ontogenetic sequence analysis and additional specimens and characters to further refine our understanding of ontogenetic and taxonomic variation in *Lystrosaurus*. A robust, easily-used alpha taxonomy of *Lystrosaurus* is needed to fully realize the taxon's potential contribution to research on the terrestrial EPME.

Funding Sources Field Museum Women in Science Graduate Fellowship (2024)

NSF Award No. 2325380 (2024)

Hinds Fund UChicago (2022, 2024)

Steiner Fund UChicago (2022)

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

The first occurrence of *Cyonosaurus* (Gorgonopsia) from the Luangwa Basin of Zambia

Acker, Alexander L.¹, Whitney, Megan¹, Peacock, Brandon R.^{2,3}, Sidor, Christian A.⁴

¹Department of Biology, Loyola University Chicago, Chicago, Illinois, United States, ²Idaho Museum of Natural History, Pocatello, Idaho, United States, ³Department

of Biological Sciences, Idaho State University, Pocatello, Idaho, United States, ⁴Burke Museum, University of Washington, Seattle, Washington, United States

Gorgonopsians were carnivorous, saber-toothed apex predators in Lopingian terrestrial ecosystems. Despite an ongoing renaissance of gorgonopsian scholarship, small-bodied taxa have remained understudied relative to larger members of the group. Here we report a gorgonopsian specimen, including a mostly complete skull and associated post-crania, collected from the upper Madumabisa Mudstone Formation (MMF) of the Luangwa Basin in Zambia. Using CT-scanning in conjunction with digital segmentation, we reconstructed the cranial anatomy and referred the specimen to the small-bodied genus *Cyonosaurus*. The visualization of delicate internal structures, including connections between the palate and braincase, has allowed for a comprehensive description of the cranial anatomy. Among these structures, a dorsal median ridge of the vomer appears to continue posteriorly via a process of the palatine. The anteroventral sloping of the ridge on the vomer leads to a more sub-rectangular midline fenestra.

Historically, *Cyonosaurus* and other small-bodied genera such as *Aelurosaurus*, *Cynariops*, and *Scylacocephalus* have been hypothesized to be comprised of immature specimens, and therefore likely referable to larger taxa. In addition to their smaller stature, these taxa are also united through many characteristics that are posited to represent immaturity, including: a dentigerous palate, slender skull arches (postorbital bar, zygoma), and a weakly reflected lamina on the angular. The Zambian *Cyonosaurus* displays these features, yet also preserves a high degree of cranial fusion, which has been demonstrated to indicate more advanced somatic maturity. Thus, the high degree of cranial fusion seems to signal that immature features can be present in

adult forms of small-bodied taxa, complicating interpretations of ontogeny, size, and taxonomy in *Gorgonopsia*. Additionally, it is noteworthy that this specimen is the largest recorded specimen of *Cyonosaurus* at ~20 cm basal skull length.

This specimen marks the first occurrence of *Cyonosaurus* outside of South Africa, where the genus ranges between the top of the *Endothiodon* Assemblage Zone to the upper subzone of the *Daptocephalus* Assemblage Zone (DAZ). The Zambian specimen is from the upper assemblage of the MMF, which is correlated with the lower subzone of the DAZ, and specifically was found alongside specimens of lystrosaurid dicynodonts, large-bodied gorgons, therocephalians, cynodonts, and pareiasaurs.

Funding Sources National Geographic Society 158R-18

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Citizen science: empowering Native youth through collegiate collaboration

Acosta, Matilde R.¹, Blomberg, Owen H.¹, Henn, Liam¹, Gardner, Jack¹, Hampton, Tim², Lovelace, David M.¹, Working Group, Fort Washakie Schools²

¹University of Wisconsin- Madison, Milwaukee, Wisconsin, United States, ²Fort Washakie Schools, Fort Washakie, Wyoming, United States

Over the last few years the University of Wisconsin Geology Museum (UWGM) and Fort Washakie Schools (FWS) from the Wind River Reservation of west-central Wyoming have partnered together to build a stronger two-way dialog of deep-time history. As part of this ongoing partnership, a group of four UWGM undergraduates have been collaborating with FWS middle and high school students and educators. Together they

are processing and cataloging fossil material repatriated after unauthorized excavations occurred on sovereign land to which the Eastern Shoshone people belong. The fossils, still in their original field packaging and plaster jackets are acting as a platform for tribal students to engage with western scientists and practice critical thinking and problem-solving skills while simultaneously relieving an unwelcomed burden to their community through citizen science.

This collaborative venture was piloted during the Spring of 2024, and is slated to continue through the Spring of 2025, though there is no foreseeable end date to the partnership and future collaborative projects. The pilot project consisted of weekly virtual class meetings with FWS students, where UWGM undergraduates and FWS educators leveraged direct interactions with fossilized material to help cement concepts core to their geoscience and biology curricula. Additionally, students will engage in experiences meant to simulate common paleontological practices, such as basic excavation and preparation techniques through the use of model excavation kits, lessons in database and information management, student-led exhibit design, and application of their own observations into scientific practice, such as functional morphology and phylogenetic inference.

This partnership was established to provide opportunities for Tribal students to participate in scientific endeavors that are actively being conducted on aboriginal lands outside of the reservation boundary. UWGM students are learning a new way to see problems, engage and work with the communities where research is happening, and develop more inclusive field practices.

By involving students in the curation and exhibition process, the project familiarizes students with post-high-school education but also presents the opportunity for them to grow a deeper connection with their

community. The ultimate objective is to create a shared understanding that reflects diverse experiences and fosters collaboration among students, a community, and academia.

Funding Sources Funding: Wisconsin Idea Fellowship, David B. Jones Foundation, Friends of the Geology Museum.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Reevaluation of *Pterodon* in Africa

Al-Ashqar, Shorouq F.^{1,2}, Borths, Matthew R.³, El-Desouky, Heba¹, Heritage, Steven⁴, Abed, Mohamed¹, Sieffert, Erik⁴, El-Sayed, Sanaa^{1,5}, Sallam, Hesham^{1,2}

¹Mansoura University Vertebrate Paleontology Center (MUVF), Mansoura University, Mansoura, Egypt, ²Institute of Global Health and Human Ecology (I-GHHE), School of Sciences and Engineering, American University in Cairo, New Cairo, Egypt, ³Duke Lemur Center Museum of Natural History, Duke University, Durham, North Carolina, United States, ⁴Department of Integrative Anatomical Sciences, Keck School of Medicine, University of Southern California, Los Angeles, California, United States, ⁵Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States

The phylogenetic position of species placed within the hyaenodont genus *Pterodon* has been complicated since the genus was established in 1839 with the Priabonian, Eurasian *Pterodon dasyuroides*. *Pterodon* – a mammalian hypercarnivore with a patent talonid – was initially treated as ancestral to *Hyaenodon*. Later phylogenetic studies demonstrated *Pterodon* and its relatives – found in Eurasia and Afro-Arabia – are a lineage distinct from *Hyaenodon* and its relatives. This suggests an independent and

more complex evolutionary history for each group. Further phylogenetic research built upon this observation, restricting Afro-Arabian *Pterodon* to three species: *P. africanus*, *P. phiomensis*, and *P. syrtos*. Here, we conduct a Bayesian phylogenetic analysis that includes morphological data from a new complete hyaenodont cranium (MUVF 634) that was unearthed from Quarry I, an early Oligocene locality in Egypt's Fayum Depression. Using novel character information preserved in MUVF 634, we resolve a monophyletic Hyainailourinae, which includes Eurasian and Afro-Arabian taxa referred to *Pterodon*. However, the genus *Pterodon* is paraphyletic within Hyainailourinae. None of the Afro-Arabian taxa attributed to *Pterodon* were recovered as sister taxa of *Pterodon dasyuroides*, nor are they resolved as a monophyletic Afro-Arabian '*Pterodon*' clade. Specimens referred to *Pterodon dasyuroides* have been discovered from Priabonian deposits, while the stratigraphic occurrences of African taxa are much younger (i.e. Rupelian). Given the morphological, phylogenetic, and temporal analysis provided in this work, we refute the monophyly of *Pterodon*. Furthermore, *Pterodon dasyuroides* is resolved near the root of Hyainailourinae and is the sister-taxon of *Kerberos*, another Eocene hyainailourine from Eurasia. At this point, there is consistent character support to assign the Afro-Arabian taxa formerly referred to '*Pterodon*' to distinct genera, restricting the genus *Pterodon* to the Eocene of Europe. This study helps establish the distinctive character of the Paleogene carnivore fauna in Afro-Arabia, and the timing of hyaenodont dispersals across the Tethys Sea.

Funding Sources Mansoura University, American University in Cairo, and Science and Technology Development Fund (STDF) grant 38284.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

An intriguing new neosuchian crocodyliform from the Upper Cretaceous (Maastrichian) Maevarano Formation of Madagascar

Allen, Harrison J., Wilberg, Eric, Turner, Alan H.

Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States

The Maevarano Formation (Maastrichian) of northern Madagascar has historically produced a wide variety of fossil vertebrates, with the crocodyliform assemblage being particularly diverse, hosting a mix of enigmatic taxa from various disparate lineages, primarily including notosuchians (*Simosuchus clarki*, *Mahajangasuchus insignis*, *Miadanasuchus oblita*, and *Araripesuchus tsangatsangana*) as well as two undescribed taxa, a likely gavialoid crocodylian, and a small platyrostral neosuchian. The neosuchian is of particular interest and is represented by a multitude of isolated and associated skeletal material that allows for a near complete reconstruction of the skull and mandible as well as much of the axial and appendicular skeleton. The maxilla possesses some distinct features, such as a remarkably flat dorsal surface that meets the lateral margin of the maxilla at nearly a right angle, as well as a toothrow that becomes increasingly medially inset as it progresses posteriorly. These characteristics are shared with a few other neosuchian taxa, including *Pachycheilosuchus tranquei*, *Unasuchus reginae*, and *Pietraroiasuchus ormezzanoi*. These taxa also share postcranial features, such as ‘centralized’ procoely of parts of or the whole axial column, in which the convexity of the posterior articular surface of the centrum is constrained to the central portion of the articular surface. The osteoderms of the new taxon are strangely

proportioned, being rectangular and anteroposteriorly elongate to a degree not seen in other crocodyliform taxa. A preliminary phylogenetic analysis including this new taxon reaffirms the morphological similarities between it and the previously mentioned taxa, with the new neosuchian being recovered in a polytomy containing *Pachycheilosuchus*, *Unasuchus*, *Pietraroiasuchus*, *Montsecosuchus*, and the clade Hylaeochampsidae+Allodaposuchidae. Notably, occurrences of Mesozoic non-marine neosuchians in the Southern Hemisphere are very rare, with only a handful of taxa known, meaning that this new freshwater neosuchian from the Cretaceous of Madagascar provides novel information related to the dispersal of non-marine neosuchians across the southern continents during the Cretaceous. This new taxon’s closest relatives also all occur in the Early Cretaceous, demonstrating that a significant potential ghost lineage exists between these related taxa and that non-marine neosuchians were indeed present at least in Africa within the Late Cretaceous.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

New fossil remains of the Lower Siwalik (Middle Miocene) mammals from northern Pakistan

Ameen, Muhammad¹, Abbas, Sayyed G.¹, Khan, Abdul Majid²

¹Department of Zoology, University of Sialkot, Pakistan, Sialkot, Punjab, Pakistan, ²Institute of Zoology, University of the Punjab, Lahore, Pakistan, Lahore, Punjab, Pakistan

The mammalian fauna of the Lower Siwaliks is well known and have been studied extensively. However, the taxonomic status of some mammalian taxa is still controversial and taxonomic work is being done to remove the ambiguity. New specimens offer a

valuable contribution to this daunting task. Current work is based on some newly collected mammalian remains from the Chinji Formation of Lower Siwaliks that dates to late Middle Miocene (14-11.4 Ma). One of the new mandibular fragments belongs to family Giraffidae and can be attributed to a rare taxon, *Progiraffa exigua*. Another mandibular fragment can be allocated to yet another rare Siwalik order, the Carnivora. An isolated upper fourth premolar and lower second molar belongs to the Tragulidae (*Siamotragulus*) and an isolated partially broken lower molar represents the species *Gaindatherium browni* (Rhinocerotidae). Among the specimens, the mandibular fragment of *Progiraffa exigua* is extremely important to further diagnose this taxon. Similarly, ongoing work has identified the presence of *Afrotragulus* and three new species, reinforcing the hypothesis that the Siwalik tragulids are much more diverse than previously thought.

Funding Sources University of Sialkot

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

A preliminary exploration of proximal ulna shape in extant mammals and reptiles: implications for fossil tetrapod posture

Andell, Justin, Patterson, Jenna, Schwartz, Aidan, Schwartz, Madison, Bonnan, Matthew F.

Biology, Stockton University, Galloway, New Jersey, United States

The forelimb posture of fossil tetrapods such as dinosaurs and non-mammal synapsids has been difficult to reconstruct. Following previous studies, we hypothesized that the shape of the proximal end of the ulna in tetrapods may be correlated with forelimb posture given its role in articulating with the humerus and receiving the M. triceps brachii.

To determine whether or not ulna shape is a reliable indicator of forelimb posture in fossil tetrapods, we chose to quantify the geometry of the proximal end of the ulna in extant mammals and reptiles with known forelimb postures using 2D geometric morphometrics. Our preliminary data indicate that the shape of the articular surface and olecranon process change significantly with increasing size in both mammals and reptiles, and that there is a significant difference in ulna shape among crocodylians, turtles, and lizards. We find that as mammals increase in size, the articular surface becomes narrow and deeper and the olecranon process becomes less lever-like and more vertically-directed which appears to correlate with increasingly erect postures. For our reptile sample, we find that the olecranon process thickens with increasing size and that the articular surface varies in shape relative to differences in forelimb posture. We hypothesize that fossil reptiles and synapsids with proximal ulna shapes similar to those of extant reptiles would more likely have had a non-erect forelimb, whereas those with narrow and deep articular surfaces and vertically-directed olecranon processes would share the erect posture of many extant mammals. We plan to expand our analysis to include extant birds and to ultimately analyze the shape of the proximal end of the ulna in fossil taxa to reassess interpretations of forelimb posture for various quadrupedal dinosaurs and mammalian ancestors.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Virtual sensory reconstruction of the early Miocene lorid *Mioeuoticus* (Strepsirrhini, Primates): implications for behavioural and evolutionary history

Anderson, Holly E.¹, Lundeen, Ingrid K.², Silcox, Mary T.³, López-Torres, Sergi¹

¹University of Warsaw, Warsaw, Poland, ²City University of New York, New York, New York, United States, ³University of Toronto Scarborough, Toronto, Ontario, Canada

The evolutionary history of lorises and pottos (family Lorisidae) potentially dates back to the late Oligocene of Namibia, but a later moderate diversification of this family occurred during the Miocene of Africa and Asia. In the African Miocene, the family Lorisidae is represented solely by one genus: *Mioeuoticus*. The phyletic position of *Mioeuoticus* has been a source of debate, as it has been suggested to belong to either the stem of the family Lorisidae or to be further nested within lorids, as a sister to the African potto clade (subfamily Perodicticinae). Reconstructing the internal sensory anatomy of this specimen could shed some light on this debate and also possibly clarify how modern lorid olfactory and visual sensitivity and locomotor abilities evolved.

Here, we collected data from the nasal turbinates, bony labyrinths and orbits of *Mioeuoticus shipmani* (KNM-RU 2052), from the early Miocene of Rusinga Island, Kenya. Measurements of the total nasal turbinate area show that *M. shipmani* has comparable values to modern pottos (genus *Perodicticus*), which are of similar body mass to *Mioeuoticus*. When turbinate surface area is plotted against skull length, *M. shipmani* falls very close to the strepsirrhine morphospace. While this points towards *Mioeuoticus* having a keen sense of smell like modern strepsirrhines, the rostro-caudal arrangement of the turbinates is not entirely consistent with that observed in modern lorids, showing a hybrid state between loroids and lemuroids. On the contrary, the inner ear data show remarkably loroid-like oval lateral semicircular canals (SCCs), as opposed to the more rounded lemuroid SCCs. Additionally, the significant deviation from orthogonality of the angles between SCCs (101-105°) suggests slow rotational head speeds, supporting

previous inferences that *M. shipmani* was a slow-moving lorid, like its modern relatives. Finally, the low values obtained when calculating the optic foramen quotient (16.9) suggest that *M. shipmani* had poor visual acuity and was most likely nocturnal.

These results are consistent with *Mioeuoticus* having developed typical modern lorid behaviour (i.e. slow locomotion, nocturnal activity pattern) and olfactory abilities consistent with modern representatives. However, the arrangement of the nasal turbinates showing an intermediate state between lemuroids and loroids is more consistent with a basal position of *Mioeuoticus* within the family Lorisidae or even the superfamily Lorioidea.

Funding Sources This research is funded by a Winifred Violet Scott Grant to HEA, an NSERC Discovery Grant to MTS, and a National Science Centre grant (no. 2022/45/B/NZ8/03585) to SLT.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Fossil bison (*Bison bison*) of the Snake River Site, Minnesota, demonstrate inconsistencies with morphological species concept

Anderson, Tasha J.^{1,2}, Mead, Jim^{2,4}, Short, Rachel¹, Swift, Sandra L.², Baez, Arturo³, Carpenter, Mary C.⁵, Martin, Jeff M.¹

¹Natural Resource Management, South Dakota State University, Rapid City, South Dakota, United States, ²The Mammoth Site, Hot Springs, South Dakota, United States, ³Laboratory on Tumamoc Hill, University of Arizona, Tucson, Arizona, United States, ⁴University of Arizona, Tucson, Arizona, United States, ⁵Badlands National Park, Badlands, South Dakota, United States

Mid-Holocene *Bison spp.* (bison) fossils are scarce in central Minnesota, making the

region critical for understanding bison evolution in the midcontinent. Here, we present findings from the Snake River Site near Becker, MN, where researchers conducted osteometric measurements and species identification on 256 bones, representing a minimum of 45 *Bison spp.* individuals, including metatarsals, metacarpals, calcanea, skulls, and horn cores. Radiocarbon analysis was performed on a total of eight teeth (molars and premolars) and one peat sample. 100 specimens were collected from three localities within SRS: Arturo Chiz-Preston area, and Tasha Plunge. A discriminant analysis with leave-one-out classification on calcaneal metrics and horn core circumference, and a student's t-test on estimated body mass calculated from calcaneal metrics were used to determine species. Radiocarbon dating revealed at least two distinct depositional events at minimal dates of 14,284 ± 48 calibrated yBP and 5,396 ± 4 calibrated yBP. The leave-one-out analysis classified 44 mature calcanea being nearly evenly distributed across species (32% *B. bison*, 25% *B. occidentalis*, and 43% *B. antiquus*). Additional classification of 11 mature horn cores were predominantly *B. bison* (64% *B. bison*, 27% *B. occidentalis*, and 9% *B. antiquus*). The average estimated body mass from mature calcanea at SRS was 679 ± 113 kg, with a student's t-test indicating SRS bison were closest in size to *B. occidentalis* ($p < 0.01$), contradicting the other classification results. Overall, the SRS provides a valuable mid-Holocene, mid-continent spatiotemporal case study that could help resolve competing theories regarding classical taxonomy based on morphological species concepts and the dynamic linear evolution of chronospecies.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Examining the pace of dinosaur discovery

Anduza, Danny¹, Kirkland, James I.²

¹Paleontologizing, Oakland, California, United States, ²Utah Geological Survey, Salt Lake City, Utah, United States

Since the early nineteenth century, resources applied toward the study of non-avian dinosaurs have yielded vital insights into the history of life on Earth. While scientific and public interest in dinosaurs has waxed and waned, it is widely held that dinosaur paleontology at the end of the twentieth century saw a flourishing which continues into the present. However, few authors have attempted to quantify the pace of dinosaur research output. Here, we do just that: a tally of newly-described non-avian dinosaur taxa throughout the years provides an imperfect, but nonetheless useful, insight into the pace and scope of research on the group. Through compiling an original dataset from the existing literature, we found that this past decade saw an average of 41 new dinosaur taxa described each year, or more than one new dinosaur genus or species published every nine days. We explore the interplay of factors such as availability of funding, prevalence of research programs, and public enthusiasm which have contributed to this upsurge in non-avian dinosaur work, particularly in countries which rank highest in new dinosaur taxa described — especially the United States, China, and Argentina. We also examine the limitations of this analysis, and how considerations of ontogeny, anagenesis, and individual variation hold the potential to skew species counts. Altogether, this work serves to highlight the rapidity with which dinosaur paleontology continues to advance, and the importance of understanding the conditions which allow the field to thrive.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Livestreaming as paleontological outreach: lessons from four years of real-time fossil science broadcasting

Anduza, Danny

Paleontologizing, Oakland, California, United States

Effective public outreach remains challenging in paleontology, especially with limited funding and few personnel, all in the midst of a changing cultural and media landscape. We posit that livestreaming (the streaming of audio and video in real time to audiences over the internet) holds significant untapped potential for public outreach in paleontology.

While livestreaming has become ubiquitous for topics such as sports and video games, the use of livestreaming as a means of science communication is fairly new. After four years of paleontology broadcasts on the livestreaming platform Twitch, we offer an example in which online paleontological livestreams have garnered significant viewership, fostered enthusiasm for paleontology, improved audiences' understanding of fossil science concepts, and even amassed funding for fieldwork and research. The very nature of livestreaming is what makes this possible: real-time interaction between the viewers and the broadcaster, through the 'chat' window, provides a level of engagement not usually possible in traditional video formats while allowing the broadcaster to answer questions and modify lessons to fit audience members' differing levels of subject matter knowledge. Furthermore, the use of relatively inexpensive solar power and satellite internet technology has allowed for the livestreaming of fieldwork from remote regions, providing viewers with a real-time view of paleontological excavations. Data collected through viewer surveys offers insight into audience makeup, highlighting the effectiveness of this medium in reaching new demographics, and numerous respondents stated their decision to pursue

careers in science was a direct result of these livestreams. This further underlines the impact this form of science communication can have in educating the public and inspiring future generations of scientists.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Changing perspectives on the synapsid evolutionary radiation and the evolution of mammals

Angielczyk, Kenneth D.

Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

The emergence of the distinctive mammalian bauplan from morphologically disparate synapsid ancestors is one of the great macroevolutionary transitions preserved in the fossil record. The quality of the synapsid record allowed the basic steps of the transition to be recognized early compared to other major tetrapod clades. Yet, the lack of tools like modern phylogenetic comparative methods and the difficulty of preparing a diverse sample of specimens resulted in simple transitional sequences based on small numbers of exemplar taxa representing broad evolutionary grades. This narrative of a linear trend towards ever more mammal-like phenotypes persisted for much of the 20th century. The past three decades have witnessed a renaissance in synapsid research, including extensive taxonomic revisions, the development of far more inclusive phylogenies, descriptions of novel morphology facilitated by methods such as CT-scanning, and a rapidly-growing interest in rigorously testing evolutionary hypotheses using modern analytical approaches. Synthesizing these results, I propose a new conceptual model for synapsid evolution: a series of temporally-successive evolutionary radiations that each explored significant

volumes of ecomorphological space, instead of a simple trend towards mammals. Within each radiation, major subclades often display divergent morphological trends (e.g., body size increase, decrease, and stasis among therapsid clades) and optimization for disparate functional regimes (e.g., optimization for strength and muscle leverage in the forelimbs of anomodonts and dinosauromorphs, versus increased mobility in biarmosuchians and gorgonopsians). Although some mammal-like traits evolved in each radiation, the ancestral mammalian bauplan (combining evidence of characters such as hair, endothermy, small body size, and mammal-like vertebral function, among others) emerged relatively late, among Late Triassic prozostrodont cynodonts. Extinction likely played a significant role in structuring the pattern of successive radiations. Breaks between the radiations often correspond with mass extinctions, and the ancestors of subsequent radiations typically evolve before extinctions, but do not diversify until the removal of incumbents during these biotic crises. A conceptual model that explicitly acknowledges the diversity of each synapsid radiation is key to framing new evolutionary hypotheses, and for communicating the scope of synapsid evolution to the public.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

**Where have all the good bones gone?
Comparing modern and fossil vertebrate
preservation under the fluvial Megafan
Model**

Apgar, Alexandra D.¹, Hutchinson, Ian S.², Redman, Cory M.³, Souberlich, Ricardo⁴, Sarubbi Jacks, Yennifer⁴, Colman, Christian⁴, Bosch, Keely¹, Moore, Jason R.⁵

¹Earth and Planetary Sciences, University of New Mexico College of Arts and Sciences, Albuquerque, New Mexico, United States, ²Biology, University of New Mexico,

Albuquerque, New Mexico, United States, ³Grand Rapids Public Museum, Grand Rapids, Michigan, United States, ⁴Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Asunción, Asunción, Paraguay, ⁵Honors College, University of New Mexico, Albuquerque, New Mexico, United States

While the majority of modern-day rivers are tributary systems, all sedimentary basins on Earth (where the geological record forms) are dominated by fluvial megafan deposition. Therefore, in order to fully understand terrestrial fossil preservation, it is imperative that megafan preservational patterns be delineated. Towards this goal, we will compare present day taphonomic patterns measured from six sedimentary subenvironments of the Pilcomayo megafan in Paraguay with deep time patterns measured from the same subenvironments identified from the Chinle Formation of Petrified Forest National Park (PEFO) in Arizona, USA. The Pilcomayo River in Paraguay represents a current 400+km long megafan with less human impact than many such systems, particularly with respect to land-usage and the presence of megafauna (albeit with a domesticated component). Exposures of Chinle Formation within PEFO contain one of the most diverse assemblages of Late Triassic vertebrate fauna. Recent sedimentological investigation determined that within the park, the Blue Mesa and Sonsela Members (both of which fall into the Adamanian faunachron) were deposited by a prograding fluvial megafan.

We gathered a range of taphonomic data from >120 modern localities on the Pilcomayo megafan over 3 field seasons and interpreted the subenvironments of each locality. These were compared to taphonomic data from all bone material within PEFO museum collections and some additional specimens from the field from >50 localities over 2 field seasons for which subenvironment could be interpreted. Preliminary results thus far

suggest that modes of preservation within DFS subenvironments are relatively consistent across geologic time. Degree of weathering is similar in modern and fossil datasets and is highest on exposure surfaces. Abrasion appears higher on flood aprons and exposure surfaces, but patterns here are harder to interpret. Evidence of scavenging appeared much more frequently on exposure surfaces for both records. Overall, the consistency between modern and fossil fan preservation suggests this is a strong model for understanding preservation throughout the terrestrial fossil record.

Funding Sources We acknowledge the UNM Honors College HRI, the UNM RAC and GEO, a UISFL Field Research Award, grants from WIPS and AAPS, Michael Sasoni, and William Verrillo.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Captivating young minds: How a comic book fosters children's interest in paleontology in Italy

Apostolidis, Emanuele¹, Ghezzi, Elena², Peloso, Michela¹, Kustacher, Evelyn³, Scarpa, Alberto¹, Ferri, Mattia¹, Santorello, Annachiara¹, Zaghis, Federico¹

¹Private company, Martellago, Venice, Italy, ²University Ca' Foscari of Venice, Venice, Italy, ³Museum of Nature South Tyrol, Bolzen, Italy

Italy is renowned for its reference sections of geological ages, fossil Lagerstätten, GSSP golden spike positions, and UNESCO world natural heritage sites. Nonetheless, the Italian paleontological heritage is poorly known by the so-called “Z and Alpha generations” in Italy and part of our job as professionals consists of stimulating the next generation to actively participate in the conservation of these invaluable scientific

resources. We initiated a project in 2021 to engage these generations, during a period when social interactions were still limited due to the pandemic. The result was *Paleostories*, a comic book series spanning five issues. The format is inspired by the “Junior Woodchucks Guidebook” with inserts on topics such as excavation techniques, essential gear for paleontological fieldwork, detailed information on anatomy, extinct species and lab analyses, the permafrost, the Northeast Passage, its relation to the fossil record, and the climatic crises, among others. Second-level messages embedded inside the story are gender equality, ethnic diversity, emotional intelligence, and disability awareness.

The first volume was released with 1500 copies in March 2023 and sold out in 8 months. The second edition has been reprinted with 500 copies in 2024, coinciding with the release of the second volume. From the outset, we believed that engaging directly with the audience through interactive workshops was crucial for deepening their interest in the book’s message and the paleontological world. Participants engaged in hands-on activities with real bones, listened to anecdotal stories, and interacted directly with the authors and paleontologists cited in the book. This approach facilitated immediate feedback and ongoing dialogue between the young readers and professionals as well as the feeling of being involved directly with research and being part of the story.

In 2023-2024 we presented at 42 venues (schools, museums, book fairs, and book shops) in 21 Italian cities, for more than 1086 boys and girls (children reached at fairs and on online social events were not counted). We received feedback from teachers; the main message was that the proposed activities were inspiring and that the lab made the students curious about writing and museums, motivating us to continue in the engaging process and to believe in a real and

thoughtfully change of the critical thinking in the young community.

Funding Sources The first volume was indirectly supported by the European Union's Horizon 2020 through the Global Marie Curie Project REFIND (agreement n. 785821)

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Skeletal pathologies in carnivores (Mammalia, Carnivora): A systematic survey of prevalence of skeletal disease and injury based on an analysis of museum specimens

Argyros, George C., Pepevnik, Samantha A., Jones, Chelsi

Biology, Emory & Henry University, Emory, Virginia, United States

Museum specimens representing 117 species of terrestrial and aquatic/marine carnivores (Mammalia, Carnivora) from 11 families were inspected for evidence of degenerative, inflammatory, and traumatic skeletal pathology. Of the more than 10,000 individuals (skeletons and/or skulls) evaluated and analyzed to date, approximately thirteen percent (13%) exhibited some form of skeletal abnormality. Observed conditions were categorized as either traumatic healed fractures, variations of osteoarthritis (OA), or other non-specific osteopathology. Of individuals exhibiting a pathologic condition, approximately 60% exhibited healed fractures, primarily of the long bones. Osteoarthritis of synovial joints, to include a large proportion affecting the Temporomandibular Joint (TMJ-OA), and in the axial skeleton (vertebral column) resulting in osteophytic or enthesophytic growths, was observed in >44% of adult individuals. Ankylosing Spondylitis (Spondyloarthropathy) was evident in the majority of individuals where OA was present in the vertebral

column. Diffuse Idiopathic Skeletal Hyperostosis (DISH) was also observed in at least 5% of individuals, the majority occurring in the Pinnipedia and Felidae. Specimens representing the Canidae had the highest number of observed healed fractures (~32%). TMJ-OA appears to be most prevalent in adult aged individuals of the Ursidae. Little is known regarding the prevalence of these types of skeletal pathologies in wild mammalian carnivores, and even less is known in extinct species, fossil or otherwise. Causation of these conditions, in both extant and particularly fossil taxa, is speculative at best. Analysis of correlation of pathologic condition with existing co-morbidities, life history pattern, ecological interactions, intraspecific ethology, food habits (e.g., hypo/meso/hyper-carnivory) are inherently complex. We present several hypotheses regarding correlative-causative relationships in extinct taxa, where modern correlates are best represented by large series of adult individuals from the Canidae, Felidae, Hyaenidae, and Ursidae where presumptive ethology and ecology can be compared.

Funding Sources Appalachian College Association (ACA) John B. Stephenson Fellowship, ACA Ledford Scholarship

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Fossil marine vertebrates from a new fossiliferous horizon in the upper-most part of the Upper Cretaceous Smoky Hill Chalk, western Kansas, USA

Armagno, Antonio G.¹, Shimada, Kenshu^{1,2}

¹Biological Sciences, DePaul University, Kildeer, Illinois, United States, ²Environmental Sciences, DePaul University, Chicago, Illinois, United States

The Smoky Hill Chalk Member of the Niobrara Chalk is a sedimentary rock unit deposited

under the Late Cretaceous Western Interior Seaway (WIS) in North America. It represents deposition during a regressive phase of the Niobrara Cyclothem. The Smoky Hill Chalk is well known for large marine vertebrate fossils, but the taxonomic composition of smaller (<1 m) taxa is less understood. Although vertebrate fossils are generally distributed sparsely in the Smoky Hill Chalk, a stratigraphic horizon rich in vertebrate remains was discovered in Logan County, Kansas, USA, near the uppermost part of the stratigraphic member approximately 5 m below the contact with the overlying Pierre Shale. Through surface collecting in the field and acid treatment of sediment samples in the laboratory, isolated skeletal and dental elements of fossil vertebrates were recovered from the fossiliferous horizon that is interpreted to be early Campanian in age (~82 mya). Although collecting of microscopic fossil remains continues, they so far include at least two chondrichthyans (*Squalicorax kaupi* and *Rhinobatos incertus*), ten osteichthyan fishes (Caturidae(?), Aspidorhynchidae(?), *Pachyrhizodus minimus*, *Cimolichthys neaholica*, *Apateodus* sp., *Enchodus* spp., and three additional teleostean taxa), and one tetrapod (mosasaur). The most abundant taxonomically identifiable vertebrate fossils collected in our study are teeth and palatine bones of *Enchodus* spp. The collection also includes small phosphatic pebbles interpreted to be coprolites of uncertain origins, some of which contain fragmentary bones of small teleosts as inclusions. The present fossil record is sufficient to indicate that the fossil vertebrate assemblage encompassed a wide range of trophic regimes, including small pelagic fishes with small sharp teeth suited for catching smaller fishes and soft-bodied invertebrates (e.g., most osteichthyan fishes), a durophagous benthic fish (*Rhinobatos*), a shark known as an opportunist or scavenger (*Squalicorax*), and a predatory marine reptile (mosasaur). The present study is significant because it

represents the first collective study of fossil vertebrates from a single stratigraphic horizon within the early Campanian portion of the Smoky Hill Chalk.

Funding Sources DePaul University

Department of Health and Sciences

1. Graduate Research Fund (GRF)

2. Biology Graduate Summer Scholarship (BIO-GSS)

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Four legs good, two legs better? Investigating if limb allometry supports an ontogenetically driven locomotor mode shift in a skeletally immature assemblage of shuvosaurids (Paracrocodylomorpha: Poposauridae) from the Upper Triassic Chinle Formation of Petrified Forest National Park

Armour Smith, Elliott^{3,2}, Sidor, Christian A.^{1,2}

¹Department of Biology, University of Washington, Seattle, Washington, United States, ²Burke Museum of Natural History and Culture, Seattle, Washington, United States, ³Department of Biology, University of Washington, Seattle, Washington, United States

Bipedality has evolved convergently in both ornithodiran and pseudosuchian archosaurs and has important functional, evolutionary, and ecological implications. Shuvosauridae is a clade of theropod-like pseudosuchians exclusively Late Triassic in age, with two North American taxa: *Shuvosaurus inexpectatus* and *Effigia okeeffae*. *Effigia* is known from two associated skeletons showing bipedal limb proportions and *Shuvosaurus* is known from a multitaxic bonebed preserving a minimum number of nine disarticulated individuals.

Here we present a morphometric survey of a minimum of 30 disarticulated individual

shuvosaurids from the Kaye Quarry (PFV 410), a monodominant bonebed in the Sonsela Member of the Upper Triassic Chinle Formation of Petrified Forest National Park. Notably, 850 elements belong to a new shuvosaurid taxon, far outnumbering previous records of the clade. These animals were smaller than both *Shuvosaurus* and *Effigia*, but the source of this variation has not yet been explored. Variable skeletal size, osteohistology, and fusion patterns in the axial and appendicular skeleton show significant intraspecific variation that may also be ontogenetic.

We recorded measurements from 20 humeri, 32 femora, 16 tibiae, and 6 fibulae to test for forelimb-hind limb allometry. We measured the length, proximal end dimensions, and midshaft dimensions in all specimens. We calculated the area of the elliptical proximal surface and midshaft for each element. The correlation between these measures was assessed using a simple linear regression.

The regression analysis results suggest the forelimb is growing under negative allometry relative to the femur. This result is primarily supported by the negative allometric growth of the humerus relative to the femur. The tibia grows under a lesser degree of negative allometry relative to the femur. Fortunately, isometric growth of the tibia and fibula suggests that the PFV 410 shuvosaurid assemblage preserves a reliable signal of skeletal proportions. These data tentatively support the hypothesis of an ontogenetic forelimb shortening trend in shuvosaurids, and the PFV 410 assemblage represents a somatically immature population. The disarticulated preservation of the material prevents the relative growth of the axial and appendicular skeleton in the PFV 410 assemblage, a key factor in assessing the hypothesized ontogenetic acquisition of bipedality.

Funding Sources Evolving Earth Foundation Grant

University of Washington, Department of Biology; Richard C. Snyder Award; Robin M. Harris Award

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Evolution of the basal joint in the cranial skeleton from the evo-devo perspective

Asakura, Yuya, Hirasawa, Tatsuya

Department of Earth and Planetary Science, Graduate School of Science, the University of Tokyo, Tokyo, Japan

In the evolution of jawed vertebrates, cranial skeletons became divided into several movable units by interlocking joints, which enable delicate manipulation and rapid movement of jaws during feeding and ventilation. Among such intracranial joints, the synovial joint between the basiptyergoid process on the neurocranium and the mandibular arch element, namely the basal joint, represents the key to understanding the evolution of cranial kinesis, as it plays a pivotal role in most cranial kinesis. During embryonic development, the basal joint is formed at the interface between two different cell lineages, namely the neurocranial and pharyngeal arch elements, unlike postcranial synovial joints that develop within contiguous cartilage primordia. Based on the fossil record, the basal joint was acquired in the common ancestor of the crown gnathostomes and has retained in the Acipenseriformes among extant fishes. The basiptyergoid process was distinct in stem tetrapods, while it later became diminutive or secondarily lost in many tetrapod lineages. Here, to understand the developmental bases behind the evolution of the basal joint, we studied the developmental processes of the basal joints in the gecko and emu, which possess the synovial basal joints, as well as the chicken, axolotl, and bester (crossbreed of the sterlet and European sturgeon),

through detailed histological observations. In the emu and gecko, the basipterygoid process arose independently of a cell population adjacent to the mandibular arch elements, and subsequently the articular cartilage became differentiated. The articular cartilage of the emu developed as a secondary cartilage accompanied by the pterygoid (dermal bone). In the chicken embryo, the basipterygoid process was recognizable transiently. In the axolotl, the basipterygoid process was chondrified as independent elements, as in the emu and gecko. On the other hand, in the better embryo, the basipterygoid process developed contiguously to the trabecular cartilage (i.e., the neurocranium), and fibrous connective tissue was formed in the region corresponding to the basipterygoid process. These results suggest that in tetrapods, the distinct basipterygoid process likely evolved through a secondarily accretion of the mandibular arch derivative to the neurocranium. Based on our observation on the secondary cartilage in the emu, this condition would have evolved in the similar manner to the secondary jaw joint of the mammalian lineage.

Funding Sources JSPS KAKENHI Grant nos. 22H01341 and 24KJ0649.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Angular acceleration capability of *Tyrannosaurus rex* and contemporaneous dinosaurs reveals new implications for predator-prey interaction

Atkins-Weltman, Kyle L.¹, Snively, Eric²

¹Anatomy and Vertebrate Paleontology, Oklahoma State University, Tulsa, Oklahoma, United States, ²Anatomy and Cell Biology, Oklahoma State University College of Osteopathic Medicine, Tahlequah, Oklahoma, United States

Locomotor performance heavily influences predator-prey interactions, specifically hunting strategies in the former and avoidance strategies in the latter. We estimated angular acceleration of adult and juvenile *Tyrannosaurus rex* and eight contemporaneous dinosaur taxa of the Hell Creek Formation to determine relative turning ability.

We created life reconstructions using a combination of 3D scans and references to skeletal diagrams of nine dinosaur taxa, including juvenile *Tyrannosaurus* (BMRP 2002.4.1) and two age classes of *Edmontosaurus annectens* and *Triceratops*, in ZBrush 2023. We sculpted respiratory spaces to subtract from body volumes in MeshMixer, and muscles relevant for turning in quadrupeds and bipeds, using osteological correlates. With MeshLab we obtained mass, centers of mass, rotational inertia, and muscle moment arms and volumes to estimate contractile force and intrinsic torque of each relevant muscle group (caudofemoralis, triceps, deltoid). To calculate angular acceleration, we divided summed laterally-directed torques of all turning muscles about centers of rotation by body mass moments of inertia about vertical axes.

Angular acceleration in adult *Tyrannosaurus rex* (5877-7359kg) was 6-12% more rapid than in a particularly large *Edmontosaurus annectens* (7995-9944kg) and 38-42% slower than large *Triceratops* (7082-8853kg) specimens. *T. rex* acceleration was 44-47% slower than smaller *Edmontosaurus annectens* (2756-3445kg) and 61-63% slower than *Triceratops* (3478-4347kg). By comparison, juvenile *T. rex* (488-588kg) turned 660-692% faster than adults, only 6-10% slower than *Struthiomimus sedens* (437-546kg), 15-22% slower than *Anzu wyliei* (238-297kg), and only 66% more slowly than the smallest dinosaur in our sample, *Eoneophron infernalis* (79-98kg), which was 13-20% the tyrannosaur's mass.

The capability for rapid turns in *Triceratops* relative to *T. rex* would make it a dangerous quarry, requiring a different hunting strategy from the less agile *Edmontosaurus annectens*. Juvenile *Tyrannosaurus rex* were closely comparable to ornithomimids and caenagnathids at equivalent sizes, consistent with findings of juvenile caenagnathid prey in stomach contents of a juvenile tyrannosaurid. Together, these results suggest differences in both hunting strategy and prey choice throughout *T. rex* ontogeny and tyrannosaurid size variance.

Funding Sources Funding through Oklahoma State University and OSU Foundation.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

Evidence of paramedullary diverticula in extinct ornithodirans

Atterholt, Jessie¹, Wedel, Mathew¹, Benito, Juan², Field, Daniel J.²

¹College of Osteopathic Medicine of the Pacific, Western University of Health Sciences, Pomona, California, United States, ²University of Cambridge, Cambridge, United Kingdom

Many crown-group birds have pneumatic diverticula (extensions of the respiratory system) that sit in contact with the spinal cord and frequently invade the vertebral canal. Known as paramedullary diverticula (PMDs), these structures commonly affect the bone of the vertebral canal in three ways: by puncturing the bone wall and generating pneumatic foramina, leaving pocked texturing around their contact with bone, and altering the geometry of the canal such that it has a figure-8 shape. While the functional significance of these diverticula (if any) remains unknown, these osteological correlates can be used to infer the presence

of PMDs in extinct ornithodirans with diverticular (“bird-like”) respiratory systems. These features can be readily identified in fossil vertebrae where the vertebral canal has been prepared and is free of matrix, as well as from CT scans of fossil vertebrae.

This study reports on a preliminary survey for osteological evidence of paramedullary diverticula in fossil taxa, including examples from non-neornithine avialans, sauropods and non-avialan theropods, and pterosaurs. The cervical and dorsal vertebrae of the Mesozoic avialans *Ichthyornis* and *Janavis* exhibit evidence of PMDs in the form of figure-8 shaped vertebral canals and frequent (often extensive) pneumatization of the vertebrae from within the canal. Evidence of PMDs also appears in the sauropod taxa *Giraffatitan* and *Alamosaurus*, in the form of pneumatic foramina and pocked texturing in the canal, respectively. Pneumatic foramina are present in the vertebral canal of some vertebrae of the theropod dinosaur *Allosaurus* and the pterosaur *Pteranodon*. In most dinosaurs and birds in which we have found evidence of PMDs, the pneumatic foramina (if any) open into the lateral walls or dorsal roof of the neural canal. *Pteranodon* is unusual in exhibiting pneumatic foramina in the floor of the canal – a characteristic shared with extant pelicans.

The results of this preliminary study suggest that PMDs were widely distributed among extinct ornithodirans. Further surveys of these structures in both extant birds and extinct archosaurs are necessary to explore questions of function and evolution. This work also emphasizes the need to document neurovascular traces within the neural canal, to better distinguish the osteological correlates of pneumatic diverticula and neurovascular pathways.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Identifying agents of deterioration and management strategies for paleontological resources at Dinosaur Ridge, Colorado, USA

Atwater, Amy L., Mason, Robert, Rea, Amanda S., KleeB, Robert A., LaCount, Erin

Friends of Dinosaur Ridge, Morrison, Colorado, United States

Dinosaur Ridge, a National Natural Landmark in Morrison, Colorado, has been a key paleontological site since dinosaur bone excavations began in the 1870s. In 1937, hundreds of dinosaur tracks were discovered in the Lower Cretaceous Dakota Group during road construction, and more were exposed on the south side in 1992. Since then, Dinosaur Ridge has become a world-renowned fossil locality. The tracksite features adult and juvenile iguanodont (*Caririchnium leonardii*), ornithomimid (*Magnavipes caneeri*) and crocodile (*Mehliella* sp.) tracks. Recently, the track highlighting process has been raised as an anecdotal threat to the tracks. Highlighting involves lightly coating the tracks with a non-permanent, pH neutral charcoal and water solution to improve visibility. The impact of track highlighting, theft, weathering and erosion on the tracksite is the subject of this project. The goal of which is to provide quantitative metrics to help assess, monitor, and conserve the dinosaur tracks. This study evaluates threats by utilizing recent photogrammetry imaging to update the 1993 track map created by Dr. Martin Lockley. By comparing this updated map with the original, we determined a 54% retention rate of the 1993 tracks, with 46% lost over time. Natural weathering and erosion emerged as the primary factors leading to track loss, particularly affecting the longer exposed north tracks. These statistics confirm that the

track highlighting process has no detrimental impact on the tracks. Importantly, this process is an indispensable tool for monitoring erosion, managing weed growth, educational engagement, and fostering a sense of stewardship among our hundreds of thousands of visitors. Given the significance of Dinosaur Ridge as an irreplaceable and unique paleontological resource, preserving the integrity of the track surface is paramount. Neglecting maintenance in terms of weed management and weathering and erosion monitoring will result in irreversible track loss, underscoring the need for proactive measures. These findings show the importance of implementing and maintaining comprehensive management strategies to counteract threats to paleontological sites like Dinosaur Ridge.

Funding Sources This project was funded by Friends of Dinosaur Ridge, the Colorado Scientific and Cultural Facilities District, and by Jefferson County Open Space.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Earliest Paleocene multituberculate mammals from the Constenius Locality, Garfield County, Montana: A perspective from premolar morphometry

Ausmus, David A.^{1,3}, Silviria, Jacqueline S.^{1,3}, Wilson Mantilla, Gregory^{2,3}

¹Department of Earth and Space Sciences, University of Washington, Seattle, Washington, United States, ²Burke Museum of Natural History and Culture, University of Washington, Seattle, Washington, United States, ³Department of Biology, University of Washington, Seattle, Washington, United States

The Cretaceous-Paleogene (K-Pg) mass extinction (66.052 Ma) is one of the most important events in mammalian evolution as

it was the catalyst for mammals to diversify and fill the ecological holes left by the extinction of the non-avian dinosaurs. This extinction event impacted all groups of mammals, including the multituberculates, one of the longest-lived and most successful clades of Mesozoic and early Cenozoic mammals.

The Constenius vertebrate fossil locality is in the lowermost Tullock Member of the Fort Union Formation in Garfield County, northeastern Montana, deposited within the first 28,000 years after the K-Pg mass extinction (66.052-66.024 Ma). Constenius is a very rich but understudied fossil locality that provides a snapshot of the immediate aftermath of the mass extinction.

In this study, we used qualitative descriptions partnered with linear measurements and principal component analyses (PCA) to identify 56 lower fourth premolars (p4s) to the lowest possible multituberculate taxon. Preliminary PCAs show that much of the variation between Constenius specimens is explained by size, with clear separation between *Mesodma* and *Stygimys* specimens along PC1. We recognize three genera of multituberculates from Constenius: *Cimexomys* (n=1), *Mesodma* (n=36), and *Stygimys* (n=17). The presence of these multituberculates supports the previous assignment of Constenius to the Pu1 interval zone of the Puercan North American Land Mammal Age (early Paleocene).

Further work on this project will include conducting size corrected PCAs to further investigate morphological variation rather than size variation, continuing to identify and measure Constenius p4 specimens, identifying and measuring multituberculate upper premolars, and conducting geometric morphometric analyses to further confirm taxonomic identifications.

Funding Sources Myhrvold and Havranek Charitable Family Fund, National Science

Foundation (NSF EAR 2321341), Geological Society of America, and the University of Washington.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A supplementary report of bovids from the Middle Siwaliks (Late Miocene) deposits of Siwaliks of Pakistan

Babar, Muhammad Adeeb¹, Aabbas, Sayyed Ghyour², Khan, Muhammad A.³, Yaseen, Amir², Jabar, Fizza¹, Akhtar, Muhammad³

¹Zoology, University of Okara, Okara, Pakistan, ²Zoology, University of Sialkot, Sialkot, Punjab, Pakistan, ³University of the Punjab, Lahore, Lahore, Pakistan

Bovids are the most abundant remains found in the Siwalik Group or Siwaliks on the Indian subcontinent. However, the taxonomy of the Siwalik bovids has not been updated since the middle of the last century. Hence, many taxa have been synonymized by other Siwalik researchers informally. In other cases, the possibility of new species need to be investigated. Here, we describe some remains collected from the Middle Siwaliks of Pakistan and highlight the of taxonomic issues of various Middle Siwalik bovid taxa including: *Sivaceros*, *Miotragocerus*, and *Tragoportax*. The described material is attributed to *Elachistoceras khauristanensis*, *Sivaceros* sp., and Bovidae gen. & sp. indet. The material described as Bovidae gen. & sp. indet. is potentially a new species but the material is lacking in diagnosable characters.

Funding Sources University of Okara, University of Sialkot and University of the Punjab, Lahore funded this research.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A review of the spiral-toothed sharks, the eugeneodontids, show a complex biogeographical history of evolution, preservation, and diversification dependent on global sea levels.

Babcock, Tobias B.¹, Tapanila, Leif^{1,2}

¹Geosciences, Idaho State University, Pocatello, Idaho, United States, ²Idaho Museum of Natural History, Pocatello, Idaho, United States

Eugeneodontids were the largest marine predators of the late Paleozoic, most notable for their bizarre medial spiral tooth whorls in their jaws. The group lived from the Pennsylvanian to the end of the Permian, though some forms survived into the early Triassic. Despite their wide variety of tooth morphologies and worldwide distribution, eugeneodontids are very poorly known due to a lack of good fossil material. A literature review of focused on the distribution of eugeneodontid taxa worldwide show patterns that may explain the lack of material for this group, and help understand the evolution of these odd sharks.

Eugeneodontid remains are found in the North America, Russia, China, Japan, and the United Kingdom. The eugeneodontids found in these countries lived in shallow water seas and coal swamps in the Panthalassic Ocean. These sharks are entirely absent from the Paleo-tethys Sea and Gondwana, with the exception of *Anisplerodontis* from the Pedra de Fogo Formation in Brazil. This implies a preservation bias or geographical constraint that prevented eugeneodontids from reaching these regions.

The highest diversity of eugeneodontid species is during the Pennsylvanian, from the Bashkirian to the Gzhelian. The oldest taxa already show high diversity of crushing, cutting, and slicing dentitions, meaning that they likely evolved before the Pennsylvanian. While fossils of these animals are common after this period, there is a decline in species

diversity that is likely due to declining global sea levels as Pangea formed. This may also be due to preservation bias, as many species of eugeneodontids, such as *Sarcoprion* and *Helicoprion* were large, open-water predators, and may not have fossilized as well as the species that lived in the Carboniferous coal swamps such as *Edestus*. The majority of eugeneodontids would go extinct in the End-Permian extinction, possibly due to their position at the top of the food chain. *Sarcoprion edax*, from Greenland, is a taxon of special importance to the study of eugeneodontid diversity, due to its size, preservation, and age. It was the largest of the latest Permian eugeneodontids, and one of the last with a cutting morphology, along with *Sinohelicoprion*. *Sarcoprion* is known from excellent remains, and a newly rediscovered specimen belonging to the holotype of *Sarcoprion* likely contains the whole head of the shark, allowing for a rare opportunity to study the skull of a large spiral-toothed shark at the very end of their reign.

Funding Sources The Jeff Gheslin Grant from Idaho State University has helped fund my research on *Sarcoprion edax*.

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Does global warming past or present create uninhabitable regions for mammals?

Badgley, Catherine¹, Morgan, Michèle E.², Pilbeam, David³, Flynn, Lawrence J.², Behrensmeyer, Anna K.⁴

¹Ecology & Evolutionary Biology, University of Michigan, Ann Arbor, Michigan, United States, ²Peabody Museum, Harvard University, Cambridge, Massachusetts, United States, ³Human Evolutionary Biology, Harvard University, Cambridge, Massachusetts, United States, ⁴Department of Paleobiology, National Museum of Natural

History, Washington, District of Columbia, United States

The distribution of mean and seasonal temperatures varies over the earth with latitude and elevation, resulting in a variety of thermal regimes that influence the structure and composition of local ecosystems. Warm-blooded animals occupy many thermal regimes with physiological ease. In the warmest regimes, such animals maintain their internal temperature through radiative heat transfer and evaporative cooling. These mechanisms may fail, however, if both ambient temperature and humidity are high. For example, exposure to wet-bulb temperatures (i.e., effectively cooled by evaporation) of 35 degrees C for more than six hours is lethal in humans. Placental mammals share similar thresholds for moist heat stress. Such heat stress is already occurring more often today in areas of high heat and humidity, resulting in increased heat-related mortality of humans and livestock, and could result in loss or extirpation of mammal populations from some regions.

During the Miocene Climatic Optimum (MCO, 16.9-14.7 Ma), global mean terrestrial temperatures were 5-6 degrees C warmer than today, with higher precipitation as well. Could regions with high heat and humidity during that time interval have been inhospitable to mammals? We examine this idea with data from the Miocene Siwalik record of Pakistan, which spans 18-1 Ma, with the interval from 18-6 Ma especially well documented. Species richness of mammals varied from 40-50 species from 17.9-14.7 Ma, then rose rapidly to over 100 species by 13.1 Ma. Taphonomic processes changed little across this transition. About half of the species present during the MCO were small (<1 kg); another 10 species were very large (>500 kg). Small species could escape heat stress in burrows or tree hollows; very large species could wallow in the rivers that created the fluvial environment of this record.

Medium-sized mammals (1-250 kg) comprised a smaller proportion of species than in later intervals but were the majority of first appearances during the cooling interval that followed the MCO. This striking pattern suggests that heat stress during global warming intervals made some regions inhospitable to particular functional groups of mammals. This idea needs testing with other records that span the MCO as well as other warm intervals in earth history, including the Paleocene-Eocene Thermal Maximum.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Reassessing out-of-Africa I: Ecometric insights from Dmanisi herbivores challenge prevailing grassland hypotheses

Bakhia, Alexander¹, Tallavaara, Miikka¹,
Saarinen, Juha¹, Parker, Abigail K.²,
Bukhsianidze, Maia³, Lordkipanidze, David³

¹Department of Geosciences and Geography, University of Helsinki, Helsinki, Uusimaa, Finland, ²Department of Computer Science, University of Helsinki, Helsinki, Finland, ³Georgian National Museum, Tbilisi, Georgia

One of the key discussions regarding the dispersal of hominins out of Africa during the Early Pleistocene has centered on the environmental conditions which the species dispersed into. Some researchers synchronize this dispersal with the expansion of grasslands, placing hominins within the narrow savanna-grassland niche. Conversely, others emphasize the adaptability of hominins to varied, diverse environments as the main reason behind Out-of-Africa I - event. To test these conflicting hypotheses, reconstructing the paleoenvironments at early Eurasia hominin sites such as Dmanisi is required.

Here we explore the ecometrics, paleodiets and average body mass of the Early Pleistocene (c. 1.8 Ma) herbivore community in Dmanisi. These are crucial for understanding the prevalent biome coinciding with hominin presence at the site. Firstly, we present estimates of precipitation, and primary productivity in Dmanisi based on dental ecometrics. Secondly, we use dental mesowear analysis to identify the dietary categories among the fossil taxa, which reflect the vegetation herbivores primarily interacted with. Additionally, regression equations based on dimensions of post-cranial bones were used to estimate the body mass of fossil specimens. A mean body mass value of all ungulates in Dmanisi was then compared with mean body mass values from other Pleistocene localities and correlated with locality-specific net primary productivity values, to see how the mean body mass value in Dmanisi compares to the prediction based on primary productivity.

Ecometric analyses reveal that Dmanisi's early Pleistocene environment was substantially drier and demanding than today, with a mean annual precipitation (MAP) of approximately 536 mm/year—significantly lower than the modern average of 700 mm/year—and a net primary productivity (NPP) of 730. The local herbivore community predominantly consisted of mixed feeders and browsers, as indicated by dental mesowear results, with little evidence supporting a grass-dominated diet. Additionally, smaller body sizes among the ungulates point to scarce resource availability, likely due to low net primary productivity and heightened intraspecific competition. These results not only challenge the notion that grassland expansion was the primary catalyst for hominin dispersal, but also provide evidence for the adaptability of hominin species to diverse habitats.

Funding Sources University of Helsinki Research Foundation

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

What is a giraffe-like camel? A taxonomic revision of the Miocene camel, *Oxydactylus*

Balassa, Daniella¹, Prothero, Donald R.²

¹Geological Sciences, California State University Long Beach, Long Beach, California, United States, ²Vertebrate Paleontology, Natural History Museum of LA County, Los Angeles, California, United States

Camels were a common and diverse group in North America from their origin in the late middle Eocene through the late Pleistocene, but the systematics of most groups is poorly understood, especially in light of the huge unstudied collections in the American Museum of Natural History. We undertook a systematic study of the early Miocene genus *Oxydactylus*, from the late Arikareean and early Hemingfordian. Prior to this study, there were eight named species referred to as *Oxydactylus*, which had become a taxonomic wastebasket for all early Miocene camels with long legs and long necks. We conducted a suite of over 24 measurements of skulls, teeth and jaws, as well as selected skeletal elements. Using univariate statistical methods (mean, standard deviation, and coefficient of variability, or CV) and bivariate analytical methods, we tried to see how many different species could be discriminated. CVs of the total samples were high, but CV<10 for the least variable tooth measurements. In addition, CVs are known to be high in many groups of artiodactyls. Bivariate plots showed complete overlap of all the “species” with no breaks that could be used to separate size groups. When the total variability of the sample is considered, and the effects of sexual dimorphism identified, there is no justification for more than a single species, *Oxydactylus longipes*. All other names that

have been given to specimens are junior synonyms, including *O. benedentatus*, *O. campestris*, *O. lacota*, *O. lulli*, and *O. wyomingensis*.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Evidence of sexual dimorphism in the Cretaceous actinopterygian, *Aethocephalichthys hyainarhinus*, of the Campanian Pierre Shale of western South Dakota

Ballou, Mackenzie

Department of Geology and Geologic Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, United States

In 1999, *Aethocephalichthys hyainarhinus* was described and named as a new species of actinopterygian from Cretaceous seaways in New Zealand and North America. *A. hyainarhinus* is known for the preservation of crania. Surprisingly, two equal morphologically variant sample sets were assigned to the specimens, herein referred to as sample set A and sample set B. Sample set A has a rectangular basicranium and exceeds the 2.7 centimeter basicranial length, and 1.4-centimeter basicranial width, as well as being characterized by deep posterior myodome, larger orbits, and a longer overall vomer to parasphenoid proportion. Sample set B has a triangular basicranium, a less than 2.7-centimeter basicranial length, and less than 1.4-centimeter basicranial width, as well as containing shallow posterior myodomes, deeper orbits and overall short vomer to parasphenoid proportion. The differences in a geometric morphometric thin plate spline interpolation led to the determination that the sample set B is a different species. This study used geometric morphometrics to assess deformation in these two sample sets to determine if the

morphologic differences are a product of diagenetic alteration or taxonomic variation. Herein the *A. hyainarhinus* skulls were reevaluated, sample set B, differs from set A due to the presence of larger orbits, decreased vertical and horizontal length, a triangular basicranium, and more shallow posterior myodomes. The geometric morphometrics suggests these two morphotypes could be a product of sexual dimorphism.

Funding Sources South Dakota School of Mines and Technology

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Fifty years at Pipestone Creek: new discoveries and insights from Canada's densest dinosaur bonebed in the Late Cretaceous Wapiti Formation, northwest Alberta, Canada

Bamforth, Emily, Sweder, Jackson

Philip J. Currie Dinosaur Museum, Wembley, Alberta, Canada

The Pipestone Creek Bonebed (PCB), located near Grande Prairie, Alberta, is one of Canada's largest and densest dinosaur bonebeds, having produced over 7 500 specimens of the endemic ceratopsian species *Pachyrhinosaurus lakustai*. This PCB produces an average of 100-300 fossils per square metre and is suggested to extend for a kilometre (0.6 miles) beyond the current excavation area. The PCB represents a single herd of animals killed in a catastrophic event, most likely a flood. Discovered in 1973 by a local science teacher, this immense monodominant bonebed galvanized vertebrate paleontology in northern Alberta, a region hitherto overlooked as a significant source of dinosaur remains. Stratigraphically situated in Unit 4 of the Late Cretaceous Wapiti Formation (Campanian, 73 Mya), the

bonebed falls within ‘the Bearpaw Gap’, a period when southern Alberta was covered by the Western Interior Sea, while northern Alberta remained on the landward side. Representing a single community of animals from a snapshot of time, the PCB provides significant insight into the paleobiology, ontogeny, and paleoecology of *Pachyrhinosaurus* specifically, and ceratopsians in general. It is also an invaluable source of information about northern dinosaur faunas, filling a knowledge gap in the understanding of Canada’s Late Cretaceous dinosaur diversity. Since the PCB and *P. lakustai* were formally described in a 2008 monograph, continued excavation by the Philip J. Currie Dinosaur Museum and its associates has yielded significant new discoveries and insights. These include 1) the discovery of paleobotanical and microvertebrate material in the PCB providing new information about the paleoenvironment, 2) the 2022/2023 discovery of parietal bones from nine individuals, each displaying a different morphology, suggesting a high degree of individual variation, 3) New cranial material from very young animals providing a more comprehensive understanding of *Pachyrhinosaurus* boss ontogeny, 4) A new 3D mapping technique allowing for a better understanding of the PCB’s deposition and taphonomy, 5) the use of new technologies such as CT scanning to gain insight into the internal structure of the skulls and braincases, and 6) the 2023 discovery of the first complete skull from the PCB in nearly 20 years. Periodically collected since the early 1980s, the PCB continues to yield new and critical information about ceratopsian communities, paleobiology, paleoecology and taphonomy.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

April Archosaur Absurdity: a seasonal online program featuring science, paleoart, school programming, and public outreach

Bamforth, Emily, Sweder, Jackson

Philip J. Currie Dinosaur Museum, Wembley,
Alberta, Canada

April Archosaur Absurdity (AAA) is a free online, interactive program developed by the Philip J. Currie Dinosaur Museum (PJCDM). Originally conceived as an online activity to engage the public during the pandemic, AAA has grown substantially in scope and reach. Based loosely on the Arizona State University’s popular ‘March Mammal Madness’, AAA is a tournament-style event, in which selected fossil archosaurs (dinosaurs, crocodiles, and birds) ‘compete’ in a series of nested hierarchical matches. Each ‘match’ is a 250–500-word narrative written by a paleontologist, presented as an encounter between two archosaurs in their natural environments, using the most informed understanding of the animal’s ecology and behavior. Encounters may be predatory, competitive, territorial, or even passive. To increase accessibility and interest, these narratives are available to participants in written form, as an audio recording, and as an animated video produced by local media company Amplomedia. These are posted on the PJCDM’s website (<https://dinomuseum.ca>) and social media channels. The archosaurs chosen each year are based on the work of a professional paleoartist, who is featured in a special interview as part of AAA. An effort is made to include lesser known and/or newly described archosaurs to introduce novel prehistoric animals to the public. In the weeks leading up to AAA, each archosaur in the competition is unveiled in a short introductory video explaining where and when the animal lived, its phylogenetic relationships, the features that make it unique, the meaning of its name, etc. The matches are posted throughout the month of April, with an opportunity for

participants to vote via social media on the winning archosaur prior each match being posted. In 2024, the PJCDM launched a school program based on AAA, which included lesson plans, student assignments, and curriculum connections. To engage local audiences, AAA also includes physical trading cards featuring the archosaurs in that year's competition, an interactive lobby display at the PJCDM, and a comic strip competition based on that year's competitors. In 2022, AAA received the Canadian Association of Science Centres (CASC) Award for Best Project in its category. Feedback from a survey provided to participants and teachers, as well as the increasing number of online participants, demonstrates that AAA is a successful, creative, and engaging way to communicate science and paleontology.

Colbert Prize Session

Comparative analysis of the nasal cavity and paranasal system in four sympatric nodosaurids and ankylosaurids from the Upper Cretaceous (upper Campanian) Dinosaur Park Formation of Alberta, Canada

Barnett, Ollie¹, Voris, Jared T.¹, Therrien, François², Zelenitsky, Darla K.¹

¹Earth, Energy, and Environment, University of Calgary, Calgary, Alberta, Canada, ²Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

The thyreophoran clade Ankylosauria is characterized by complex and convoluted nasal airways and paranasal sinus system. Despite being a taxonomically diverse clade, little is known about the morphological variation in nasal internal structures that exists within Ankylosauria, particularly between closely related and sympatric taxa. Here we virtually reconstructed and compared the morphology of the nasal

airways and paranasal sinuses of four contemporaneous ankylosaurs, the ankylosaurids *Anodontosaurus lambei* and *Euoplocephalus tutus* and the nodosaurids *Edmontonia rugosidens* and *Panoplosaurus mirus*, from the Upper Cretaceous (upper Campanian) Dinosaur Park Formation of Alberta, Canada, by segmenting CT scan slices with the software Amira.

As previously demonstrated, the nasal cavity and paranasal sinus system of ankylosaurids is more complex and convoluted than those of nodosaurids. However, we observed few differences in the morphology of the nasal cavity and paranasal sinuses between the ankylosaurids *Anodontosaurus* (TMP 1997.132.1) and *Euoplocephalus* (AMNH FR 5405), the two being largely identical. From the nares, the airway initially takes a dorsomedial course of the rostral loop that makes multiple turns before exiting through the choana. In contrast, the nasal cavity morphology differs considerably between the nodosaurids *Edmontonia* (TMP 1998.74.1) and *Panoplosaurus* (ROM 1215). From the nares, the nasal airway of *Panoplosaurus* is characterized by a rostral loop that twists laterally and then continues to the caudal loop before exiting ventromedially through the choanae. In *Edmontonia*, the airway is funnel-shaped and lacks the coiled rostral loop present in *Panoplosaurus*, thus the airflow followed a more direct anteroposterior route to the choana.

The differences in nasal cavity morphology observed between *Edmontonia* and *Panoplosaurus* suggest that this feature could be important for nodosaurid taxonomy and systematics. Whereas *Edmontonia* has previously been argued to be congeneric with *Panoplosaurus*, the observed differences in nasal cavity morphology are significant and are here argued to support a generic distinction. Further study of the nasal cavity and paranasal sinus system of other ankylosaurs could greatly assist in phylogenetic studies of this clade and

possible functional interpretation of morphological differences.

Funding Sources Program for Undergraduate Research Experience (PURE) award to OB
NSERC Discovery Grant to DKZ

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

A new juvenile bonebed of chasmosaurine ceratopsids from the Upper Campanian Cerro del Pueblo Formation, Coahuila, Mexico: affiliation to the *Pentaceratops*-lineage of southern Laramidia

Barrera Guevara, Daniela^{1,2}, Freedman Fowler, Elizabeth^{1,2}, Posada Martinez, Daniel⁴, de León Dávila, Claudio³, Flores Ventura, José⁵, Aguillón Martínez, Martha Carolina⁵, Guzmán Gutiérrez, José Ruben⁵, Rivera Sylva, Héctor⁵, Fowler, Denver²

¹Natural Sciences, Dickinson State University, Anchorage, Alaska, United States, ²Paleontology, Badlands Dinosaur Museum, Dickinson, North Dakota, United States, ³Olga Moreno 396, Ignacio Zaragoza 3ra Amp, Saltillo, Coahuila, Mexico, ⁴Jesús Perales Galicia 427, Colonia Magisterio, Saltillo, Coahuila, Mexico, ⁵Paleontology, Museo del Desierto, Saltillo, Coahuila, Mexico

As with other dinosaurs of the Late Cretaceous Western Interior of North America, it has been suggested that chasmosaurine ceratopsids exhibit biogeographic differences between northern and southern regions of Laramidia, a hypothesis largely based on discoveries from the USA and Canada. As the southernmost part of Laramidia, the fossil record of Mexico has great potential for new data and testing of this hypothesis. Unfortunately, to date only a single taxon has been described from Mexico: *Coahuilaceratops magnacuerna*, attributed to the upper Campanian Cerro del Pueblo

Formation of Coahuila. However, it has been realized only recently that *Coahuilaceratops* actually derives from the overlying Maastrichtian Cerro Huerta Formation.

Here we describe a new chasmosaurine bonebed certifiably within the Cerro del Pueblo Formation which comprises two associated juvenile partial skulls with fragmentary postcrania: four postorbital horncores, a partial parietal, squamosal fragments, left and right lacrimals, nasal horncore, partial right dentary, various phalanges, and six vertebrae. As juveniles, the specimens cannot be reliably attributed to a known or new taxon, but they exhibit dorsolaterally deflected brow horns and a weak median embayment of the posterior margin of the parietal, comparable to Upper Campanian *Pentaceratops*-related chasmosaurines from Colorado and New Mexico. Although most *Pentaceratops*-related chasmosaurines do not initially appear to bear laterally deflected brow horns, this is probably a result of these specimens being preserved on their sides and thus compressed laterally. The new specimens are consistent with the hypothesis that the *Pentaceratops* clade originated in southern Laramidia, later becoming more cosmopolitan when sea level lowered in the latest Campanian and the population was able to spread north. This discovery also represents one of the few known multi-individual bonebeds for a chasmosaurine dinosaur. That both specimens are juvenile and of near-identical size adds evidence to the proposal that young dinosaurs may have lived as cohorts, separately from breeding adults.

Technical Session 16: Mammal Evolution (Friday, November 1, 2024, 1:45 PM)

Functional and taxonomic turnover are decoupled across the Neogene mammalian record of eastern Africa

Barrett, Paul Z.¹, Rowan, John², Smiley, Tara M.¹

¹Ecology & Evolution, Stony Brook University, Sound Beach, New York, United States, ²Department of Anthropology, University at Albany, Albany, New York, United States

The diverse mammal communities documented in the Neogene fossil record of eastern Africa evolved in the context of massive biotic and physical environmental changes. These changes include the immigration and diversification of laurasiather and replacement of endemic afrothere taxa, increasing aridity and spread of grassland ecosystems, and development of the East African Rift System. How these events shaped the evolution and ecological interactions of eastern African mammals during this time remains unclear, but ongoing field work and recent advances in network-based community detection approaches offer the opportunity to assess these dynamics. Using an updated fossil occurrence and functional trait (body size, diet, locomotion) database of over 900 species > 1kg from 140 fossil sites spanning the last 27 Myr, we applied network analyses to detect functional and taxonomic faunas across the mammalian fossil record of eastern Africa. Our results reveal an interplay of long-term stability in functional faunas with disparate rates of taxonomic turnover. Two persistent and well-supported functional faunas were recovered, correlating to pre- and post-grassland expansion in eastern Africa, transitioning at 10-7 Ma. The first functional fauna is associated with small browsing and frugivorous taxa, many of which are semi-arboreal, while the second is dominated by large-bodied mixed-feeding and grazing taxa, many being cursorial. The dominant and singular shift in functional faunas is not matched by a corresponding turnover in taxonomic faunas. Instead, terminal Oligocene to Miocene mammalian communities display slow, or limited

taxonomic turnover, until the onset of grassland expansion. Thereafter, rapid species turnover among communities dominates the Pliocene-Pleistocene, though these new species are slotting into the same existing niches. Sensitivity analyses demonstrate that these patterns are robust to various sampling issues, suggesting diversification rates and/or species duration dynamics experience a shift within the last 10 million years. What processes are correlated, or even responsible, for this shift is a topic of ongoing research. However, our current findings suggest that global temperature, exemplified by the Middle Miocene Climatic Optimum, was an unlikely catalyst, given the timing and diminished affect at lower latitudes.

Funding Sources Funding for this work was received from NSF-FRES awards 2021579 (Stony Brook), 2021666 (LDEO), and 2021591 (Hamilton).

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

A technique for cutting and preparing a section of Cretaceous/Paleogene boundary for exhibition

Bastien, Salvador, Toth, Natalie G., Noonan, Brooke, Lyson, Tyler

Earth Sciences, Denver Museum of Nature and Science, Denver, Colorado, United States

We developed a method for cutting and polishing soft sedimentary rocks for exhibition, featuring a Cretaceous/Paleogene (K/Pg) boundary section collected from the uppermost Maastrichtian Lance Formation (Powder River Basin) of Central Wyoming. This field sample highlights the iconic moment of extinction and evolutionary transition caused by the Chicxulub impact,

highlighting the boundary clay and spherules resulting from the impact. Sections of boundary rock were collected using plaster field jackets, capturing 18 centimeters of rock above and 27 centimeters below the boundary. The field jacket was left open on one side and later consolidated with epoxy to stabilize the layers of rock. Clear epoxy resin and hardener were mixed completely, then diluted 20% by mass with denatured alcohol to lower viscosity for improved absorption. Epoxy was poured into the open block of sediment in several rounds until saturated. After curing, the block was placed into a bin and leveled with bedding tilted vertically. The block of sediment was wrapped in plastic, and plaster was poured into the bin to hold it in place for cutting. At the Lyons Sandstone quarry (Colorado), the block was cut with an industrial diamond wire saw. The two halves were each embedded in plaster individually and saturated again with diluted epoxy. A second round of cuts was completed at the Lyons quarry, creating two 1.5 cm thick slices of sediment and two thicker end caps resulting in four total display pieces. The wire saw was oriented parallel with bedding to help hide cutting imperfections. Two of these pieces were consolidated again, one with diluted epoxy, and the other with Tenax Tiger Agar Sealant. Both pieces were polished down from 40 to 2000 grit, the epoxy sample with diamond studded buffing pads on an angle grinder and the Tiger Agar sample with aluminum oxide sandpaper on an electric hand sander. The final step to create a smooth surface required polishing the slabs with a cotton buffing wheel and jeweler's rouge. Epoxy consolidation resulted in a more solid display piece with more color distortion, while Tiger Agar consolidation gave truer colors, but filled holes less effectively. Both polishing methods display layers of the rock and spherules clearly and create a more robust finished product than an unfinished surface. The two polished specimens are currently featured in temporary exhibits at the

Denver Museum of Nature & Science and Betty Ford Alpine Gardens (Aspen, Colorado).

Funding Sources Denver Museum of Nature & Science, National Science Foundation (Frontier Research in Earth Sciences grant EAR-2317666).

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

How special are pterosaurs? Comparing cross-sectional structure of pterosaur humeri to that of birds

Baumgart, Stephanie L.¹, Habib, Michael B.², Brown, Matthew³, Schachner, Emma R.¹

¹Department of Physiological Sciences, University of Florida College of Veterinary Medicine, Gainesville, Florida, United States, ²Division of Cardiology, University of California, Los Angeles, Los Angeles, California, United States, ³Department of Geological Sciences Jackson School of Geosciences, University of Texas at Austin, Austin, Texas, United States

Powered flight has evolved in archosaurs multiple times, first in pterosaurs and then at least once in birds. Each clade has a unique wing structure – pterosaurs with an elongated 4th manual digit supporting a wing membrane and birds with a fused manus supporting a set of flight feathers – yet the underlying proximal skeletal structure is homologous. With the use of micro-computed tomographic data, we first compare structural properties of humeri of birds across four orders of magnitude in body size (8g-11,300g) to map out how phylogeny and ecology relate to bone distribution and biomechanical properties. We used humeri from 84 birds covering 27 orders and 49 families representing a wide array of ecologies. We find that birds have a loosely correlated negative relationship between body mass and bone compactness

(Cg). Relative shaft length and degree of curvature of the bone were also key variables to help separate different ecologies. Understanding how bird humeral structure changes in relation to ecology or stress is critical for looking at patterns within pterosaurs to interpret how they might be using their bones.

We added pterosaur humeri to our analyses to see what happens in flying archosaurs larger than modern birds, including one of the largest known pterosaurs, *Quetzalcoatlus northropi*, estimated to have had a body mass between 200-300kg. If the pterosaurs fit into the trends established by birds, then we hypothesize that cross-sectional geometries are under similar influences. If the trend of pterosaur humeri does not follow that of birds, then their humeri are under different stresses than bird humeri, therefore pterosaurs are facing different biomechanical constraints. We found that *Tupandactylus* is comparable in humerus bone distribution to birds of similar body mass. However, overall pterosaur Cg plummets after body masses around 10kg and continues to have a negative relationship with body mass. Pterosaur Cg is as low as 0.12 in *Quetzalcoatlus northropi* compared to the lowest bird value in the shoebill (*Balaeniceps rex*, 0.26), or the heaviest bird in the Andean condor (*Vultur gryphus*, 0.42). This indicates that pterosaurs had an internal humeral structure different than birds, likely to accommodate the increased stresses of quadrupedal stance and powered flight experienced by their much larger body sizes.

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Later Clarkforkian (latest Paleocene) mammals from the Great Divide Basin (southwestern Wyoming) and a revised biozonation scheme for the Clarkforkian NALMA

Beard, K. Christopher¹, Anemone, Robert L.², Jones, Matthew F.³

¹Biodiversity Institute, University of Kansas, Lawrence, Kansas, United States, ²University of North Carolina at Greensboro, Greensboro, North Carolina, United States, ³Arizona State University, Tempe, Arizona, United States

Latest Paleocene (Clarkforkian) mammal faunas are poorly represented in North America, particularly outside the Clarks Fork Basin (CFB). Within the CFB, a biozonation scheme has been proposed that includes three successive interval zones: a Rodentia interval zone (Cf-1), a *Plesiadapis cookie* interval zone (Cf-2), and a *Copecion* interval zone (Cf-3). The Clarkforkian spans an interval from ~57.4-56.0 Ma, suggesting that these three Clarkforkian interval zones average <500 Ka in duration.

The Twelvemile Gulch local fauna (12MG) occurs near the western margin of the Great Divide Basin in southern WY. As currently understood, 12MG includes 21 species of mammals, among which the rodent *Acritoparamys atwateri* enables it to be assigned to the Clarkforkian NALMA. 12MG lies ~32 km north of Big Multi Quarry (BMQ) near Bitter Creek, WY. BMQ is currently the most diverse Clarkforkian fauna known, with 43 species of mammals. Two other Clarkforkian faunas from outside the CFB in WY are known: Buckman Hollow in the Green River Basin and various sites in the Purdy Basin near Togwotee Pass. Attempts to extend the biozonation scheme developed in the CFB elsewhere in WY have been problematic, partly because all the latter faunas might plausibly be referred to the Cf-2 biozone based on the common presence of *P. cookei*. Not only would this imply that all four of these Clarkforkian assemblages sample the same limited interval (<500 Ka), it also conflicts with biostratigraphic evidence that 12MG is significantly younger than BMQ.

An alternative to relying on *P. cookie* for biozonation of the Clarkforkian focuses on immigrant clades. Coryphodontidae (Pantodonta) and Miacidae (Carnivoramorphia) appear virtually synchronously in the CFB, near the midpoint of the local Clarkforkian section. Both taxa can be interpreted as invasive clades from Asia, making them excellent candidates as index fossils. *Coryphodon* is one of the largest Clarkforkian mammals, and it rapidly becomes abundant after its first appearance. We propose the *Coryphodon* interval zone as a new Clarkforkian biozone, preceded by the Rodentia interval zone and followed by the Wasatchian. This biozonation scheme allows us to discriminate earlier Clarkforkian faunas like BMQ from later Clarkforkian faunas like 12MG. It also facilitates intercontinental correlation with faunas like Petit Pâtis in the Paris Basin, which likely correlates with the *Coryphodon* interval zone based on the occurrence of a miacid there.

Funding Sources This research was supported by NSF-BCS 1227329 and the David B. Jones Foundation. Fieldwork was facilitated by BLM permits 287-WY-PA95 and PA15-WY-234.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A survey of paleopathologies in the Early Cretaceous therizinosaurian *Falcarius utahensis* from the Crystal Geyser Quarry, Utah, USA

Beguesse, Kyla A.^{1,2}, Freimuth, William J.^{1,2}, Herzog, Lisa², Zanno, Lindsay E.^{1,2}

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States

Paleopathological surveys of mass-death events are valuable in that they capture a broad snapshot of a species health, injury or disease status in a single time and place, in contrast to attritional assemblages. Such data can be used to understand the frequency, skeletal distribution, and age distribution of trauma and disease at the population level, a scale that is difficult to study in the fossil record.

One such sample is that of the early-diverging, therizinosaurian dinosaur, *Falcarius utahensis*, recovered from the Crystal Geyser Quarry (CGQ), a paucispecific bonebed in the Lower Cretaceous Cedar Mountain Formation of Utah. CGQ comprises hundreds of individuals of various ontogenetic stages hypothesized to have perished in one or two catastrophic events. Although taphonomic studies have yielded important information on the depositional history of the quarry itself, the cause of this mass mortality event has remained unresolved for over two decades. Here we add new data to the CGQ mass death assemblage, and behavior of *F. utahensis* by surveying the assemblage for evidence of pathology.

Of the 1511 *F. utahensis* specimens available for study, only four elements exhibit pathology, including a right metatarsal II, left humerus, right tibia, and left tibia. Based on the depositional distance and size variation, it is unlikely that any of these elements are from the same individual. Evaluation via macroscopic, histologic, and computed tomography reveal different processes occurring in each element; three suggest trauma whereas the other an infectious cause. Overall, CGQ exhibits a relatively low frequency of pathology (0.26% of elements) and an uneven skeletal distribution pattern of solely appendicular elements, with 75% of pathologies localized to the hindlimb (50% tibiae). This pattern differs from the frequency (0.2–3.1%) and skeletal distribution (primarily axial/pedal) of pathologies from other

monospecific dinosaur assemblages, hinting at behavioral or other paleobiological differences in *F. utahensis*.

Further research is required to evaluate the prevalence of additional *F. utahensis* pathologies, and if these pathologies have any correlation with the mass mortality event(s). These data will ultimately help us piece together key components in the paleobiology of this enigmatic dinosaur, and may also reveal potential mechanisms of mortality that may have resulted in such a unique mass death assemblage.

Funding Sources This material is based upon work supported by the National Science Foundation award #1925973 to Lindsay E. Zanno.

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

**Body fossils versus footprints –
Investigating the taphonomy and
paleoecology of contrasting records of a
Pleistocene vertebrate community in the
Turkana Basin, Kenya**

Behrensmeyer, Anna K.¹, Roach, Neil²,
Hatala, Kevin G.³

¹Paleobiology, Smithsonian Institution,
Arlington, Virginia, United States, ²Human
Evolutionary Biology, Harvard University,
Cambridge, Massachusetts, United
States, ³Biology, Chatham University,
Pittsburgh, Pennsylvania, United States

The Turkana Basin, northern Kenya, preserves a well-studied and diverse Plio-Pleistocene vertebrate fossil record including multiple hominin taxa. Deposits in the 1.6-1.4 Ma Okote Mb of the Koobi Fora Formation contain numerous bedding surfaces with hominin and other vertebrate footprints as well as abundant body fossils. These sources of faunal evidence occur in different but interfingering fluvio-lacustrine lithofacies in

two regions of East Turkana and are contemporaneous within the same 200 kyr interval, based on Ar-Ar dating and correlation of volcanoclastic units. Variable collecting strategies have resulted in samples of the Okote paleocommunity with different degrees of time-averaging and other potential biases. Catalogued fossils represent >100kyr resolution and collecting favored some taxa over others, while standardized surveys at specific stratigraphic levels and excavations represent ~10²-10⁴ years and are free of collecting biases. In contrast, individual track surfaces record activities within hours to days, and species representation is limited by environment and animal behavior. All these samples provide evidence about the Okote Mb vertebrate community, and taxonomic abundance comparisons highlight unique information and biases affecting each data type. Catalogue records have high numbers of primates (including hominins) and low representation of large taxa such as hippo and elephant, thus are not reliable indicators of taxon abundance. In the northern area (Ileret, Areas 1A, 8A), the standardized sample is dominated by bovid+suid (49%), reptile (mainly crocodilian teeth) (19%) and hippopotamus (18%); hominins and birds are rare at <1%. Identifiable footprints (N=205) from a set of 20 randomized excavations = 86% bovid+suid, 2% reptile, 2% hippopotamus, 4% hominin and 5% bird, (including giant stork). In the southern area (Koobi Fora, Area 103, ~40 km from Ileret), standardized samples have 29% bovid+suid, 41% reptile, 17% hippopotamus, 0% hominin and 3% bird. In contrast, 55 tracks from one excavation are 17% bovid+suid, 69% hippopotamus, and 14% hominin. Footprint records sample animal activities in specific shoreline environments and are unlikely to mirror paleocommunity composition based on body fossils. Comparisons of taxonomic abundances in the two datasets suggest that rare taxa such as birds and hominins were habitual users of lakeshore environments,

contributing to broader understanding of the vertebrate community.

Funding Sources NSF Grant EAR77-23149, BCS - 1128170, 0924476, 1232522; DGE – 0801634; EAR77-23149; SMA - 1409612; National Geographic Society, W.H. Donner Foundation.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Evidence for clinging scansoriality in a stem lepidosaur from the Middle Jurassic of Scotland

Benson, Roger B.¹, Ford, David², Griffiths, Elizabeth³, Evans, Susan⁴

¹Department of Vertebrate Paleontology, American Museum of Natural History, New York, New York, United States, ²Natural History Museum, London, United Kingdom, ³University of Oxford, Oxford, United Kingdom, ⁴University College London, London, United Kingdom

Lepidosaurs include more than 10,000 living species of squamates, plus *Sphenodon* the tuatara. This ecologically diverse and speciose group had originated by the Early Triassic. However, both stem lepidosaurs and stem squamates are poorly represented in the fossil record, with few species known, primarily from incomplete specimens, and subject to great phylogenetic uncertainty. This causes a substantial knowledge gap regarding deep evolutionary divergences of the lepidosaur total group, including their ecological traits. *Marmoretta oxoniensis*, from the Middle Jurassic of the UK, is one of the most completely known candidate stem lepidosaurs, although some recent studies have returned it instead as an early-diverging stem squamate. Previous studies proposed that it may be semiaquatic, based primarily on its abundance in marginal marine rocks. A partial skeleton of *Marmoretta* comprising the

skull, forelimb and large parts of the vertebral column was reported in 1994 from the Kilmaluag Formation (Bathonian) of the Isle of Skye, Scotland, but is largely embedded in rock yielding only incomplete anatomical knowledge. We used synchrotron micro-computed tomography to obtain a complete visualization of the preserved anatomy of this specimen. The forelimb includes a near-complete left hand with features that have classically been interpreted as evidence of clinging scansorial habits in squamates, including proportionally long phalanges (when compared to metacarpus length), and elongate penultimate phalanges which curve distoventrally along their lengths. However, inferences of scansorial habits from manual proportions in fossil amniotes have typically been based on datasets that are focused on mammals and may not be appropriate for lepidosaurs. We therefore present an extended training dataset of manual proportions and habitat use (e.g. clinging scansorial|grasping scansorial|terrestrial), focused on extant squamates. We use this to evaluate the habitat use of *Marmoretta*. Our linear discriminant analysis returns strong evidence for clinging scansoriality in *Marmoretta* (posterior probability = 0.91), which clusters among scansorial gekkotans and iguanians in our principal component analysis. Evidence of scansoriality in *Marmoretta* provides the first information about habitat use in a stem lepidosaurs and illuminates the vertical structure of ecological communities of mid Mesozoic.

Funding Sources European Synchrotron Radiation Facility

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

At the feet of the dinosaurs: undergraduate projects lead to more than 20 publications

Benton, Michael J.

Earth Sciences, University of Bristol, Bristol, United Kingdom

Since 2011, undergraduates have been recruited to summer internships at the University of Bristol, and set the task of mastering the practicalities and the palaeontology of Rhaetian (latest Triassic)-aged microvertebrate faunas. The aim has been to encourage them to produce work of publishable quality. Through group training in the laboratory methods (acid digestion of bonebed samples, formal anatomical description, stacking image microphotography, digital image generation), about 50 students have completed the program, and more than 20 publications have emerged. Many projects involve fieldwork and collection of material, and in all cases the bonebeds are put in geological context. Some students adapt quickly and complete the work in good time, whereas others work better as members of teams, and the eventual publication involves diverse contributions by each student. Most of the first authors of the papers have since gone on to PhD programs, and some have now completed. This has been a pioneering effort but modern approaches, including the fact that journals now regularly publish colour images, have made a classic kind of fundamental paleontological research into an attractive training program for students, but also a means to complete the kinds of fundamental studies that can often be neglected.

Funding Sources None

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Bite force and gape reconstruction of South African sabertooth and non-sabertooth felids

Berger, Arin, Brown, Reece A, Deutsch, Ashley R, Hartstone-Rose, Adam

Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

Masticatory gape and bite force provide important insight into dietary ecology, feeding, and social behaviors in living felids but cannot be directly observed in extinct taxa. However, it is possible to use our understanding of the soft-tissue anatomy of modern felids to reconstruct the myological abilities of fossil specimens. To this end, we have studied the osteological correlates of masticatory adductor fascicle length (which relates to myological stretch) and physiological cross-sectional area (which relates to myological force) in 11 species of modern felids spanning the entire extant body size range of the family (including *Felis nigripes* to *Panthera leo* and *P. tigris*), and use these correlates to estimate relative gape and bite force abilities in a diverse range of 17 South African fossil felids from the terminal Miocene site of Langebaanweg to the Pliocene and Pleistocene sites of Makapansgat and the Sterkfontein Valley. This sample includes 7 sabertooth specimens (representing *Dinofelis werdelini*, *Lokotunjailurus chinsamya*, and *Megantereon whitei*) as well as 10 non-sabertooth specimens. We found that the fossil non-machairodont felids from South Africa seem to span the body size range of the extant members of the family and have reconstructed gape and bite force abilities commensurate with that. As expected, our analyses confirm previous observations that sabertooths, in general, have relatively weaker bite forces. However, contrary to previous predictions, our fascicle length proxies suggest that *Dinofelis* and *Lokotunjailurus*, despite having larger reconstructed body masses, had fascicle lengths similar to those of the smallest *Panthera* species indicating an absence of extraordinary gape in these least morphologically “sabertooth” machairodonts. As has been previously

noted, the South African *Megantereon* are fairly divergent in size as are our reconstructed fascicle lengths with the smallest individuals having reconstructed fascicle lengths similar to those of caracals and ocelots and the largest individuals having reconstructed fascicle lengths falling between those of jaguars and tigers – both taxa that are thought to be much larger in body mass. While previous conclusions have been based on qualitative observations about osteological muscle attachment site, our myological approach allows for quantitative comparisons of these fossils to modern felid taxa.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Bone histology and life history of freshwater turtles (Testudines: Cryptodira)

Bhat, Mohd Shafi¹, Cullen, Thomas^{1,2}

¹Department of Geosciences, Auburn University, Auburn, Alabama, United States, ²Department of Earth Sciences, Carleton University, Ottawa, Ontario, Canada

The growth dynamics and lifestyle habits of freshwater turtles is poorly understood. This is the first ever study that examines the growth pattern and lifestyle habits of the freshwater snapping turtles *Chelydra* and *Macrochelys* based on limb bone histology. In our study, femora, humeri, and tibiae of twenty-five individuals selected from a range of ontogenetic stages were assessed to determine inter-element and intraskeletal histological variation. Osteohistological assessment of multiple elements is consistent with overall moderate growth rates as revealed by the dominance of parallel fibered bone. However, the growth was episodic as shown by deposition of multiple LAGs in the compacta. It appears that *C. serpentina* bone tissue is more variable through ontogeny with intermittent higher

growth rates. *M. temminckii* appears to grow more slowly than *C. serpentina* possessing compact and thick cortices in accordance with their larger size. Overall, vascularisation decreases through ontogeny with humeri and femora being well vascularized in both species. Contrarily, epipodials are poorly vascularised, though simple longitudinal and radial canals are present, suggesting differences in growth pattern when compared with associated diaphyseal sections. The tibiae were found to be the least remodeled of the limb bones and therefore better suited for skeletochronology for snapping turtles. Intra-elementally, femora and humeri preserved higher cortical vascularity ventrally, suggestive of faster relative growth. We hypothesize that the differential growth pattern in limb bones of snapping turtles may relate to differential functional constraints, where forelimbs are operational in swimming while the hindlimbs provide stability.

Funding Sources This work is supported through project grants to TMC and postdoctoral support to MSB.

Regular Poster Session 2 (Thursday, October
31, 2024, 4:30 - 6:30 PM)

A comparison of the gigantism of Mesozoic ichthyosaurs and Cenozoic whales

Bi, Yuntian², Li, Guozhen¹

¹HD Beijing Secondary School, Beijing, Beijing, China, ²School of Earth and Space Sciences, Peking university, Beijing, Beijing, China

As the most successful tetrapod amniotes to venture into marine environments, Mesozoic ichthyosaurs and Cenozoic cetaceans, with comparable body shapes, body sizes and life styles, have attracted significant attention from evolutionary biologists. Both clades became the apex predators respectively in their own marine ecosystems, and some of

them became gigantic creatures which are capable of reaching lengths of more than 20 meters. One key question is whether the gigantism observed in both clades was driven by similar factors. However, given their distant systematic relationships and disparate epochs of existence, whether their processes of gigantism can be straightforwardly analogized is ripe for discussion. Ichthyosaurs, as reptiles, differ notably from mammalian cetaceans in their path to gigantism, particularly regarding spinal morphology and vertebral count changes, which may stem from variations in metabolism and developmental growth. By examining the morphological and numerical alterations of vertebrae during the gigantism process in these two marine amniote clades, along with the proportion of individual vertebrae in total length, we can explore how segmentation genes influence the development of gigantism through differential expression, highlighting differences between ichthyosaurs and whales.

Through comparing the gigantism of ichthyosaurs and whales, we propose that cetacean gigantism occurred primarily through the enlargement of individual vertebrae without extensive structural modifications to the skeletal system, a process potentially linked to environmental shifts and altered nutritional regimes. Conversely, ichthyosaur gigantism was mainly achieved through an increase in the number of vertebral segments, a mechanism tied to the expression of segmentation genes. While both groups underwent gigantism, the specific pathways and underlying reasons for this phenomenon diverge between the two clades.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

**Cranial anatomy of *Phenacolemur pagei*
(Paromomyidae, Euarchonta, Mammalia)**

from the late Paleocene of northwestern Wyoming

Bloch, Jonathan I.¹, Crowell, Jordan W.^{2,3}, Boyer, Doug⁴, Gawlak, Dana S.⁵, Houde, Peter⁶, Silcox, Mary T.⁵

¹Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States, ²The Graduate Center, City University of New York, New York, New York, United States, ³New York Consortium in Evolutionary Primatology, New York, New York, United States, ⁴Department of Evolutionary Anthropology, Duke University, Durham, North Carolina, United States, ⁵Department of Anthropology, University of Toronto Scarborough, Toronto, Ontario, Canada, ⁶Biology Department, New Mexico State University, Las Cruces, New Mexico, United States

Paleogene paromomyids are small euarchontan mammals with primate-like molars indicating a mixed diet with an emphasis on frugivory, and postcranials suggestive of agile arboreal behaviors including climbing on large and small diameter supports. A previously described well-preserved skull (USNM 421608) of the paromomyid *Ignacius graybullianus* from the early Eocene of Wyoming is often used as a model for the family when evaluating anatomy and relationships in the context of early primate evolution. Here we describe a new partial skull of a the paromomyid *Phenacolemur pagei* from the late Paleocene (Cf2 interval zone of the Clarkforkian North American Land Mammal Age) of the Clarks Fork Basin, Wyoming. In lateral view, the skull is undistorted and notably more domed than previously described for *Ignacius* (USNM 421608 is dorsoventrally flattened) with similarity to the extant marsupial sugar-glider *Petaurus*, possibly reflecting a similar gummivorous diet, as has been suggested based on paromomyid tooth and lower jaw morphology. A partial endocast produced using microCT data shows overall similarity to

what has been previously described for *Ignacius*, including relatively large olfactory bulbs that, when analyzed as a percentage of body mass based on associated postcrania (femur, humerus; ~529g), are 0.038% in *Phenacolemur pagei* compared to 0.049% in the somewhat smaller (~400g) *Ignacius graybullianus*. The dorsal surface of the jugal has a smooth crescentic facet with a short dorsal process that has not previously been observed in paromomyids, allowing for more accurate assessment of orbit size. Optic foramen size metrics of *Phenacolemur* (OFI = 0.83; OFQ = -43.8) are lower than that of *Ignacius*, suggesting a more nocturnal or cathemeral activity pattern. Although incomplete, the bulla of *Phenacolemur* has more of a petrosal contribution than interpreted for *Ignacius*. The posterior carotid foramen is very small and the absence of grooves for branches of the internal carotid artery on the surface of the promontorium suggests that it was non-functional. The orbital mosaic is well preserved in the new skull, with clear sutures showing a large lacrimal and frontal, and small palatine contribution in the posteroventral aspect of the orbit that does not contact the lacrimal. The orbital foramina are perfectly preserved and allow for resolution of long-standing debates about this region in paromomyids, which were based on less well-preserved specimens in this region.

Funding Sources This study was supported by funds from the Florida Museum of Natural History to JIB, NSERC to MTS, and NSF BCS 1552848 & DBI 2149257 to DB.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Advantages of 3D models in science education and outreach: example from the Popo Agie Formation

Blomberg, Owen H.¹, Lovelace, David M.^{2,1}, Hartman, Scott³, Kufner, Aaron M.^{2,1}

¹UW Geology Museum, University of Wisconsin-Madison, Wellesley, Massachusetts, United States, ²Department of Geoscience, University of Wisconsin-Madison, Madison, Wisconsin, United States, ³Department of Integrative Biology, University of Wisconsin-Madison, Madison, Wisconsin, United States

Paleontology is the window through which the history of life is viewed. Yet there is often a disconnect between what is known and how that information is perceived by the public. This disparity is exacerbated with taxa unfamiliar to the public, fragmentary taxa, and when museum displays or outreach imagery are difficult to update with new information. One solution is the creation of 3D models that are easy to edit as new information arises, poseable so they can be repurposed across more outreach programs, easily shareable, and can be 3D printed at any scale on today's cost-effective 3D printers.

As a test case, we present the Popo Agie Formation of Wyoming which has yielded fragmentary remains of rhynchosaurs, poposaurids, and temnospondyls. Using 3D sculpting software ZBrush, and guided by phylogenetic bracketing, we modeled *Beesiiwo*, *Poposaurus*, and *Buettnererpeton*. ZBrush is relatively inexpensive for educational and research use, can be run on modest computer hardware, and allows for models to be rapidly updated as necessary if new information is recovered in the future. The models presented here were made for a small scale exhibit to print as a single object on a Formlabs Form 3 resin printer (build volume: 14.5 x 14.5 x 18.5 cm), but the models are easily scalable. The models can also be easily shared via online 3D repositories such as Morphosource or SketchFab.

Utilizing the free 3D program Blender, computer models also allow for animation and the potential for scientific simulation by

developing an underlying control hierarchy or “rig”. We rigged the model of *Buettneriherpeton* with a biologically plausible range of motion, as inferred from osteological constraints and extant phylogenetic bracket taxa such as salamanders. This allows plausible but dynamic postures for the models to be used as artistic reference, outreach manipulatives, or in exhibits creating a more engaging and meaningful experience for museum visitors.

Funding Sources David B. Jones Foundation.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Hunting for an answer: new insights on the predatory ecomorphology of *Borophagus*

Bogner, Emily^{1,2}, Savani, Anissa¹, Tseng, Z. Jack^{1,2}

¹Integrative Biology, University of California Berkeley, Berkeley, California, United States, ²University of California Museum of Paleontology, Berkeley, California, United States

Borophagine canids were a diverse and successful lineage of predators that thrived throughout North America for nearly 30 million years. As borophagines evolved, their skulls exhibit morphological traits convergent with those of hyaenids and later-diverging genera, such as *Borophagus*, are often referred to as bone-cracking dogs. Unlike the skull, the postcranial anatomy of *Borophagus* is not as well understood. *Borophagus* had robust limbs with proportionally longer proximal elements and shorter distal elements, which has been interpreted as being flexible in its predatory strategies, but contrasts with other fossil and extant canids that show a general trend toward pursuit-hunting habits. A perceived lack of suitable modern analogs makes reconstruction of *Borophagus*' predatory ecomorphology difficult. Additionally, previous studies

examined the cranial and postcranial skeleton separately, but to understand predatory ecomorphology it is important we assess the skeletal morphology as a whole. This project utilizes 3D geometric morphometrics and phylogenetic comparative methods to compare the skull, humerus, and femur morphology of *Borophagus* with 12 extant genera from seven families of Carnivora. Results from principal component and discriminant function analyses indicate *Borophagus*' skull shares some morphological similarities with hyaenids, but is more likely to be grouped with felids and canids. When assessing *Borophagus*' postcranial skeleton, the humerus shares morphological characteristics with felids and ursids, and the femur bears a striking resemblance to ursids. Combining the cranial and postcranial results, we get a rough picture of the predatory ecomorphology of *Borophagus*. As its name implies, *Borophagus* was most likely a bone cracker as the maxillary anatomy and sagittal crest are morphological characteristics that liken *Borophagus* to hyaenids, whereas the post-dental cranial anatomy reflects features similar to canids and felids. A shallow trochlea, enlarged medial epicondyle, and robust deltopectoral crest would increase supination and dexterity for grappling prey and climbing, but would limit maximum achievable speed as a trade-off. Lastly, a robust femur can be beneficial for resisting axial and bending stresses during digging or withstanding body weight loads generated while hunting. Ongoing research with additional skeletal elements will be of importance to more completely understand the predatory ecomorphology of *Borophagus*.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

Description of the southern Illinois colosteid braincase via x-ray computed tomography

Bohus, Caleb P.¹, Miyashita, Tetsuto², Fraser, Danielle², Maddin, Hillary C.¹

¹Earth Sciences, Carleton University, Ottawa, Ontario, Canada, ²Beaty Centre for Species Discovery and Palaeobiology Section, Canadian Museum of Nature, Ottawa, Ontario, Canada

Colosteids are a group of stem tetrapods typically known from the Late Mississippian to the Early Pennsylvanian times. Colosteids, such as *Greererpeton burkemorani*, are well described in the literature. However, their braincases are relatively understudied compared to other stem tetrapods (e.g., *Ichthyostega*, & *Acanthostega*), even though numerous skulls are preserved with complete, albeit crushed, braincases. A previously reported specimen of *Greererpeton*, KUV 87695, from southern Illinois has an exceptionally well-preserved skull with little to no taphonomic deformation. The southern Illinois colosteid material was collected in 1984 by field parties from KUV and attributed to *Greererpeton burkemorani*, and was never fully described. We recently examined the southern Illinois specimens and propose here that they instead belong to a potentially new genus of colosteid altogether. KUV 87695 has been CT scanned, which revealed an intact braincase, and with segmentation we reconstructed the endocast to interpret its neuroanatomy. Not surprisingly, the braincase shares many similarities with *Greererpeton*, such as large fan-like stapes and separation of the sphenethmoid from the otico-occipital region. However there are several aspects of anatomy that are not described in *Greererpeton*, such as a large, wing-like extension of the parasphenoid that contacts the stapes, and a buccohypophyseal canal. This is the most complete colosteid braincase ever reported and is the first in this lineage to be described utilizing a micro-CT dataset. This new work elucidates parts of the colosteid braincase anatomy never before described, and makes

it one of the few early tetrapods with a relatively complete braincase that receives a thorough description.

Funding Sources NSERC Alliance Grant

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Depictions of paleontology in three major American newspapers in the 1990s, a key period in the history of paleontological portrayals in the media

Boll, Eric

E.W. Scripps School of Journalism, Ohio University, Athens, Ohio, United States

Paleontology has long been of broad interest to the public, often communicated via journalists and the media. This project is an exploratory content analysis of US newspaper paleontology coverage during the 1990s, seeking to document data relevant to both paleontologists and journalists. For journalists, this study provides insights into the media's failings, successes, and commonly used tropes when reporting on paleontology. For paleontologists, this project analyzes which eras of prehistory receive the most media attention, which paleontologists were the darlings of the media, and the shifting relationship between media and scientists.

This study examined 239 paleontology-focused articles from *USA Today*, *NYT*, and *The Associated Press* as part of the author's journalism master's degree research. This study recorded the era of prehistory discussed, paleontologists spoken with, the topic within paleontology (e.g., commercial collecting), the occurrence rate of common criticisms (e.g., journalists misusing Latin), the "mascotification" of certain species, the depiction of paleontologists as Indiana Jones-esque adventurers, and to what extent the

Jurassic Park film franchise caused news media to devote more resources to covering paleontology. This study used several communications research theories including the visible scientist, framing, agenda setting, and news values.

Unsurprisingly, the paleontologists identified as "visible scientists" in this study are commonly known: John Ostrom, Robert Bakker, and Paul Sereno, to name a few. Similarly unsurprisingly, the "mascotification" of certain species was the most common trope observed by this study, offering a valuable tool for journalists to communicate a vast amount of information with few words (e.g., "*Afrovenator* was the *T. rex* of Jurassic North Africa"). Other notable findings include that in the 1990s journalists were better with Latin names than they get credit for and the Indiana Jones-esque adventurer is rare in routine coverage but common in profiles and has existed since ancient times. Findings relevant to journalism include the need to develop an adapted news values theory for use in science communication studies, the emphasis on "broad science" rather than specific theories, and that the National Science Foundation intentionally released paleontology research timed to take advantage of *Jurassic Park*'s theatrical release.

Funding Sources Funding for this work was received from an AmeriCorps education grant ID# 1591632

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Rare earth elemental concentrations as a novel proxy for lateral continuity: an initial case study at the Hanson Ranch Bonebed, Cretaceous Lance Formation, Wyoming

Booth, Skylor L.¹, Synder, Keith², Chadwick, Arthur³, Ash, Richard⁴, Ullmann, Paul¹

¹Geology and Geological Engineering, University of North Dakota, Northfield, New Jersey, United States, ²Biology, Southern Adventist University, Collegedale, Tennessee, United States, ³Biological Sciences, Southwestern Adventist University, Keene, Texas, United States, ⁴Geology, University of Maryland, College Park, Maryland, United States

The Hanson Ranch (HR) Bonebed in the Cretaceous Lance Formation of eastern Wyoming is a monodominant assemblage containing thousands of bones of the hadrosaurid *Edmontosaurus*. So far, five "main quarries" have been opened in the largest exposure of the bonebed, as well as three quarries in an adjacent butte. Prior taphonomic analyses of the main quarries indicated the HR Bonebed represents a partially reworked or short-distance-transported mass death assemblage, and that this depositional history has imparted infrequent attritional signatures onto the assemblage. We performed trace element analyses of seven bones from one of the nearby quarries, Neufeld, to determine if the compositions of bones within this presumed lateral continuation of the HR Bonebed are consistent with those of bones in the main quarries. Our comparisons constituted the first use of trace elements not simply for stratigraphic correlation, but also as a means of verifying a potential case of the geologic principle of lateral continuity. Bones from both the main quarries and Neufeld exhibit similar patterns of elemental alteration, such as concentrations of lanthanum dropping < 500 ppm by 2 mm into the external cortex and variation of shale-standardized rare earth element (REE) compositions within just one order of magnitude. Several bones from each locality exhibit oversteepened and surficially-leached concentration-depth profiles, evidence of diffusion from within the medullary cavity, and spikes in europium and holmium relative to neighboring REEs. Most bones also exhibit positive

(Ce/Ce*)_N anomalies within the external cortex, indicating that surficial trace element uptake primarily occurred under reducing conditions. Additionally, typical REE fractionation patterns are evident in specimens from both sites, with increasing concentrations of heavy REEs at greater cortical depths. Although uniform trace element concentrations and/or signatures would be ideal to demonstrate lateral continuity of the assemblage between the sites, their close geographic proximity (~250 m), overlapping faunal representations, and the similar chemical and taphonomic alteration to fossils at each site provide compelling evidence that the fossil horizon at the Neufeld quarry is a lateral continuation of the HR Bonebed assemblage exposed at the five main quarries. In the future, stratigraphic data could be used to independently test this conclusion.

Funding Sources This research was supported by Southwestern Adventist University and the University of North Dakota.

site in southern Spain, boasts Europe's oldest evidence of controlled fire usage and bifacially flaked handaxe, along with well-preserved faunal remains. Excavations from 1990-2023 yielded 816 individual avian samples, with bones identified to various taxonomic levels. A total of 53 species were identified. High and medium-confidence species were analyzed for their associations with specific modern habitats using the IUCN Habitat Classification Scheme. Comparisons with contemporary avifauna suggest the past presence of a freshwater lake, temperate forest, grassland, rocky area, and temperate shrubland. This diversity highlights the environmental suitability of Cueva Negra for human habitation and suggests a relationship between habitat diversity and hominin settlement patterns.

Funding Sources Funding was provided by the Murcian Association for the Study of Palaeoanthropology and the Quaternary and the Joukowsky Institute for Archaeology and the Ancient World.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Inferring environmental conditions at a late Early Pleistocene site using avifauna

Bornheim, Sierra^{1,2}, Gatesy, Stephen¹, López Martínez, Mariano², Haber Uriarte, María^{2,3}, López Jiménez, Antonio², Linares Matás, Gonzalo^{2,4}, Walker, Michael²

¹Biology, Brown University, Providence, Rhode Island, United States, ²Murcian Association for the Study of Palaeoanthropology and the Quaternary, Murcia, Spain, ³Universidad de Murcia, Murcia, Spain, ⁴University of Cambridge, Cambridge, United Kingdom

Avian remains offer valuable insights into past environments because of their well-defined and extensively studied ecological niches. Cueva Negra, a late early Pleistocene

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The state of Quaternary vertebrate paleontology research in the Caribbean: areas of rigor and opportunities for growth

Boville, Alexandra, Jacisin, John, Kemp, Melissa

Integrative Biology, The University of Texas at Austin, Austin, Texas, United States

Paleontological research has flourished in the Caribbean for well over 150 years, providing deep insight into the biogeography, extinction and diversification dynamics, and ecological processes of a globally significant insular biodiversity hotspot. These data not only prove pivotal in contextualizing modern-day patterns of biodiversity, but they can also play a role in safeguarding Caribbean biotas from

future global changes that disproportionately impact insular systems. As Caribbean paleontology continues to grow, it is important to take a step back and evaluate where our knowledge is deepest, as well as areas of opportunity for future growth and discovery. Through an extensive literature search that centers Quaternary vertebrate paleontology, we compile a database of over 600 publications spanning the years 1902-2024 with the goal of characterizing the state of Caribbean vertebrate paleontology research. We note a broad geographic distribution of paleontological sites across all three island groups, though the main islands of the Greater Antilles and select islands of the Bahamas and Lesser Antilles dominate the literature. Additionally, there is great disparity in terms of taxonomic representation, with mammals being the most well-represented vertebrate group, whereas descriptions of herpetofauna are much rarer. Many studies lack clarity about the excavation methods employed, making it difficult to determine if disparities in taxonomic diversity are due to methodological biases, taphonomic processes, or a combination of factors. We delve into the paleobiology of several sites distributed across this region to explore the availability of ancillary data such as abiotic climate proxies and radiocarbon dates, in addition to potential biases between well excavated sites and the vertebrate diversity identified. We also examine patterns of authorship and specimen accession to evaluate who has opportunity and access to Caribbean vertebrate fossil specimens. This review, while primarily composed of English literature, incorporates literature in multiple other languages and international journals to expand and diversify our knowledge of this region. Based on our review we identify areas of opportunity for future research and collaboration within the Caribbean paleontology community.

Funding Sources Funding for this work was received from NSF Grant 2050228.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Making a good impression: identification of multiple diagenetic pathways for the formation of dinosaurian ‘mummies’

Boyd, Clint A.¹, Drumheller, Stephanie K.³, Householder, Mindy L.⁴, Woodruff, Cary²

¹Paleontological Resource Protection, North Dakota Geological Survey, Bismarck, North Dakota, United States, ²Earth and Planetary Sciences, University of Tennessee, Knoxville, Tennessee, United States, ³State Historical Society of North Dakota, Bismarck, North Dakota, United States, ⁴Phillip & Patricia Frost Museum of Science, Miami, Florida, United States

The preservation of dinosaurian 'mummies' is poorly understood, with most explanations centering on rapid burial, resulting in impressions of soft tissues which backfill with sediment forming natural casts. However, not all 'mummies' fit within this paradigm and several exhibit features consistent with long-term exposure pre-burial and then direct mineralization of the dermal tissues. To explore these disparate signals, we employed a pXRF to determine the composition of the bone, reported dermal tissues, and the encasing matrix in four ornithischian dinosaur 'mummies': GPDM 115.001 (*Brachylophosaurus canadensis*: Judith River Fm.); SMF R 4050 (*Edmontosaurus annectens*: Lance Fm.); NDGS 2000 (*Edmontosaurus* sp.: Hell Creek Fm.); and, MOR 979 (*Thescelosaurus* sp.: Hell Creek Fm.). All four specimens display evidence of long-term exposure prior to burial, matching the proposed desiccation and deflation model of natural mummification. Within each specimen, bone

samples preserved a consistent signal, containing significantly elevated concentrations of Ca, Cr, Cu, Hg, P, Sr, Th, U, and Y relative to matrix and dermal tissue samples. Dermal tissue samples in NDGS 2000 and MOR 979 contained significantly elevated concentrations of Ag, Fe, Mn, Mo, and Ni relative to other samples from the same specimens and relative to dermal tissue samples from GPDM 115.001 and SMF R 4050. In fact, dermal tissue samples from the latter two specimens are largely geochemically indistinguishable from their respective matrix samples. To further investigate those differences, we made thin sections of the proposed dermal tissues of NDGS 2000 and GPDM 115.001. In NDGS 2000, the dermal tissues preserve portions of the original three-dimensional dermal structures via replacement with either siderite or iron oxides. The putative dermal tissues of GPDM 115.001, in comparison, are actually thin layers of clay minerals, indicating they were formed by sediment infilling of skin impressions. Based on these findings, we propose that three-dimensionally preserved dermal tissues do not fossilize via the same process as bone and other hard tissues; instead, they display a distinct geochemical signature that may explain their relative rarity in the fossil record. It is clear that the term ‘mummy’ has been used as a taphonomic catch-all for a variety of disparate fossilization pathways and more work is needed to delimitate those pathways and understand the diagenetic conditions under which they form.

Funding Sources Funding for this work was provided by the State of North Dakota and the David B. Jones Foundation.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Phylogenetic analysis of stem, toothed mysticetes and their relationships to archaeocetes and odontocetes

Brand, Nickolas A.^{2,1}, Uhen, Mark D.³, Peredo, Carlos M.⁴

¹Schiele Museum of Natural History, Gastonia, North Carolina, United States, ²Environmental Science and Policy, George Mason University, Reston, Virginia, United States, ³Department of Atmospheric, Oceanic, and Earth Sciences, George Mason University, Fairfax, Virginia, United States, ⁴Department of Biological Sciences, Miami University, Oxford, Ohio, United States

The split between the mysticetes and odontocetes, together forming the Neoceti, is one of the most consistently supported phylogenetic hypotheses in cetacean evolution. While extant mysticetes are edentulous as adults, many representatives of this group traditionally recovered outside of crown Mysticeti possess large, multicusped teeth reminiscent of those seen in early odontocetes and basilosaurid archaeocetes. Recent phylogenetic analyses conducted across independent research efforts have yielded a novel topology, wherein non-aetiocetid toothed “mysticetes” are recovered outside of Crown Cetacea, prior to the mysticete-odontocete split. This analysis uses a supermatrix to test this new phylogenetic hypothesis, which positions many stem “mysticetes” as highly derived archaeocetes, or stem neocetes depending on definitions used. This dataset contains 70 taxa coded for 505 morphological characters, with coverage focusing on stem mysticetes, the most basally branching odontocetes, and recently described kekenodontids. Phylogenetic analyses were conducted in PAUP using the random stepwise-addition heuristic search functionality. Two parsimony analyses were conducted with characters weighted equally, and with implied character weights ($k = 3$). Both analyses provided consensus topologies that support a

traditional model of neocete relationships, wherein mysticeti and odontoceti are sister groups, crownward of basilosaurid archaeocetes. The contested “stem neocete” taxa are all recovered as mysticetes, including kekenodontids, which are associated with *Coronodon* in both analyses. The equal weights analysis placed *Llanocetus* and *Mystacodon* as the basalmost mysticetes. Notably, the aetiocetids and mammalodontids are grouped into a monophyletic clade near the base of mysticeti. Under this model, *Niparajacetus* is the most derived mysticete retaining an adult dentition. The implied weights analysis placed *Coronodon* and the kekenodontids as the basalmost mysticetes, and included a monophyletic clade of mammalodontids and llanocetids just crownward of that group. *Niparajacetus* was again recovered as the most crownward mysticete retaining an adult dentition. Neither analysis supports the “stem neocete” hypothesis, suggesting that this hypothesis is not as parsimonious if a larger set of characters is used, or alternatively, that the difference in parsimony is small enough to be influenced by the addition of more characters from the literature.

Funding Sources Funding for this research was generously provided by the Presidential Scholarship fund of George Mason University.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Lost bones: Rediscovering county museum specimens to enrich Minnesota’s Quaternary fossil record

Brandel, Marcus G.¹, Hastings, Alex K.¹, DeVault, Grace¹, White, Richard²

¹Palaeontology, Science Museum of Minnesota, Saint Paul, Minnesota, United States, ²Palaeontology, The Mammoth Site, Hot Springs, South Dakota, United States

Through outreach and collaboration with 42 small town and county historical museums across the state of Minnesota, this volunteer effort aims to bring new specimens, additional taxa, enriched faunal distribution data, and increased regional sampling of Minnesota’s Pleistocene–Holocene Transition (PHT) fauna to the larger scientific community and the public.

Over the last year, as part of this Science Museum of Minnesota (SMM) effort, a volunteer has visited historical societies and smaller museums across the state to document PHT specimens in their collections. The resulting multi-institutional dataset includes the museum name, catalog number, display status, element, locality, provenance, date acquired, label/display text, and where possible, size, donor, GPS coordinates, and other supplemental data; including related newspaper or print articles and references in scientific publications, for each specimen. Data were collected either in person or in limited cases, via email. Accompanying scaled photographs were taken for nearly all specimens. Additionally, morphological metrics were recorded for two fairly complete Bison skulls for use in larger studies.

The PHT fauna from Minnesota documented through these collaborations includes mammals from the families Elephantidae, Mammutidae, Equidae, Bovidae, Cervidae, and Cricetidae; a bird from the family Anatidae; and unidentified material belonging to Testudines and Osteichthyes; with possible occurrences of the mammal families Sciuridae and Ursidae. Of the 42 museums contacted, 19 have been visited in person. A total of 227 specimens were documented, including, but not limited to, 25 isolated Bison skulls, 4 fully articulated Bison skeletons, 4 Bison assemblages, 9 mammoth molars, 9 mammoth tusks or tusk sections, 2 mastodon molars, and 1 mastodon tusk. The dataset and all supplemental materials have been shared with SMM and the host

institutions as part of this collaborative effort. The ultimate goal will be to share these data through large online biodiversity data aggregators. All Bison specimen data has also been made available to The Mammoth Site in Hot Springs, South Dakota. In addition, select specimens are shared weekly as part of a #LostBones series on Mastodon (@Sergeir), Twitter/X (@Sergeir), and Instagram (@mbrandel1) to increase public awareness of the PHT fossil record in Minnesota and to promote the multitude of local museums and historical societies involved.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Cross-sectional area of the maxillary canal suggests acutely developed facial sensation in gorgonopsians

Brant, Anna, Sidor, Christian A.

Department of Biology and Burke Museum of Natural History and Culture, University of Washington, Seattle, Washington, United States

The maxillary canal is an osseous tube that runs parallel to the alveolar margin of the maxilla and houses the maxillary branch of the trigeminal nerve (CN V). In extant reptiles, the maxillary canal is long and simple, with a small number of branches extending from the canal to terminate in neurovascular foramina above the teeth. Non-mammalian synapsids display an elongated maxillary canal similar to the reptilian condition, but exhibit a denser, more complex network of branching rami leading to foramina spread across the external surface of the maxilla. In non-mammalian Prozostrodontia, the maxillary canal becomes a foreshortened, non-ramified foramen. As such, the maxillary canal is partially homologous to the infraorbital foramen present in extant mammals. The infraorbital foramen allows for

passage of the infraorbital nerve (a branch of CN V), which continues anteriorly towards the rostrum and ramifies in soft tissue rather than in bone. Increased innervation by the infraorbital nerve has been correlated with important aspects of mammalian ecology, such as foraging behavior. Specifically, ecologies and behaviors that necessitate a higher degree of facial sensitivity, such as whisking in rodents and aquatic hunting in pinnipeds, have been shown to correspond with a larger cross-sectional area (CSA) of the infraorbital foramen. Despite the evidence suggesting that CSA of the infraorbital foramen covaries with facial sensitivity in extant mammals, this type of analysis has never been applied to the fossil specimens of non-mammalian therapsids.

Here, we present preliminary data on the CSA of the maxillary canal in gorgonopsians in order to infer degree of tactile facial sensitivity. We collected data on CSA of the maxillary canal and infraorbital foramen for a small sample of reptile and mammal skulls. CSA was then normalized relative to geometric mean cranial shape, a commonly used measure of skull size. When we compared the normalized CSA of gorgonopsian specimens to the normalized CSA of extant taxa, the gorgonopsians displayed values on par with that of modern crocodylians. Gorgonopsians therefore may have had facial sensitivity more refined than lizards and primates, but not as highly developed as mammals that rely heavily on vibrissae. Though further research is needed to substantiate these findings, our preliminary results suggest that some basal therapsids might have had a higher degree of facial somatosensation than previously suggested.

Funding Sources University of Washington Department of Biology

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

High-resolution track surface analysis for informing mitigation and resource preservation strategies at Dinosaur Ridge, Colorado

Breithaupt, Brent H.¹, Matthews, Neffra A.³, Murphey, Paul C.²

¹Wyoming State Office, Bureau of Land Management, Cheyenne, Wyoming, United States, ²Prehistoric Impressions, Lakewood, Colorado, United States, ³San Diego Natural History Museum, Department of Paleontology, San Diego, California, United States

Dinosaur tracks and trackways are the highlight of Dinosaur Ridge, an important paleontological area to the west of Denver, Colorado. These trace fossils are preserved in concave epirelief primarily in the Lower Cretaceous South Platte Formation of the Dakota Group. The best-known dinosaur track locality at Dinosaur Ridge is the Main Tracksite (DRMT), which preserves the most abundant tracks and trackways and is the type locality for two ichnospecies: the ornithomimid *Caririchnium leonardii* and the theropod *Magnoavipes caneeri*. Since 1938, mapping of tracks and trackways at Dinosaur Ridge has had three overlapping purposes. First, maps were prepared to document the tracks and trackways in support of scientific research, although evidence of vandalism was also recorded. Second, maps were developed as a part of the educational and interpretive mission of the Friends of Dinosaur Ridge (a non-profit organization established in 1989). And third, the creation of maps utilizing photogrammetric techniques as a means of precise geospatial documentation and track surface analysis, as efforts to monitor the DRMT and study the causes of track degradation. The degradation and loss of fossil footprints at Dinosaur Ridge

have been recognized for years, as studies focused on the causes of surface deterioration and rate of change at the DRMT have been auxiliary to the ichnological work. Between 2001 and 2023, a number of ground-based and UAS photogrammetric projects were conducted at DRMT, with basic photogrammetric best practices followed. Utilizing state-of-the-art technology, the 2023 photogrammetric work established a sub-millimeter resolution baseline dataset for the entire DRMT surface. The photogrammetry results supported anecdotal observations that had generally concluded that, although attritional erosion of the entire sandstone surface was a factor in overall track surface degradation, this was a minor factor in comparison with larger scale water, freeze-thaw, and gravitationally induced fragmentation, dislodging, and movement of sandstone fragments and slabs from the DRMT surface. Recognizing the need for further studies to monitor the rate of change and study the causes of track degradation, episodic, high-resolution photogrammetric analysis of the DRMT will continue through 2025. This documentation is critical for resource management and preservation, as well as shedding light on various aspects of dinosaur paleobiology, paleoecology, and behavior.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Cranial redescription of *Stegoceras validum* gives first look into skull morphology in Pachycephalosauria (Dinosauria: Ornithischia) informed by X-ray computed tomography

Brennan, Jennifer A.³, Alfano, Julia E.³, Evans, David¹, Currie, Philip J.², Forster, Catherine A.³

¹Biological Sciences, George Washington University, Washington, District of Columbia, United States, ²University of Toronto, Toronto,

Ontario, Canada, ³University of Alberta, Edmonton, Alberta, Canada

Pachycephalosauria is a clade of small-bodied ornithischian dinosaurs from the late Cretaceous of North America and Asia, known for their cranial ornamentation and thickened skull roofs. Most pachycephalosaurian specimens consist of isolated cranial bones, with frontoparietal skull elements being the most common. Post cranial elements are rare, so much of our understanding of pachycephalosaurian phylogenetics is based on incomplete cranial material. Thus, the phylogenetic relationships of Pachycephalosauria within Ornithischia are unclear. Relationships within Pachycephalosauria are also clouded by variation in ontogenetic development of cranial ornamentation and frontoparietal domes. Although X-ray computed tomography (CT) has been applied to pachycephalosaurian specimens for histological studies and nasal cavity reconstruction, CT data has not been used to assess the complete cranial skeleton. Here, we present the first complete cranial description for Pachycephalosauria informed by CT scans and corroborated by direct osteological observation. We reconstruct the cranium, mandible, and dental morphology of a *Stegoceras validum* specimen (UALVP-2), one of the best-preserved examples of North American Pachycephalosauridae. We find evidence that UALVP-2 is a subadult specimen based on the presence of multiple sutures with variable patency throughout the cranium. Partial suturing exists at the medioventral contact of the frontal and parietal bones but is completely fused in the coronal region of the cranial dome. We also find asymmetrical suture patency and fusion with two supraorbital bones present on the right and a singular fused supraorbital complex present on the left side of the skull. In contrast to previous anatomical descriptions, we did not find any fusion of the prefrontal bones with the supraorbital bones

on either side of the skull. Our work underscores the utility of CT scanning for investigating key anatomical and developmental characteristics that will be critical for future clarification of pachycephalosaurian ontogenetics, systematics, and taxonomy. We encourage further efforts to digitize additional pachycephalosaurian specimens to facilitate comparative studies.

Funding Sources The Weintraub Fellowship
The Harlan Fellowship

Dean's Dissertation Completion Fellowship,
The George Washington University

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

A stable isotope-based investigation of mammalian paleoecology across the Cretaceous/Paleogene boundary in the Denver Basin, Colorado, U.S.A.

Breyak, Annie¹, Fricke, Henry C.¹, Wainwright, Jensen², Blumenthal, Scott², Chritz, Kendra⁴, Lyson, Tyler³, Krause, David W.³, Chester, Stephen G.⁵

¹Colorado College, Colorado Springs, Colorado, United States, ²University of Oregon, Eugene, Oregon, United States, ³University of British Columbia, Vancouver, British Columbia, Canada, ⁴Denver Museum of Nature and Science, Denver, Colorado, United States, ⁵Brooklyn College, New York City, New York, United States

Understanding and mitigating the effects of our ongoing biodiversity crisis requires a deep-time perspective on how ecosystems recover in the aftermath of environmental catastrophes. The mass extinction event at the Cretaceous/Paleogene (K/Pg) boundary (ca. 66 Ma) represents a natural laboratory wherein the tempo and mode of biotic recovery can be studied with high

chronostratigraphic resolution. Although the morphological evolution of mammals across this event has been reconstructed from skeletal remains, the exact nature of any changes in dietary preference remains unknown. A primary goal here is to fill this gap by investigating how ecological preferences of mammals, reflected by diet, changed from the Late Cretaceous, when they shared landscapes with dinosaurs, to the earliest Paleogene, when they did not.

To accomplish this, carbon and oxygen isotope ratios of fossil tooth enamel (bioapatite) were measured using laser-ablation mass spectrometry in order to infer animal diet and drinking water sources, which vary depending on the niche occupied by an animal. Fossil teeth were collected from two sites located within 400 meters of one another within the West Bijou Creek field area of the Denver Basin, one 9 meters (~128 ky pre-K/Pg) below the boundary (teeth from ceratopsian and hadrosaurid dinosaurs and the multituberculate mammal *Mesodma*, as well as gar fish scales), and the other 4 meters (~57 ky post-K/Pg) above (*Mesodma* teeth and gar fish scales).

Carbon isotope ratios ($\delta^{13}\text{C}$) of *Mesodma* tooth enamel vary significantly across the K/Pg boundary, with Late Cretaceous teeth having lower and more variable $\delta^{13}\text{C}$ (-10.1 to -16.4‰, n=4) and early Paleocene teeth having higher and less variable $\delta^{13}\text{C}$ (-5.3 to -9.0‰, n=5), the latter being similar to values for Late Cretaceous dinosaurs. These results suggest *Mesodma* had very different dietary behaviors following the extinction event, presumably a result of the disappearance of non-avian dinosaurs as well as 57% of North American plants, both of which made new food sources and niches available to them. These results also hint at a decoupling of behavioral change from morphological change, at least in the case of *Mesodma*, over 10 ky timescales. Isotopic analysis of teeth from other Late Cretaceous and earliest Paleogene mammalian taxa is ongoing and

will hopefully allow for more detailed interpretations of ecological change across the K/Pg extinction event in the Denver Basin.

Funding Sources National Science Foundation (Frontier Research in Earth Sciences grant EAR-2317666).

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

A ferugliotheriid mammal from the Upper Cretaceous (Campanian) Aguja Formation of Texas, USA

Brink, Alyson A.^{1,2}, Krause, David W.^{3,4}, Wick, Steven L.⁵

¹School of Biological, Environmental, and Earth Sciences, University of Southern Mississippi, Hattiesburg, Mississippi, United States, ²Department of Vertebrate Paleontology, Sam Noble Oklahoma Museum of Natural History, Norman, Oklahoma, United States, ³Department of Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States, ⁴Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ⁵Texas Vertebrate Paleontology Collections, University of Texas at Austin, Austin, Texas, United States

Ferugliotheriids are a very poorly known and phylogenetically enigmatic group of allotherian mammals with unique and distinct transverse “crest and groove” molariform teeth. Ferugliotheriids currently include only *Ferugliotherium* (including the junior synonyms *Vucetichia* and *Argentodites*) and *Trapalcotherium*, both known from the Late Cretaceous (Campanian–Maastrichtian) of Argentina. Another possible ferugliotheriid, *Magallanodon*, is known from the Late Cretaceous (late Campanian–early Maastrichtian) of Chile.

A single fragmentary tooth (TMM 45947-244) representing a probable ferugliotheriid was

discovered in the Abajo Shale Member (82–81 Ma, lower Campanian) of the Aguja Formation in West Texas, southwestern U.S.A. It exhibits brachydont morphology, with a series of transverse ridges and furrows across the width of the tooth. The ridges vary in width and length and are not parallel. What is interpreted to be the mesiobuccal corner of the tooth is missing, and due to this and to heavy wear on the crown, a cusp formula cannot be determined. Because the teeth of ferugliotheriids are so distinctive, there is little doubt concerning the affinities of this specimen.

The presence of a ferugliotheriid in Texas, if TMM 45947-244 is correctly referred, dramatically expands the paleogeographic range of the clade from the southern regions of South America to southern North America. As such, it joins numerous other vertebrate taxa (e.g., hadrosaurian, ankylosaurian, and titanotherian dinosaurs; metatherian and eutherian mammals) that have been hypothesized to have been present on both continents during the later stages of the Cretaceous.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

The intrinsic neck posture of an apatosaurine sauropod dinosaur based on virtual and physical models

Britt, Brooks¹, Boisvert, Colin^{1,2}, Scheetz, Rod³, Stevens, Kent A.⁴

¹Geological Sciences, Brigham Young University, Provo, Utah, United States, ²Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma, United States, ³BYU Museum of Paleontology, Provo, Utah, United States, ⁴Computer and Information Science, University of Oregon, Eugene, Oregon, United States

Sauropods, the largest of all dinosaurs, are renowned for their extraordinarily long necks. The intrinsic (osteological neutral) pose of the necks of these giants remains contested, with straight (horizontal or inclined) or S-shaped (inclined) type necks having been previously proposed based on 2D images and, later, 3D virtual models. All models are often hampered by incompleteness of the vertebral series, distortion (diagenetic, preparation), and the intricacies of virtual articulation. Previous intrinsic (osteological neutral) neck posture hypotheses were tested using BYU 18531, a large apatosaurine (*Apatosaurus/Brontosaurus*) with a 2-m-wide pelvis and 1.7-m-long femur from the Brushy Basin Mbr of the Morrison Fm near Moab, Utah. Presacral vertebrae 2-19 of the specimen are exquisitely preserved with no, or minimal, distortion. These vertebrae were rendered in 3D primarily via photogrammetry, along with laser scanning, and CT segmentation (for articulated vertebrae). Gluing errors induced during mechanical preparation were corrected virtually. The vertebrae were articulated with the zygapophyses maximally overlapped and the centra closely appressed, resulting a gap between centra of ~ 2 cm.

Individual vertebrae were rendered in 3D and virtually articulated in Autodesk's Maya. The resultant neck model indicates a gentle U-shaped dorsocervical transition, with cervical vertebrae 15-6 gently arched and 5-2 slightly dorsoflexed. Simply put, the distal half of the neck droops, placing the snout at circa 1 m above the ground. To test the virtual model, a physical model was created by printing the vertebrae at 26% of their original size, affixing each to a jig stand, and articulating the vertebrae using the same criteria as the virtual model. The physical model closely matches the virtual model save for having smoother and somewhat more pronounced curves.

Both models argue against previously proposed straight and S-shaped neck

postures, which put the snout at near-shoulder height. Attempts to virtually recreate the rejected poses using BYU 18531 led to intercentral disarticulation and inconsistent zygapophyseal articulations. The best interpretation for the osteological neutral position of this individual is a drooping neck with cervicals 2-5 reflexed, similar to the posture previously recovered for *Dicraeosaurus*. This posture may reflect the norm for apatosaurine, and more broadly, diplodocoid necks, and shed light on their feeding habits.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Disparate regional responses to climate change across the East African Rift Valley System: Insights from the late Miocene and Pliocene of Uganda

Brochu, Christopher A.¹, Adams Tarailo, Amanda²

¹Earth & Environmental Sciences, University of Iowa, Iowa City, Iowa, United States, ²Biological Sciences, Fort Hays State University, Fort Hays, Kansas, United States

During the late Miocene and Pliocene, crocodile faunas from the eastern Kenya (Gregory) branch of the East African Rift Valley System (EARS) were dominated by crocodylines related to modern *Crocodylus*. They indicate a gradual reduction in diversity from 5 co-occurring species in the late Miocene to one species at present. Their morphological disparity also contracted with the loss of tubulirostrine forms by the late Pleistocene. This is thought to reflect regional xerification and subsequent contraction of wetland area.

Crocodiles from contemporaneous deposits near Lake Albert in western Uganda suggest different responses in the western (Albertine)

branch of the EARS. The generalized crocodiles from the Kakara (~10 Ma), Nkondo (~5.5 Ma), and Warwire (~4 Ma) Formations are osteolaemines related to the living West and Central African dwarf crocodiles (*Osteolaemus*). One of them, reaching lengths up to 4 m, had a broad, deep snout resembling that of the extinct osteolaemine *Kinyang*, though it retained a plesiomorphic interfingering occlusal pattern. Another, based on lower jaws previously referred to *Mecistops* (modern sharp-nosed crocodile), is referable to either the early and middle Miocene osteolaemine *Brochuchus* or a close relative. Generalized osteolaemines like these had disappeared from the Kenya Rift by the late Miocene.

Tubulirostrine gharials ("*Tomistoma*" *coppensi* from the Nkondo Formation and a close relative from the ~2.6 Ma Hohwa Formation) are known from these deposits. They have close relatives in the Kenya Rift, such as *Eogavialis andrewsi*, but the hypertubulirostrine osteolaemine *Euthecodon*, which is abundant at many sites in the Kenya Rift from the late Miocene through Pleistocene, is absent from localities in Uganda.

Reports of *Euthecodon* at sites in the nearby Democratic Republic of the Congo, based on fragmentary material, require further assessment. The same is true of specimens referred to *Euthecodon* from the early Miocene of the Kenya Rift. If absent from the Uganda sites, this would be another similarity between late Miocene and Pliocene of the Albertine Rift and the early Miocene of the Kenya Rift.

The persistence of generalized osteolaemines in the late Miocene and Pliocene of the Albertine Rift, but their absence from the Kenya Rift, may reflect the persistence of continuous forest cover in the Albertine Rift as such biomes were replaced by mixed woodland savannahs further east over the past 10 million years.

Funding Sources US National Science Foundation, Leakey Foundation

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Dromaeosaurid feeding traces on multiple ornithomimid skeletons and isolated bones from the Dinosaur Park Formation (Campanian) of Alberta, Canada

Brown, Caleb M.

Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

Feeding traces from theropod dinosaurs (i.e., tooth marked bones) are relatively well-documented from the Dinosaur Park Fm., but are largely restricted to isolated bones (mainly Ornithischia) with the tracemaker generally attributed to Tyrannosauridae. Here extensive feeding traces are reported on an incomplete, but articulated, ornithomimid skeleton, consisting of pelvis, sacrum, two dorsals, five caudals, and four chevrons. At least 65 tooth traces are seen, which is an underestimate as the specimen is still partially in the matrix. Traces occur laterally on the left ilium (n=3), left ischium (n=11), first (n=3) and third (n=1) chevrons, and many surfaces of both pubes (n=26, 8), and two fragments (n=12, 1). Tooth traces are narrow, V-shaped furrows, 0.42–3.15 mm wide (mean=1.1 mm) and 1.4–25.6 mm (mean=6.9 mm) long. Trace width distribution does not deviate from normality. Clean edges of the traces differ from the ‘serration’ of *Linichnus serratus*. Most are straight, but nine are arced, three have terminal hooks, and six bear orthogonal serration (denticle) drag traces - *Knethichnus parallelum*. Trace denticle spacing range is 0.21–0.36 mm (mean=0.30 mm), and 0.23–0.42 mm (mean=0.34 mm) when corrected for drag angle. When compared to possible ziphodont tracemakers, this denticle spacing is significantly larger than in *Richardoestesia*

(mean=0.14, 0.12 mm), smaller than both Troodontidae (mean=0.52 mm) and Tyrannosauridae (mean=0.72 mm), but consistent with Dromaeosauridae (both *Dromaeosaurus albertensis* mean=0.29 mm and *Saurornitholestes langstoni* mean=0.22 mm), suggesting a dromaeosaurid as a likely trace maker. A survey of ornithomimid material in the Dinosaur Park Fm. reveals at least nine other specimens with 55 feeding traces of similar morphology and scale, including another skeleton (disarticulated) and eight isolated elements (vertebrae, phalanges, metatarsals, humerus). The disarticulated skeleton and an isolated vertebra show closely spaced (1.1–1.3 and 5.9 mm) parallel furrows, suggesting small, closely spaced teeth, while another vertebra shows a denticle drag with spacing of ~0.35 mm. All are consistent with Dromosauridae as a likely tracemaker. Nearly all feeding traces were previously not recognized. Together this suggest that dromaeosaurids often fed on ornithomimids and that dromaeosaurid tooth traces may be underreported, overshadowed by the larger, and more obvious, tooth traces attributed to Tyrannosauridae.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The location of pneumatic foramina in pterosaur vertebrae is constrained by biomechanical stresses

Buchmann, Richard, Rodrigues, Taissa

Universidade Federal do Espírito Santo, Vitoria, ES, Brazil

Reconstructions of pterosaur postcranial skeletal pneumatization are supported by the presence of pneumatic foramina on the cortical surface of axial and appendicular bones. Among them, variations in the position of the pneumatic foramina are especially well-documented in cervical

vertebrae, where they vary between the neck regions and between different clades. These variations likely impacted the biomechanical properties of the vertebrae.

Here, we used Finite Element Analysis to determine whether the observed variations in the position of the pneumatic foramina of the cervical vertebrae were related to structural mechanical requirements. We analyzed the cervical series of *Anhanguera piscator* (NSM-PV 19892), which has lateral pneumatic foramina on the centrum, and *Azhdarcho lancicollis* (ZIN PH and CCMGE, several specimens), in which pneumatic foramina lie next to the neural canal. The loads of the cervical muscles responsible for the stress exerted on the vertebrae were inferred from a previously established muscular arrangement for the neck of pterosaurs.

We observed that the places most susceptible to receiving greater stress were the dorsal region of the neural arch, the ventral region of the centrum, and the lateral region of the zygapophyses, which do not present any pneumatic foramen in both species.

In *Anhanguera piscator*, stress from the dorsal flexor muscles spread from the neural spine to the dorsal margin of the lateral pneumatic foramen, and stress from the ventral and lateral flexor muscles was concentrated in the caudal pedicles and extended slightly to the caudal edge of the lateral foramina.

In *Azhdarcho lancicollis*, the tubular shape of the mid-cervical vertebrae allowed stresses to propagate laterally from the neural arch to the centrum in response to dorsoventral flexion, which may explain the absence of lateral pneumatic foramina. In cranial and caudal views of *Azhdarcho lancicollis* vertebrae, stresses spread only to the margins of the pneumatic foramina, possibly because these stresses arise from thin lateral muscles.

Therefore, our analysis shows that pneumatic foramina are located in areas of the vertebra where stresses due to muscular loads are minimal.

Funding Sources Funding from Conselho Nacional de Desenvolvimento Científico e Tecnológico (421412/2018-6) and Fundação de Amparo à Pesquisa e Inovação do Espírito Santo (705/2022).

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Pulling teeth: Modeling correlations between crown height and body mass for determination of a functional trait from microfossils

Burch, Helen E., Foffa, Davide, Nesbitt, Sterling J.

Geosciences, Virginia Tech, Blacksburg, Virginia, United States

Functional traits describe an organism's use of its environment (e.g., diet, feeding mode, mobility, tiering, and body size) and are fundamental to modelling ecological roles in a community. Characterization of functional traits is a challenge in modern vertebrate ecosystems and is even more problematic in extinct communities, which are affected by the biases of the fossil record. Vertebrate community paleoecology often fails to utilize microfossils, largely overlooking teeth even though they are excellent indicators of ecological roles as they are linked to body size, diet, and diagnostic to larger clades. In reptile-dominated communities, like those of the Triassic Period, isolated teeth are often the most abundant remains: enamel enables teeth to survive transport and burial, and most reptiles continuously replace their teeth throughout their lifetime. Incorporating isolated teeth in ecological analyses therefore samples a more complete portion of the community compared to using only

skeletal material. Our research aims to determine relationships between tooth crown height and body mass to promote the use of isolated teeth in modelling community ecology. Crown height and body mass are known to be strongly correlated in small groups (e.g., primates, rabbits, sharks, and alligators), but this relationship has yet to be characterized more broadly across vertebrates. Body mass data from specimens among lepidosauromorphs, archosauromorphs, and amphibians were recorded from museum collections and computed tomography data for extinct and extant taxa ($n \sim 200$) using direct measurements if available, or from reliable correlates (e.g., femoral and skull dimensions). We analyzed a suite of tooth measurements with the body mass data using a log-transformed linear regression in each group sampled, recovering a strong correlation between the average tooth crown height and body mass within Archosauromorpha and Lepidosauromorpha, respectively ($r^2=0.83$, $r^2=0.80$). We show that any isolated tooth, body mass can be estimated and bracketed by the maximum and minimum mass for the animal assuming smallest/biggest tooth in the mouth. Our methods greatly expands the quantity of specimens, and further, the number of microvertebrate assemblages, fit to be included in paleoecological analyses across the entire Mesozoic Era. This will ultimately improve the resolution (both geographical and stratigraphic) of ecological analyses and evolutionary patterns.

Funding Sources Virginia Tech Department of Geosciences, National Science Foundation

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Dental microwear texture analysis reveals temporal and geographical variation in the dietary behaviour of grey wolves

Burt, Amanda A.¹, Adams, Neil^{2,3}, Pigiere, Fabienne F.¹, Schreve, Danielle^{1,2}

¹School of Geographical Sciences, University of Bristol, Bristol, City and County of Bristol, United Kingdom, ²Fossil Mammals, Natural History Museum, London, Greater London, United Kingdom, ³Centre for Palaeobiology and Biosphere Evolution, School of Geography, Geology and the Environment, University of Leicester, Leicester, Leicestershire, United Kingdom

The dietary behavior of grey wolves (*Canis lupus* L., 1758) is explored with dental microwear texture analysis. We examine variation in modern and past wolf diets, to assess the impact of forcing factors such as changes in climate, environment, prey community and carnivore competition on feeding behavior and the rates of change at which these occur. Diet is broadly considered the most influential factor for understanding behavioral and ecological variation in animals. Dental microwear texture analysis is a well-established method for reconstructing the dietary behaviour of extinct and extant animals. This method uses the quantification of dental textures in three dimensions by combining confocal microscopy with scale-sensitive fractal analysis and 3D surface texture analysis. These techniques have proven successful for distinguishing between closely related species and niche position within species. Dental textures can be examined to demonstrate the extent to which carcasses are utilized and thus evaluate durophagous behavior among carnivores. We use these measures to investigate dietary behavior of wolves from glacial and interglacial periods over the last 200 000 years in Britain. We have also sampled modern wolf populations from Europe and North America to ground truth evidence generated by this paleodietary approach. Results show that dental texture values used to reconstruct the dietary behavior of wolves fluctuate in correlation with changing environmental conditions. The conservation

status of grey wolves varies from Endangered to Least Concern across their ranges in the Northern Hemisphere. Incorporating information from the fossil record of wolves informs our understanding of their ecological resilience to changing climatic and environmental conditions over a longer period of time than can be obtained through modern observations alone.

Funding Sources This work is funded by the United Kingdom Research and Innovation, Natural Environment Research Council.

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Pathologies as a paleoecological signal in drought-induced placental mammal assemblages: a case study at Waco Mammoth National Monument (Texas, USA)

Butler, Dava K.¹, Yann, Lindsey T.^{2,1}, Peppe, Daniel J.¹

¹Geosciences, Baylor University, Waco, Texas, United States, ²Waco Mammoth National Monument, Waco, Texas, United States

Drought is often cited as the driver of mass mortality accumulations, and there are numerous lines of evidence used as indicators of drought. Actualistic studies reveal taphonomic, sedimentological, geochemical, and other signatures created by drought conditions. Further, malnutrition and starvation commonly result from prolonged drought, leading to pathologies. Thus, assessments of pathologies in fossil assemblages could complement the suite of known drought signatures.

Waco Mammoth National Monument (WMNM) is a Pleistocene fossil site in Texas that preserves two Columbian mammoth (*Mammuthus columbi*) populations, one at ~66ka (N≈16), and one at ~55ka (N≈3). Fossils of other fauna, such as fish, bison, and giant

tortoises, are known only from fragmentary bones and teeth, making the site effectively monodominant. Taphonomic and isotopic data are consistent with recurring episodes of drought, suggesting a high potential for malnutrition-induced pathologies. One such pathology, Harris lines (HLs), develops in metaphyseal, trabecular bone due to malnutrition, systemic illness, or trauma. Also known as transverse lines or growth arrest lines, this pathology records instances of reduced or delayed growth of limb bones, which would be expected in populations experiencing malnutrition from prolonged drought conditions.

Mammoth humeri (N=20), ulnae (N=15), femora (N=20), and tibiae (N=10) from WMNM were visually examined for HLs. Humeri were selected for diagnostic radiology, being the least dense of the elements examined. Seven humeri displayed visible HLs. Radiographs were taken of 6 WMNM humeri (4 with HL, 2 of unknown status) and 2 non-WMNM humeri of unknown status. X-ray imaging confirmed the results of the visual inspection and identified HLs in an additional WMNM humerus. Of the 20 WMNM humeri, 40% had strongly developed HLs, and 25% had partial/ambiguous HLs. Neither of the non-WMNM humeri had HLs. Importantly, HLs were in the most recent growth in WMNM juveniles, consistent with prolonged stress around the time of death. Prior to these findings, HLs had only been documented within Boreoeutheria. These results broaden HL susceptibility to the entirety of Afrotheria. HLs may have arisen independently in Afrotheria, or it may be synapomorphic within Placentalia. While more work is needed to determine the taxonomic breadth, these results will allow for a better understanding of the health of proboscideans and potentially xenarthrans throughout time.

Funding Sources National Park Service Graduate Fellowship; Bryce C. Brown Research Fellowship Program at Baylor University's Mayborn Museum.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Using intertrabecular space to validate pneumatic bone: implications for assessing postcranial skeletal pneumaticity in stem archosaurs

Byrne, Paul J.^{5,1}, Smith, Nathan D.¹, Botha, Jennifer², Rytel, Adam A.³, Huttenlocker, Adam⁴

¹Earth Sciences, University of Southern California, Los Angeles, California, United States, ²Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States, ³Evolutionary Studies Institute, University of Witwatersrand, Johannesburg, South Africa, ⁴Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland, ⁵Integrative Anatomical Sciences, University of Southern California, Keck School of Medicine, Los Angeles, California, United States

Trabecular bone is a highly porous, anisotropic material found in the epiphyses of long bones and vertebral bodies. Macroscopically, trabecular architecture is organized to optimize load transfer and is a determinate of local and global stress. Microscopically, the distribution, number, and orientation of trabecular rods and plates determine these mechanical properties. In extant birds, diverticula from the air sacs and lungs invade through the cortical surface of bone, residing within intertrabecular space. As a consequence, there is an increase in mean trabecular spacing between rods. In this study, we used 9 extant CT and histology datasets consisting of avian, crocodylian, squamate, testudine, and osteoglossiform taxa to understand if intertrabecular space and angulation can verify bone pneumatized via soft tissue from the pulmonary system. External morphology and CT data of the archosauromorphs

Prolacerta and *Tanystropheus*, the archosauriformes *Euparkeria* and *Garjainia*, and the avemetatarsalians *Coelophysis* and *Archaeornithomimus* were included as case studies to test if pneumatic bone could be identified in ambiguously-pneumatic stem archosaur taxa. Initial results suggest that external foramina open into large cavities with high amounts of intertrabecular space between rods in the neural arch region but not in the anterior and posterior ends of the centrum in the archosauriformes *Euparkeria* and *Garjainia*. This condition is more similar to extant avians than to the crocodylians and squamates examined, which exhibit interspersed regions of densely-packed trabecular bone in the neural arch. Moving forward, we plan to quantify intertrabecular angling and integrate histology from extinct taxa to verify if pulmonary diverticula truly result in these large open pockets between trabecular rods or if changes in vasculature supplying nutrients result in this trabecular modification.

Funding Sources The University of Southern California; the National Science Centre, Poland (grant 2020/39/O/NZ8/02301).

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

A small juvenile *Triceratops* from the Hell Creek Formation, Montana, reveals details of early ontogeny

Cajune, Sophia M.², Scannella, John¹

¹Museum of the Rockies and Department of Ecology, Montana State University, Bozeman, Montana, United States, ²Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, Montana, United States

The ceratopsid *Triceratops* is the most commonly recovered dinosaur (n>100) in the uppermost Cretaceous Hell Creek Formation

(HCF) of Montana and surrounding regions. Studies of this large sample of specimens have revealed dramatic cranial changes throughout ontogeny, including reorientation of the postorbital horn cores and flattening of frill epioassifications. Despite the abundance of *Triceratops*, representatives of very early ontogeny remain relatively rare and only a few have been described in detail. In 2006, the partial skull of a small juvenile *Triceratops* (basal skull length approximately 43 cm) was discovered in Garfield County, Montana, in a gray mudstone in the middle unit of the HCF. This specimen (MOR 2569) fills a gap in the early ontogeny of *Triceratops*, being only slightly larger than the smallest known specimen (UCMP 154452; basal skull length approximately 32 cm). Further, MOR 2569 was found stratigraphically lower in the HCF than most other reported juvenile specimens. Recovered material includes the parietal, squamosals, left postorbital horn core, quadrates, jugals, and the smallest reported examples of the maxilla, ectopterygoid, and frontals. The skull is disarticulated aside from a maxilla and ectopterygoid. Several maxillary teeth are preserved in position. The small postorbital horn core (13 cm in length) is caudally curved with an open suture for the prefrontal. Margins of the parietal and squamosals are strongly crenulated; no frill epioassifications were recovered with the skull. Long-grained surficial bone texture is present on the parietal and squamosals with pronounced mottled texture, indicating areas of resorption, lateral to the parietal midline. MOR 2569 provides new details of juvenile *Triceratops* anatomy, contributing to an unfolding view of how this dinosaur changed throughout growth and geologic time.

Funding Sources Field collection of MOR 2569 supported by the Smithsonian Institution and donors to the Hell Creek Project.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Variation in occlusal morphology among hadrosaurids: implications for ecologic diversity

Caldwell, Heath R., Varricchio, David J.

Earth Sciences, Montana State University, Clancy, Montana, United States

The ecological significance of hadrosaurid diversity and disparity has been the subject of intensive research. However, previous investigations of hadrosaurid ecology have used similar data sets involving cranial, appendicular, and dental measurements, but produced conflicting results. In the context of studying the relationship between diet and dental morphology, developments in quantitative methods (orientation patch count, Dirichlet normal energy, slope, and relief index) have allowed for distantly related taxa (e.g., carnivorans and rodents) to be more readily compared in an ecologic context. Here, we assess the dentitions from the maxillae (n=24) and dentaries (n=12) of lambeosaurines (n=11) and saurolophines (n=16) from the Campanian Two Medicine Formation and Belly River Group of western North America. These quantitative measures were applied to three-dimensional models of the dental occlusal surfaces and interpreted in the context of published data for extant ungulates. The consistently recovered quantitative differences in occlusal morphologies between lambeosaurines and saurolophines generally match those reported for selective and non-selective foraging ungulates, respectively. Although this disparity in dental morphology among hadrosaurids has been previously described qualitatively, this quantitative comparison with extant taxa allows for more nuanced and justified ecologic interpretations. These results potentially reflect the ecologic diversity of hadrosaurids and a mechanism

by which sympatric taxa were able to partition the resources in their ecosystems.

Funding Sources Montana State University-Undergraduate Scholars Program

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

New methods for complex morphologies: quantifying three-dimensional complexity in mammalian cranial sutures

Camaiti, Marco¹, He, Yichen¹, White, Heather², Didziokas, Marius⁴, Sharp, Alana³, Grisan, Enrico⁵, Goswami, Anjali¹

¹Department of Life Sciences, Natural History Museum London, London, United Kingdom, ²Department of Life Sciences, Natural History Museum London, London, United Kingdom, ³University College London, London, United Kingdom, ⁴University of Liverpool, Liverpool, United Kingdom, ⁵London South Bank University, London, United Kingdom

Cranial sutures are a network of fibrous joints that connect and form boundaries between skull bones. These joints are growth sites of skull bones during development, and act as absorbers of biomechanical stresses the skull is subjected to. Suture outlines form interdigitations whose frequency and amplitude correlate with both growth and stress absorption patterns, and thus represent important developmental, biomechanical and ecological markers for extant and fossil taxa. Efforts to quantify and compare suture morphology have been hindered by their large intra- and inter-specific variability, the lack of strict homology, and by challenges in extracting them from CT scans. Traditional methods were limited to assessments of suture outlines in two dimensions without

considering underlying three-dimensional morphologies. Thanks to recent advancements in parcellation techniques, it has now become possible to quantify and compare their 3D morphology. Here, we showcase the first-ever methodological steps for extraction and visualisation of detailed three-dimensional suture outlines in mammalian taxa. We then apply three-dimensional complexity metrics to quantify and compare their morphologies. We introduce the use of alpha complexity as an effective means to capture the functional and developmental aspects of suture morphology, such as interdigitation. Due to the elevated variability introduced by complex geometrical structures, these aspects are not clearly captured by other quantification methods such as 3D geometric morphometrics. We applied this new approach to a sample of fifteen mammals to quantify variation in suture complexity and assess its relationship to skull function, including feeding and brain protection. We find that across mammals, facial sutures are generally characterised by higher complexity compared to the sutures of the cranial vault, indicating that biomechanical stress from mastication is a dominant influence on suture morphology. Herbivores generally show more complex sutures than taxa with diets that require less oral processing. Going forward, we are expanding our dataset to include non-mammalian synapsids to reconstruct changes in cranial sutures associated with the evolution of complex mastication along the lineage leading to mammals.

Funding Sources Leverhulme Trust grant RPG-2021-424

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Description of a near-complete specimen belonging to the Late Cretaceous

**mosasaur subfamily Plioplatecarpinae
(Squamata, Mosasauridae)**

Cameron, Amy A.¹, Konishi, Takuya²,
Caldwell, Michael W.¹

¹Department of Biological Sciences,
University of Alberta, Edmonton, Alberta,
Canada, ²Department of Biological Sciences,
University of Cincinnati, Cincinnati, Ohio,
United States

Currently on display at the Burke Museum of Natural History and Culture in Seattle, Washington, is a previously undescribed adult mosasaur (UWBM 75083). It was uncovered in 1978 from the Late Cretaceous Pierre Shale Formation in southwest South Dakota, USA. This specimen is nearly complete and free of selenite encrustation. Most of the skeleton is articulated - from the skull, visible in dorsal aspect, to the near posterior end of the tail, including the forelimbs. However, the vertebrae in the pelvic region are disarticulated and the hindlimbs are missing, potentially the result of scavenging by sharks. UWBM 75083 is currently ascribed to *Platecarpus tympaniticus*, but preliminary observations suggest it displays features consistent with the diagnosis of *Latoplatecarpus*, another genus within the mosasaur subfamily Plioplatecarpinae (Squamata, Mosasauridae). As in *Latoplatecarpus*, the last two and a half maxillary teeth underlie the orbit, whereas only the last maxillary tooth is suborbital in *Platecarpus tympaniticus*. The premaxillary-maxillary suture terminates anterior to the anteriorly deepest section of the maxilla; in *Platecarpus*, this suture would terminate at that deepest point. The frontal possesses a prominent median dorsal keel and pointed posterolateral alae. UWBM 75083 possesses a distinct and pointed parietal crest and a pyriform parietal foramen located immediately anterior to the posterior edge of the frontal bone but does not invade it, unlike the condition in *Plioplatecarpus*. The

scapular blade is semicircular and the suprascapular cartilage is still preserved around the right scapula of this specimen. Forelimbs possess five digits with hourglass-shaped phalanges, and digit V is divaricate. If UWBM 75083 belongs to *Latoplatecarpus*, it would be the only known specimen in the genus to clearly exhibit the curvature of the terminal caudal section, a condition observed in many other hydropedal mosasaur taxa, including *Platecarpus*. The genus *Latoplatecarpus* contains two species: *L. willistoni* and *L. nichollsae*. At this point, it is undecided which species this specimen belongs to, though preliminary phylogenetic analyses suggest it is *L. willistoni*. This may become clearer with further comparisons to other specimens assigned to *Latoplatecarpus*, though it is possible that the current diagnoses of these species might require revision.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The *Podokesaurus* Project: Rediscovering Holyoke's swift-footed lizard

Candlen, Maxwell M., Wilhelm, Freya S.

Paleontology, New York State Museum,
Albany, New York, United States

Podokesaurus holyokensis is a theropod dinosaur from the Early Jurassic of North America, known from a nearly complete and partially articulated postcranial skeleton from the Longmeadow Sandstone of South Hadley, Massachusetts. The Connecticut Valley tetrapod fauna, primarily documented through bountiful ichnites, is poorly-known from body fossils, especially ones of such completeness. The species was described in 1911 by Mignon Talbot, the first woman to discover and name a non-avian dinosaur. Only six years later, this unique fossil was destroyed in a devastating fire. The *Podokesaurus* Project is a comprehensive

endeavor to review and revise the history, anatomy, and systematics of this enigmatic species.

Richard S. Lull was instrumental to the original interpretation and publication of the fossil, and a search of his personal correspondences with Talbot, Gerhard Heilmann, and others, archived at Yale University, revealed a great deal of previously unpublished information. This new data is the focus of the current presentation, and includes not only definitive dates for key events, alternative interpretations of anatomy and affinity, and details on regions of the fossil never figured or described in the literature, but also a look behind the scenes at the lives of and the interpersonal tensions between these eminent paleontological personalities.

Combined with an exhaustive search of prior publications and existing materials, this represents the first phase of the Project, which will be compiled into an authoritative history of *Podokesaurus* from discovery to the modern day. The second phase will consist of organized efforts to locate new fossil material in the Connecticut Valley, and the third phase will culminate in a reinterpretation of *Podokesaurus holyokensis*, with a revised anatomical description and several phylogenetic analyses. Tangential efforts include the rediscovery of the type locality and a study of other theropod material from the Newark Supergroup.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

Applying isotopes to the pterosaur fossil record (Ornithocheiridae) to understand their movement patterns

Caputo, Cooper, Cullen, Thomas, Haibo, Zou

Auburn University, Auburn, Alabama, United States

Our understanding of pterosaurs flight has improved considerably since the initial observations that they were likely volant organisms. Hypotheses concerning the specific forms of flight used by individual pterosaur clades have been proposed based on studies of functional morphology, comparative morphology, and environmental association. Stable isotope approaches have rarely been applied to test hypotheses of pterosaur movement, and represent an untapped resource for elucidating their behavior. Here we sample and isotopically analyze enamel from a selection of isolated ornithocheirid pterosaur teeth from the nearshore marine Albian-Cenomanian Cambridge Greensand Formation, UK. Based on their depositional associations and wing morphology, ornithocheirids have been hypothesized to be partially to primarily marine-feeding pterosaurs capable of long-distance foraging, and potentially even trans-oceanic migrations. To assess for the habitat use and movement patterns of these ornithocheirids, we analyzed the $^{87}\text{Sr}/^{86}\text{Sr}$ of the sampled tooth enamel. As $^{87}\text{Sr}/^{86}\text{Sr}$ values differ depending on local bedrock composition, and ocean water also has a relatively consistent value at any given point in Earth history, this proxy can be used to test if organisms are engaging in long-distance travel, as well as provide general indications of their habitat breadth and use patterns. Results so far suggest that the sampled ornithocheirid $^{87}\text{Sr}/^{86}\text{Sr}$ is most consistent with the values of the Cambridge Greensand Formation and not of the $^{87}\text{Sr}/^{86}\text{Sr}$ oceanic values of this time, providing evidence against the hypothesis that these animals engaged in extended trans-oceanic migration or foraging where resource intake was exclusively of marine origin. However, these data are potentially supportive of several alternative hypotheses, such as: 1) more exclusive foraging and movement in

nearshore settings, 2) relatively long-distant foraging across the epeiric seas of the archipelago system present across much of Europe at this time with little time over more open seas and deeper marine basins, or 3) a mixture of nearshore/terrestrial and some marine feeding. At this time, we lack sufficient comparative data of $^{87}\text{Sr}/^{86}\text{Sr}$ ranges of locales consistent with the environmental/geographic end-member areas to distinguish between these potential interpretations, but ongoing analyses and comparisons to pterosaurs sampled from other settings should allow these alternate hypotheses to be directly tested.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Reevaluating neural preservation in the Carboniferous actinopterygian *Trawdenia planti*

Caron, Abigail¹, Tietjen, Kristen², Coates, Michael³

¹Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois, United States, ²University of Kansas, Lawrence, Kansas, United States, ³Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States

Soft tissue preservation is rare in the fossil record. When it does occur, structures that decay more slowly are usually preserved, such as muscles, tendons, or integument. However, there are two Carboniferous vertebrates with fossilized neural tissue - an iniopterygian from Lawrence, Kansas and an actinopterygian from Trawden, UK. The latter locality has further yielded two specimens of *Trawdenia planti*, NHMUK P7989 & 11656 and MM WI 146, which have previously been externally described. Here, we present new neural and endocranial data from microcomputed tomography (μCT) of these

specimens and discuss implications on neural evolution and preservation. Combined digital renderings reveal the entire neurocranium, the shape of which is starkly different from contemporaneous fusiform fishes; it is expanded dorsally above and in-between the orbits, the nasal region is enlarged, and there are reduced basipterygoid processes and unpaired posterior myodomes. Furthermore, the inner endocranial walls are sculpted to reflect precise divisions between brain regions; unexpected, since both previous reports of preserved fish brains highlight how tiny the brain is relative to the volume of the endocranial chamber. Subsequent examination of the radiodense signal within the endocranial cavity in both specimens reveals laterally symmetric structures; however, the recovered anatomy is dissimilar: one specimen resembles previous descriptions of tiny fossil brains, while the other reveals a much larger structure somewhat displaced to one side of the cranial cavity. This larger body has sulci that match the crests on the inner neurocranial walls, and we thus interpret it as the brain and the smaller structures as ventricular spaces. Notably, this implies that cranial endocasts can be an informative tool for understanding the evolution of endocranial soft tissues. Existing models of biotic iron pyritization under anoxic conditions may explain the observed taphonomic differences between these specimens, noting that MM WI 146 appears to be regurgita and would have thus fossilized under different initial conditions.

Funding Sources National Science Foundation grant: NSF (EAR) 2218892

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Growth series of *Tyrannosaurus rex* and *T. bataar* (Dinosauria, Theropoda,

Tyrannosauridae) share the same order of character changes, weakening the “*Nanotyrannus*” hypothesis

Carr, Thomas

Biology, Carthage College, Kenosha, Wisconsin, United States

A recent review of the problematic taxon “*Nanotyrannus lancensis*” claims that it is valid based in part on the morphology of juveniles; three of those are assessed here. (1) The authors claim the number of differences between “*Nanotyrannus*” and adult *Tyrannosaurus rex* is remarkable, but differences should be expected between different growth stages of a single taxon and different species alike. Therefore, the mere presence of many growth differences is not remarkable: numerous differences between adults and juveniles of many tyrannosaurids are reported in the literature, including *Bistahieversor sealeyi*, *Albertosaurus libratus*, *A. sarcophagus*, *Daspletosaurus horneri*, and *T. bataar*.

(2) The authors claim there is a lack of intermediates between “*Nanotyrannus*” and *T. rex*, so the juvenile hypothesis cannot be true. However, previous work has shown a developmental progression of characters from juveniles to their full expression in adults. That is, relatively more mature juveniles can be distinguished from less mature juveniles, and relatively mature juveniles share similarities with adults that are not seen in the least mature juveniles. Ergo, combinations of states link one growth stage to the next.

(3) The authors claim that the growth changes from “*Nanotyrannus*” to *T. rex* is not seen in other tyrannosaurids. However, the contentious Cleveland skull (CMNH 7541) matches the morphotype of juveniles of other taxa, including *A. libratus*, *D. horneri*, and *T. bataar*. Juvenile features seen in all taxa include narrow teeth, shallow jaws, uninflated facial bones, and subtle cephalic

ornamentation, among others. Also, it has been shown that *T. rex* ontogeny is peramorphic relative to other tyrannosaurids and so not all growth changes in *T. rex* are universal.

The claim that “*Nanotyrannus*” is inconsistent with tyrannosaurid ontogeny was tested here by comparison of cladistically-recovered growth series between *T. rex* (28 specimens, 948 characters) and *T. bataar* (14 specimens, 287 characters). The *T. rex* sample includes the disputed “*Nanotyrannus*” specimens. The results found comparable growth series (*T. rex*: 12 MPTs, 1406 steps, RC 0.54; *T. bataar*: 9 MPTs, 334 steps, RC 0.59): 51 growth changes were shared between the taxa, and 29 occur in the same order, from growth stage to growth stage. Therefore, the claim that the growth series of these sister species are fundamentally different is not true, and so the “*Nanotyrannus*” hypothesis lacks this critical line of support.

Funding Sources No funding sources to report.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Testing evolutionary hypotheses with historically collected *Triceratops* from the Hell Creek Formation of Carter and Fallon County, Montana

Carroll, Nathan R.¹, Moore, Sabre¹, Scannella, John²

¹Carter County Museum, Ekalaka, Montana, United States, ²Museum of the Rockies, Bozeman, Montana, United States

Extensive exposures of the uppermost Cretaceous Hell Creek Formation (HCF) in and around Carter and Fallon County, Montana have yielded several significant paleontological discoveries in the last century. Carter County Museum (CCM) is the

state's oldest county museum, with a vertebrate paleontology catalog that was officially formed in 1933 from local collections dating back to 1900. Over 1,000 HCF specimens are catalogued in the museum's collection, providing a resource for the testing of evolutionary and ecological hypotheses regarding the terminal Cretaceous. The ceratopsid *Triceratops* is the most commonly recovered dinosaur in the HCF. Several nearly complete or partial skulls (n=34) have been historically collected in Carter and Fallon County and accessioned at CCM, including CCM V49-1, the first complete skull of this dinosaur to be displayed in Montana. Studies of *Triceratops* biostratigraphy have found that the two recognized species, *T. horridus* and *T. prorsus*, are stratigraphically separated within the HCF with *T. prorsus* found in the upper unit and *T. horridus* recovered from lower in section. This is hypothesized to represent an anagenetic evolutionary transformation. CCM V49-1 was collected in 1949, approximately 20 m below the K/Pg boundary. The expanded nasal process of the premaxilla and enlarged epinasal present in CCM V49-1 are consistent with referral to *T. prorsus*, as predicted. This specimen provides an additional test of this evolutionary hypothesis and further demonstrates how the formation of local museums is an effective means of preserving natural history objects and archives to yield valuable scientific data and test current and future hypotheses.

Funding Sources Funds for the excavation and preservation of CCM V49-1 were provided through local support of the Carter County Geological Society.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

Elucidating spinal column dynamics in terrestrial Permian taxa

Carter, Aja M.¹, Caporale, J. Diego³,
Koditschek, Daniel², Johnson, Aaron¹

¹Mechanical Engineering, Carnegie Mellon University, Pittsburgh, Pennsylvania, United States, ²Electrical and Computer Engineering, University of Southern California, Los Angeles, California, United States, ³Electrical and Systems Engineering, University of Pennsylvania, Philadelphia, Pennsylvania, United States

The availability of new 3D printing technologies has led to new approaches to locomotor reconstruction and analysis in extinct taxa. The primary focus of many researchers has been quantitative investigations of both joint kinematics and muscle dynamics of the appendicular skeleton to reconstruct plausible gaits. However, our understanding of axial column dynamics in crown tetrapods is still lacking for late Paleozoic taxa, and from this gap we lack a complete understanding of these tetrapods' locomotor abilities. Previous works on the axial column focused on joint kinematics or static loading of the axial column. However, these types of studies cannot capture the dynamic mechanical properties of the spine, which vary with respect to time scale and frequency during locomotor motion. Additionally, these studies have focused on single vertebral units, i.e., two centra and a single intervertebral joint, obscuring potential differences in behavior generated by multijointed modes. To investigate the dynamic capabilities of the spinal column in ancient tetrapods, we captured a range of material properties of single and multi-jointed vertebral units from *Diadectes sideropelicus*, a large crown herbivorous diadectid from the Permian era. We estimated bending stiffness, damping coefficient, and resilience during dynamic bending. For our model, we created multilateral prints composed of modeled notochords, articular cartilages, and spinal cords. We discovered that the single-jointed and multijointed models are not easily

comparable under mediolateral flexion. Conversely, the multijointed model has a predictable behavior under dorsoventral flexion compared to a single-jointed model. Additionally, we found mediolateral stiffness at all frequencies to be greater than dorsoventral stiffness. We anticipate that subsequent researchers will be able to use these data to build dynamic-legged models that investigate the spine's role in situ during dynamic locomotor gaits. Our study advances the broader study of dynamic locomotion in terrestrial tetrapods.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Preliminary statistical study of Late Triassic archosauriform teeth from the Homestead Site, a microvertebrate assemblage in east-central New Mexico

Carter, Caeden¹, Heckert, Andrew B.¹, Lauer, Bruce H.², Lauer, Rene²

¹Department of Geological and Environmental Sciences, Appalachian State University, Asheville, North Carolina, United States, ²Lauer Foundation for Paleontology, Science and Education, Chicago, Illinois, United States

During the Triassic, archosaurs underwent dramatic diversification, and archosauriformes in particular exhibit great dental diversity. Taxonomically assessing this diversity is difficult due to the isolated or fragmentary nature of most fossil teeth. The Homestead (HS) site, in the Upper Triassic Garita Creek Fm of east-central New Mexico, yields thousands of teeth, bones, scales, and coprolites, most being microvertebrate (<1cm) size. Past qualitative studies have shown that teeth are some of the most diagnostic specimens from these microvertebrate sites, but as specimens get smaller (<2mm) identifications become increasingly tenuous. Simple linear

measurements and other statistical analyses, often used on Cretaceous dinosaur teeth, also show insufficient separation. Non-metric Multidimensional Scaling (nMDS) analysis uses descriptive characters (e.g., binary traits) to create a quantitative data table. The resulting analysis attempts to show the pairwise dissimilarity between objects in a low-dimensional space. Morphotypes based on qualitative observations may not account for, or be able to discriminate among, convergence or ontogenetic, positional, or other sources of variation. An initial manual qualitative analysis was done first to create groups of morphotypes deemed unique, this was done using in-hand analysis with the addition of references to similarly aged microvertebrate sites. Four distinct groups are identified, with an additional five morphotypes belonging to only one specimen; these groups are not considered morphotypes until more specimens appear with a similar score/morphology. Our preliminary nMDS analysis (n=40 teeth) identifies four clusters of tooth morphotypes, all showing morphology unique enough to be differentiated enough given our a priori traits. These analyses also allow for more rigorous comparison to broadly contemporaneous microvertebrate assemblages, such as the Owl Rock Formation (Member) from northeastern Arizona, yielding superficially similar low-crowned teeth. In addition to incorporating more specimens, we plan to add more characters to further discriminate among tooth morphotypes.

Funding Sources LAUER FOUNDATION FOR PALEONTOLOGY, SCIENCE AND EDUCATION

Appalachians State University

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Early divergence of the four major clades of macropodiform (kangaroo-like) marsupials

from the latest Oligocene of South Australia

Case, Judd A.

Biology, Eastern Washington University,
Cheney, Washington, United States

Among extant kangaroo-like marsupials or Macropodoidea, there are three families, the Hypsiprymnodontidae (musky rat kangaroos), the Potoroidae (rat-kangaroos) and the Macropodidae (kangaroos and wallabies) with the potoroids and macropodids as sister families. Additionally, there is an extinct family, the Balbaridae (ca 24 Ma to 11.6 Ma), whose placement is disputed to be either outside of Macropodoidea or in a polytomy with hypsiprymnodontids and the common lineage to potoroids and macropodids (all four families form the Macropodiformes). All four macropodiform families first appear in the latest Oligocene, Etadunna Fm. from 25 to 23 Ma.

The divergence of these four clades is earlier in the Etadunna Fm. than that predicted in molecular studies and earlier than in previous studies, which show the presence of these four families in early to middle Miocene deposits (Riversleigh Faunal Zones B–C, 18.24 – 13.48 Ma).

The Etadunna Fm. is divided into five faunal levels A–E, based on fossil mammals. The earliest appearance of a macropodiform is from the lowest faunal level (Faunal Zone A), a new Genus K (Potoroidae). In Faunal Zone C is the first appearance of balbarids with two new species in the genus *Nambaroo*. Faunal Zone C also contains the first appearance of macropodids with a new Genus P and a new Genus W. Potoroids are also present in zone C with *Purtia mosaicus*. Finally, hypsiprymnodontids first appear in Faunal Zone E with a new Genus M. This study includes described species of *Nambaroo* and *Paleopotorous* from the time equivalent Namba Fm., South Australia.

The key characters illustrating these divergences come from the last lower premolar (p3) and the first lower molar (m1), the posterior three molars are either semilophate (hypsiprymnodontids and potoroids) or fully lophate, (balbarids and macropodids). The anterior end of m1 is very similar in all of these taxa as they have: a central protoconid with an anteriorly directed preprotocristid; a lingual metaconid connected to the protoconid by the postprotocristid; and a buccal protostylid with the cristid obliqua connected to it. The protoconid, metaconid and protostylid are the three main trigonid cusps.

The phylogenetic analyses of these latest Oligocene taxa result in the Balbaridae being the sister family to the potoroid/macropodid clade with *Paleopotorous* as the most plesiomorphic balbarid, supporting the hypothesis that lophodonty in the balbarids and macropodids is a case of homoplasy.

Funding Sources Eastern Washington University Faculty Grant for Research and Creative Works 2024 - 2025.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Evidence for the earliest appearance of Brachylophosaurini (Hadrosauridae: Saurolophinae) from the lower Wahweap Formation of southern Utah, USA

Cassiano, Bryce¹, Sertich, Joseph J.², Watkins, Madison S.³, Toth, Natalie G.⁴, Bastien, Salvador⁴, Titus, Alan L.⁵

¹Department of Geography and Environmental Studies, University of Colorado Colorado Springs, Colorado Springs, Colorado, United States, ²Department of Geosciences, Colorado State University, Fort Collins, Colorado, United States, ³Southern Utah University College of Geosciences, Cedar

City, Utah, United States, ⁴Department of Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States, ⁵Paria River District, Bureau of Land Management, Kanab, Utah, United States

Despite a rich and abundant North American fossil record, the early diversification of Hadrosauridae during the Santonian and early Campanian remains poorly understood. Hadrosaurid materials from this interval are limited, with diagnostic remains older than ~81 Ma currently limited to the Aguja Formation (Fm) of West Texas (*Aquilarhinus palimentus*). Bayesian models based on updated geochronologic dating of the Wahweap Fm recover the base of the Last Chance Creek Member (modelled between 83.64 and 81.54 Ma) near the Santonian-Campanian boundary. This suggests possible overlap with biota from the Abajo Shale Member of the Aguja Fm of West Texas (~81 Ma), providing potential for insight into the early evolution and distribution of hadrosaurids in Laramidia. Recent field surveys in the Last Chance Creek Member have recovered abundant vertebrate fossils, including five associated partial hadrosaurid skeletons, four of which preserve a mixture of appendicular and vertebral elements, and one that preserves the first cranial elements from this unit. All specimens possess characteristics that suggest affinities with Brachylophosaurini, most notably the pubes, preserved in two of the specimens. The prepubic blades are ventrally deflected and longer than tall, with rounded margins and are approximately the same length as the proximal constriction, all characteristic of Brachylophosaurini. The well-preserved maxilla possesses a jugal process that closely resembles that of the basal hadrosaurid *Aquilarhinus*, while the slope of the ectopterygoid shelf is more similar to brachylophosaurins like *Probrachylophosaurus*. In contrast to these other early hadrosaurids, this specimen has only one functional tooth per maxillary

alveolus, a feature more typical of non-hadrosaurid hadrosauroids. Preliminary phylogenetic analyses recover the cranial remains as sister to either *Probrachylophosaurus* or *Aquilarhinus*, while analysis of the combined postcranial specimens recover the taxon within Brachylophosaurini. Additionally, a combined analysis utilizing morphology from all five specimens results in the recovery of the Last Chance Creek taxon as a member of Brachylophosaurini. This placement is significant, as it would extend the temporal range of Brachylophosaurini by up to 3 million years, hints at a southern Laramidia origin for the tribe, and suggests deep divisions within Saurolophinae, with Brachylophosaurini and Kritosaurini established by the beginning of the Campanian.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

The ancestral blink: assessment of abducens muscles and nictitating apparatus sheds light on turtle eye evolution

Cerio, Donald G., Bever, Gabriel S.

Center for Functional Anatomy and Evolution, Johns Hopkins University, Baltimore, Maryland, United States

Crown turtles have features superficially inconsistent with crown archosaurs (famously, temporal fenestrae) but also stem turtles (carapace vs. ribs). Crown-stem differences are unsurprising and shed light on evolving developmental dynamics from which morphological differences arise. A system linking turtles to archosaurs (i.e., Archelosauria) is the nictitating apparatus (NA), which maintains corneal competency via a mobile conjunctival fold (i.e., nictitation). However, turtles in fact share NA muscles with crown archosaurs and

lepidosaurs. The ancestral NA for Archelosauria is thus somewhat unclear.

We conduct anatomical surveys of crown and stem taxa, in addition to a literature review, to address this question. We correlate soft tissues of NA with bony attachments in crown archelosaurians using microCT (more mature samples) and immunohistostaining (early embryonic tissue). We study fossil basicrania of stem turtles, stem archosaurs, and stem diapsids to identify shared evidence of NA. We observe that in crown turtles *M. retractor bulbi* (mRB; indirect actuator of NA) arises from paired fossae on the parabasisphenoid, medial to abducens foramen (CN VI) and lateral to sella turcica. This state differs from crocodylians, which lack the fossae, but is like lepidosaurs. In ontogeny, mRB of turtle (*Trachemys scripta elegans*) embryos (stages 21 & 22) attach to cartilage condensations lacking fossae medial to CN VI. Stem turtles *Mongolochelys* and *Proganochelys* preserve mRB fossae much like the crown condition in mature turtles, whereas similar fossae are absent from stem archosaur *Trilophosaurus*. Likewise, whereas CN VI tunnels through dorsum sellae in crown turtles, leaving a canal, signs of CN VI are ambiguous in stem archosaurs *Trilophosaurus*, *Mesosuchus*, and *Prolacerta*, and weak at most in stem diapsid *Youngina*. Similarity of these stem-archosaur and stem-diapsid conditions suggests that NA in the ancestral archelosaurians was more like these stem taxa, and mRB fossae evolved later.

However, nictitating soft tissues at the Archelosauria node remain equivocal. Crown-like turtle NA most likely evolved concurrent with or before a crown-like carapace. Retractor bulbi (or a homolog) is present in lepidosaurs, archosaurs, and turtles, so we reconstruct ancestral archelosaurs as having this muscle. CT scans of rootward stem turtles that retain scleral rings, which show evidence of another NA muscle (pyramidalis) in crown archosaurs, could yield future insights.

Funding Sources Johns Hopkins University School of Medicine

National Science Foundation DEB-1947025

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Fancy feet: An ecomorphological assessment of the terminal phalanx in Order Artiodactyla

Chambers, Kaori S.¹, Badgley, Catherine¹, Zelditch, Miriam²

¹Ecology and Evolutionary Biology, University of Michigan, Ann Arbor, Michigan, United States, ²Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States

Artiodactyla, the even-toed ungulates, is a diverse order of mammals originating in the early Eocene. In the study of artiodactyl paleoecology, the teeth as well as the calcaneus and astragalus in the hind foot are often assessed for insights into diet and locomotion of extinct species. However, when it comes to assessing the substrate use of an organism, the bones directly in contact with the substrate may be more informative than other postcranial elements. It is these bones that the keratin hoof grows around, which we can observe to exhibit adaptation to different substrate types in extant artiodactyls. Understanding the link between organismal form and function in extant species is an important foundation for making inferences about related fossil organisms. Using 2D geometric morphometric analysis, I measured the shape of the terminal phalanx of 40 species spanning eight extant artiodactyl families to evaluate the relationship between morphology and habitat use in order to develop a framework for relating phalanx shape to habitat openness, substrate type, and substrate grade, or steepness. Results

indicate that, after accounting for phylogeny, Artiodactyl phalanx shape exhibits a stronger association with substrate firmness than with habitat openness. My findings suggest that future investigations would benefit from including representatives of multiple families rather than focusing on individual families.

Funding Sources Rackham Graduate School Merit Fellowship

U of M EEB Block Grant

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Novel aspects of maxillary canal anatomy in a Zambian gorgonopsian revealed by high-resolution CT scanning

Chao, Arion, Brant, Anna, Sidor, Christian A.

University of Washington, Seattle, Washington, United States

The maxillary canal is a bony tube that runs through the maxilla and premaxilla above the alveolar margin in amniotes. The canal houses the maxillary branch of the trigeminal nerve (CN V2), which is one of the primary nerves responsible for receiving sensations of touch from the integument of the face. The morphology of the canal as well as the distribution of its corresponding foramina have been used as a proxy to estimate sensory biology and nervous tissue morphology in many extinct amniotes, such as theropod dinosaurs, marine reptiles, and non-mammalian therapsids. Previous studies investigating the morphology of the maxillary canal in basal therapsids have provided important insight into the evolution of mechanosensation and whiskers in mammals. However, few detailed morphological studies have been conducted on non-mammalian therapsids such as gorgonopsians.

Here we describe the detailed maxillary canal morphology of a medium-sized gorgonopsian from the upper Permian of Zambia based on high-resolution CT scans. While the general morphology of the maxillary canal agrees with previous work, the high-resolution scan reveals heretofore unrecognized details. For example, whereas previous studies clearly divided the maxillary canal branches into the alveolar, external nasal, internal nasal, and superior labial canals based on their direction and branching order, our scans indicate a much denser and more complex pattern, such that the delineation between these four branches is not particularly clear. The segmented canal also has far smaller branches (~0.3 mm diameter) than what previous studies have reconstructed for gorgonopsians. Some smaller diameter canals do not clearly fit into the four major branches of the maxillary canal based on their orientations and branching patterns.

Currently, it is not certain if the observed differences between our segmented canals and previous segmentations are due to differences in CT scan resolution, segmentation procedures, or genuine taxonomic variability among gorgonopsian taxa. High-resolution CT data for a wide range of gorgonopsian species will be needed to clarify an answer to this question.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

New data on the postcranial anatomy of *Massospondylus carinatus* (Dinosauria: Sauropodomorpha) and implications for postcranial ontogeny

Chapelle, Kimberley (Kimi)^{2,1}, Barrett, Paul^{3,1}

¹Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ²Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ³Fossil

Reptiles, Amphibians and Birds Section,
Natural History Museum, London, United
Kingdom

The Early Jurassic sauropodomorph *Massospondylus carinatus* as one of the first dinosaurs described from southern Africa. Over the last 200 years, almost two hundred specimens have been referred to this species, but there has been little work to define the taxon rigorously or make these referrals on the basis of clear diagnostic characters. The incompleteness of the neotype, and the difficulty in referring other specimens, has resulted in an incomplete understanding of this taxon's anatomy. In particular, the pelvic girdle, tail, and hindlimb of the neotype are poorly known, undermining the many referrals of partial skeletons that consist largely of these skeletal regions. Here, we present the postcranial anatomy of BP/1/5241, a near-complete specimen that can be confidently assigned to *Massospondylus carinatus* based on cranial characters. Osteohistology indicates that it is a subadult individual. BP/1/5241 includes a complete hind limb, providing the first insights into this part of the anatomy for the taxon, which includes a diagnostic prominent fibular condyle that projects posterolaterally from the proximal tibia, which will enable the secure referral of other hind limb-bearing specimens to the taxon. The ontogenetic stage of this specimen also allows for a better understanding of postcranial variation through ontogeny and how these changes impact the character scoring of specimens for phylogenetic analysis. *Massospondylus carinatus* has been diagnosed based on an elongate deltopectoral crest and elongate cervical centra. However, both of these features vary during ontogeny, highlighting the importance of considering ontogenetic stage when referring specimens to taxa, even in those cases where specimens are 'well-known' and abundant.

Funding Sources Stony Brook University

DSI-NRF GENUS Center of Excellence in
Palaeosciences

Science Investment Fund (Natural History
Museum, London)

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Evolutionary patterns of cat-like carnivorans

Chatar, Narimane¹, Michaud, Margot^{2,3},
Tamagnini, Davide⁴, Fischer, Valentin²

¹Integrative Biology, UC Berkeley, Berkeley,
California, United States, ²Evolution and
Diversity Dynamics Lab, Université de Liège,
Liège, Belgium, ³Département Formation et
Recherche Sciences et Technologie,
Université de Guyane, Cayenne,
Guyana, ⁴Department of Biology and
Biotechnologies, Sapienza University of
Rome, Rome, Italy

The sabertooth morphology is a classic example of convergence, appearing repeatedly across various vertebrate groups, particularly within two carnivoran clades: felids and nimravids. Despite its frequent occurrence, the evolutionary mechanisms behind these recurring phenotypes are not well understood due to a lack of a solid phylogenetic and spatiotemporal framework. In this study, we reconstruct the tempo and mode of craniomandibular evolution in Felidae and Nimravidae, evaluating the distinction between conical and saber-toothed species and within saber-toothed morphotypes. We examine morphological variation, convergence, phenotypic integration, and evolutionary rates using a comprehensive dataset of nearly 200 3D models of mandibles and crania from both extinct and extant cat-like carnivorans, covering their entire evolutionary history. Our findings challenge the notion of a distinct sabertooth morphology, instead revealing a

continuous spectrum of cat-like phenotypes in both cranium and mandible, with occasional instances of convergence. Morphological disparity peaked at the end of the Miocene and is generally higher in clades with extreme sabertoothed adaptations. We demonstrate that saber-toothed taxa exhibit a lower degree of craniomandibular integration, allowing for a greater range of phenotypes. These groups also typically show a burst of morphological evolutionary rate early in their evolutionary history. Therefore, we propose that reduced integration and rapid evolutionary rates are two key factors in the development of sabertooth morphology across multiple clades.

Funding Sources F.R.S.–FNRS (FRIA FC 36251 & MIS F.4511.19)

Belgian American Educational Foundation (BAEF)

Italian Ministry of University and Research, project CN000000033

SYNTHESYS

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Assessing phylogenetic congruence with a high-homoplasy phenotypic dataset: a case study using the avian pectoral girdle and forelimb skeleton

Chen, Albert¹, Steell, Elizabeth^{2,1}, Benson, Roger B.³, Field, Daniel J.¹

¹Department of Earth Sciences, University of Cambridge, Cambridge, United Kingdom, ²Department of Earth Sciences, University College London, London, United Kingdom, ³American Museum of Natural History, New York, New York, United States

Despite a long and extensive history of scientific research, the phylogenetic interrelationships among crown-group birds remain highly contentious, with the results of

even recent phylogenomic studies exhibiting substantial conflict with one another. Such uncertainties pose serious challenges to interpreting anatomical evolution within the avian crown group and phylogenetic placement of fossil avian taxa.

To determine whether morphological data can help assess these alternative phylogenomic hypotheses, we used a fully illustrated dataset of 204 discrete characters from the avian pectoral girdle and forelimb skeleton scored for a phylogenetically diverse range of 75 extant bird species and two crownward stem-birds. Both qualitative comparisons and quantitative metrics indicate that this anatomical region exhibits high levels of homoplasy and presents limited phylogenetic signal relevant to inferring the higher-order interrelationships of crown-group birds, possibly as a consequence of repeated functional convergence and rapid diversification near the origin of Neoaves. In follow-up analyses, we quantitatively assessed topologies recovered from unconstrained and partially constrained analyses of our morphological dataset for overall similarity with respect to competing results among recent phylogenomic studies. In addition, we mapped morphological characters onto alternative phylogenomic topologies to examine hidden morphological character support for clades identified with genetic data.

Across different metrics the morphological data were most consistently congruent with a recently proposed topology in which *Mirandornithes* (flamingos and grebes) are placed as the extant sister group to the remaining taxa within Neoaves, and the clades *Opisthocomiformes*, *Gruiformes*, *Charadriiformes*, *Phaethoquornithes*, and *Strisores* form a novel clade called *Elementaves*. This aligns with previous research suggesting that this phylogenetic hypothesis is more congruent with the distribution of nine continuous anatomical traits in birds compared with other

phylogenomic topologies. Our findings suggest that even anatomical datasets exhibiting extensive homoplasy can be leveraged to supply independent support for competing phylogenetic hypotheses.

Funding Sources This work was supported by a UKRI Future Leaders Fellowship and the Isaac Newton Trust (DJF), and a Paleontological Society Student Research Award (AC).

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

New insights into pterosaur cranial anatomy: X-ray imaging reveals palatal structure and evolutionary trends

Chen, He¹, Jiang, Shunxing², Kellner, Alexander W.³, Wang, Xiaolin²

¹School of Ecology, Sun Yat-sen University, Shenzhen, China, ²Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China, ³Department of Geology and Paleontology, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The identification of individual bones in the skull can be very difficult in extinct clades, and this difficulty is particularly true for pterosaurs, a group of extinct flying reptiles. Among the least studied portion of the pterosaur skull is the palate, which tends to be poorly preserved and commonly only visible from one side (the ventral portion). Even in well-preserved specimens, the bones tend to be fused, with the limits of individual palatal elements obscured. To shed new light on this region, we employed advanced X-ray imaging techniques on the non-pterodactyloid *Kunpengopterus* (Wukongopteridae), and the pterodactyloids *Dsungaripterus* (Dsungaripteridae),

Hongshanopterus (Istiodactylidae), and *Hamipterus* (Hamipteridae). Our analyses revealed the presence of sutures between palatal bones in *Dsungaripterus* and *Kunpengopterus*, which resulted in different interpretations of the relation between palatine, ectopterygoid, and pterygoid, leading to a new identification of the palatal openings. Furthermore, our study shows six main observations such as the variation of the angle between the palatine rami and the variation in the relative sizes of the palatal openings. We also point out that the presence of a maxillopalatine fenestra (previously identified as postpalatine fenestra), is unique within Diapsida. Although much more work needs to be done, we showed that advanced X-ray imaging techniques open a window for understanding pterosaur cranial anatomy and provide a new perspective for investigating the evolutionary history of these flying reptiles.

Funding Sources NSFC 42288201, 42072028, 41572020, 42302003; CAS-SPRP(B) XDB26000000; CAS-YIPA 2019075; CNPq # 308707/2023-0, #406779/2021-0, #406902/2022-4; FAPERJ #E-26/201.095/2022.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Voorhies groups revisited: Critical mobility, travel distance, and sorting of mammal and extinct reptile skeletons

Chiappone, Michael A.², Guala, Michele¹, Rogers, Raymond³, Makovicky, Peter²

¹Department of Earth and Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States, ²Department of Civil, Environmental and Geo Engineering and St. Anthony Falls Laboratory, University of Minnesota, Minneapolis, Minnesota, United States

States, ³Geology Department, Macalester College, Saint Paul, Minnesota, United States

Understanding taphonomic processes that shape the fossil record is integral to interpreting the composition and function of extinct ecosystems. Bones preserved in fluvial environments make up a major portion of the vertebrate fossil record, and unsteady state flows (flooding, crevasse splays, debris flows) are often invoked as drivers of mobility and agents of burial, in addition to steady state river flow. Experiments have explored the fluvial transport of mammal skeletons, but other vertebrates, especially extinct clades, have only been sparingly studied. Because of this, researchers have raised concerns that non-mammalian bones could exhibit different mobility and sorting patterns. Here we investigate the mobility of hadrosauroid dinosaur and sheep bones using 3d printed models weighted to a range of densities feasible for bone in a large-scale flume setup.

In steady state conditions, mass and bone shape have important effects on the critical mobility conditions for hadrosauroid skeletal elements. Under flash flood conditions, we find that bone mass and shape are significantly correlated with travel distance by both the model hadrosaur postcrania and the sheep bones. Our hadrosauroid bone models sort into statistically significant groups based on transport distance. These groups share some overall similarities with the original Voorhies Groups, but group placements of some elements are variable based on differing morphologies from mammal bones. Voorhies Groups were originally constructed from qualitative observations on the order of bone mobility rather than transport distance. Using our quantitative parameters, it was not possible to match the sheep bones to the originally established Voorhies Groups in a non-arbitrary manner due to their continuous distribution of travel distances. Furthermore, critical mobility was not necessarily correlated with actual distances moved,

suggesting that using Voorhies Groups alone may not be an effective method to determine distances traveled by bones in the fluvial fossil record, especially when complicating factors such as bedforms, bone re-orientation, and scour burial may inhibit further movement. As a result, we used our experimental data to guide development of non-dimensional mathematical models to predict behavior of bones of various shapes in flow: this will facilitate quantitative comparisons at fossil sites where hydrological parameters may be difficult to estimate.

Funding Sources This research was partially funded by National Science Foundation award FRES 1925884

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Using 3D paleotopographic maps to explore tectonics and sea level change in museum and classroom settings

Chiappone, Michael A.¹, Radermacher, Viktor J.¹, Son, Minyoung¹, Scotese, Christopher², Makovicky, Peter¹

¹Earth and Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States, ²Department of Earth and Planetary Sciences, Northwestern University, Evanston, Illinois, United States

3D printing can be creatively used to illustrate and model concepts in Earth history to K-12 audiences. As part of the Broader Impacts goals of an NSF award to study how geological events affected the distribution and composition of biotas in the mid-Cretaceous of North America, we developed a way to turn 2D paleogeographic reconstructions into 3D models as outreach tools for exploring concepts such as sea level change and its impacts on biogeography and evolution.

We made a topographic 3D model of North America during the Cenomanian (112-99Ma), with the Western Interior Seaway (WIS) bisecting the continent into eastern and western landmasses. To generate a 3D model, we rasterized a digitized paleogeographic map. Color information was converted to grayscale values in image editing software, with brighter values representing higher elevations and darker representing lower ones. Brighter values were exaggerated to facilitate comprehension on the final model. This grayscale image was then applied as a displacement map in Blender freeware to create the final 3D model, which could then be 3D printed.

This model served as a prop at an outreach event at the Bell Museum (University of Minnesota) in 2023. We placed the model in a basin and had visitors pour water into it to illustrate rising sea levels. With the right flow rate, we could demonstrate how the seaway formed through merging northern and southern arms, and how separation into eastern and western land masses led to vicariant evolution of the dinosaur faunas in each. We emphasized these learning goals by placing different dinosaur models on the eastern and western parts to illustrate vicariance, and marine reptiles in the Seaway. Real fossils from the WIS accompanied our map model to capture visitor attention and further promote learning goals. The 3D paleomap was the most popular of our visitor stations, prompting many conversations and learning interactions with and among families. The active ‘flooding’ of the continent especially captured the imagination of younger children.

We found 3D printed paleotopographic models to be useful for hands-on learning of earth science concepts with a wide range of museum visitors. Such models can easily be integrated into K-12 classroom activities, and also be incorporated into learning and outreach activities aimed at visually impaired audiences. Our poster will feature

instructions on how to use freeware to generate a 3D model for any paleogeographic map.

Funding Sources Outreach work presented here was funded in part by National Science Foundation award FRES 1925884.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

The role of ancient hyperthermals in shaping dinosaur macroevolution

Chiarenza, Alfio A.

Department of Earth Sciences, University College London, London, United Kingdom

Understanding the biospheric response to climate change over evolutionary time scales is a paleontological endeavor. Dinosaurs offer a unique opportunity to examine continuous (>150 million years, Ma) responses to climate in a large clade of terrestrial tetrapods. Throughout the Mesozoic, multiple hyperthermal events influenced diversity, biogeography, ecosystem structure, and adaptations. Employing phylogenetic comparative methods (PCMs) on Dinosauria subclades, evolutionary rates and lineage occupancy were analyzed across the climatic ‘adaptive landscape’. Paleorotations of fossil occurrences from tectonic models were computed for the Carnian–Maastrichtian interval (237–66 Ma), calibrated with HadCM3L paleoclimatic models that replicate temperature and precipitation conditions and dinosaur phylogenies to investigate the effect of significant climatic shifts (at the end-Triassic, Early Jurassic, Jurassic/Cretaceous, ‘mid-Cretaceous’, end-Cretaceous) on dinosaur macroevolution. Notable thermal regime shifts occurred during the Early Jurassic ‘Jenyns’ event and the Cretaceous Thermal Maximum (KTM), around the Cenomanian/Turonian (C/T)

boundary. Ornithischia transitioned from warm to cooler climates (30° to 15°C), with sustained evolutionary rates in Thyreophora before decelerating in Neornithischia from the Early Jurassic. Sauropodomorpha shifted to higher temperatures (~25°C) due to reduced thermal diffusion in the Early Jurassic, with evolutionary rate increases towards higher thermal optima of 24–23°C in Neosauropoda and stabilization at high temperatures across the C/T. A significant shift to colder climates is observed in Theropoda during the Early Jurassic, at the base of the Coelurosauria radiation, associated with the origin of main tetanuran clades and possibly early pterosaurs. The 'Jenkyns' and the KTM highlighted crucial time horizons of adaptation coinciding with hyperthermals, with empirical evidence suggesting a correlation with the concomitant radiation of eusauropods and their attainment of large sizes (>10 m in length) between 184–180 Ma. Ornithischians and theropods might have broadened thermal landscapes due to an early acquisition of homeothermy, a trait potentially exaptive during the 'Jenkyns' event. Endothermy could represent an evolutionary by-product of ecologically selected processes, with homeothermic coelurosaurs likely initially filling cooler niches, eventually leading to broader thermal ranges in later diverging clades.

Funding Sources Funding for this work was received from the Royal Society (NIF\R1\231802), European Research Council (947921) and the Spanish Ministry of Science and (FJC2020-044836-I).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Osteological evidence for a re-entrant periotic system in the inner ear of the stem snake *Dinilysia patagonica* and the

evolution of the crista circumfenestralis in snakes

Chilver, Laura, Head, Jason

Zoology, University of Cambridge, Cambridge, United Kingdom

Snakes possess a highly specialised middle and inner ear in which the tympanic membrane is lost and an expanded periotic sac forming a re-entrant fluid circuit lies on the external surface of the stapedial footplate. The housing for this sac consists of a juxtastapedial sinus composed of a fibrous pericapsular membrane that walls the space laterally and connects to a bony crest complex, the crista circumfenestralis (CCF) which encloses the stapes anteriorly and extends posteriorly to partially cover the recessus scala tympani (RST). The CCF is formed through the contact of three crests on the prootic and otoccipital, crista prootica, crista interfenestralis, and crista tuberalis, and is variably developed in all extant snakes. The evolution of the CCF is poorly understood, and its occurrence in the Late Cretaceous stem snake *Dinilysia patagonica* is controversial.

To infer if *Dinilysia* possessed a periotic sac and a re-entrant perilymph circuit, we digitally dissected the otic regions of well-preserved specimens and examined individual elements in multiple views within a comparative anatomical framework. We found that crista prootica and crista interfenestralis formed the dorsal, anterior, and anteroventral margins of a juxtastapedial sinus similar to extant snakes. Crista tuberalis is widely separated from crista interfenestralis posteriorly, by a lateral extension the basioccipital, a plesiomorphic condition previously cited to indicate the absence of the CCF. However, the basioccipital possesses an upturned lateral margin forming a ventral crest between the cristae interfenestralis and tuberalis. This crest completes a rim around the ventral

margin of the juxtastapedial sinus, consistent with the presence of a pericapsular membrane and expanded periotic sac. Our results suggest the early occurrence of a similar auditory system in *Dinilysia* as is found in modern snakes, and that the presence/absence of the CCF as a phylogenetic character should more appropriately be dissected into multiple character states.

Funding Sources Funded by Natural Environment Research Council grants NE/W007576/1 and NE/S000739/1 to JJH, and by the Snowdon Trust Scholarship to LC

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The clavicle of *Cerasinops* and a preliminary reassessment of pectoral girdle anatomy in ceratopsian dinosaurs

Chinnery, Brenda^{1,2}, Scannella, John³

¹Clinical Anatomy, TouroCOM Montana, Great Falls, Montana, United States, ²Vertebrate Paleontology, Museum of the Rockies, Montana State University, Bozeman, Montana, United States, ³Vertebrate Paleontology, Earth Sciences, Museum of the Rockies, Montana State University, Bozeman, Montana, United States

Clavicles are preserved in the pectoral girdles of many saurischian dinosaurs but are only known from a single group of ornithischians: the ceratopsians, or horned dinosaurs. Several ceratopsian taxa including *Psittacosaurus*, *Auroraceratops*, *Protoceratops*, *Montanoceratops*, and *Leptoceratops* have associated clavicles, and this bone is currently unknown in the quadrupedal ceratopsidae. A clavicle was recently identified in the holotype material of *Cerasinops hodgskissi* (MOR 300), a possibly bipedal leptoceratopsid from the Campanian Two Medicine Formation of Montana.

Identification of the *Cerasinops* clavicle highlights variation in this element among ceratopsian taxa and invites a reinterpretation of previously described examples. In *Montanoceratops*, the clavicles are sinusoidal with tapered lateral extensions where articulation with the acromion process of the scapula occurs. *Leptoceratops* expresses a more “L-shaped” clavicle. The *Cerasinops* clavicle appears intermediate in shape between the morphologies observed in *Montanoceratops* and *Leptoceratops*. The bone is relatively robust and exhibits well defined articular facets; however, the exact placement of the clavicle relative to the scapula and coracoid is uncertain. This study highlights historical ambiguity in the positioning of the clavicle relative to the rest of the ceratopsian pectoral girdle as well as the function of this element within the group.

Funding Sources Funding for excavation of MOR 300 provided by NSF Grant EAR8305173

Technical Session 3: Sauropodomorpha (Wednesday, October 30, 2024, 1:45 PM)

Osteohistological insight into the growth dynamics of Sauropodomorpha

Chinsamy, Anusuya¹, Toefy, Fay-Yaad¹, Krupandan, Emil^{2,1}

¹Biological Sciences, University of Cape Town, Cape Town, Cape Town, South Africa, ²Cenozoic Palaeontology, Iziko SA Museum, Cape Town, South Africa

Over the past few years, osteohistological analyses of several basal sauropodomorph dinosaurs, have demonstrated that the paradigm of a dichotomous cyclical growth in basal forms and a noncyclical growth for the derived sauropods is not well supported. Indeed, more recent osteohistological studies of the Lower Jurassic sauropodiform *Mussaurus patagonicus* from Argentina has further revealed that the situation is much

more complex than previously envisioned: *Mussaurus* exhibits a huge amount of intraspecific variability, with some individuals growing much faster than others. Additionally, different *Mussaurus* individuals exhibit different growth dynamics. Such variation could be indicative of sexual dimorphism or may reflect growth plasticity, and a variable response to prevailing environmental conditions. Here, we examined four sauropodomorph dinosaurs that have been recovered from the Elliot Formation of South Africa: *Plateosauravus*, a basal sauropodomorph dinosaur, two sauropodiform taxa, NMQR 3441, NMQR 1551, and a sauropod indet. taxon (SAM-PK-K382). Our aim was to i) analyse the growth dynamics of these sauropodomorph dinosaurs, and ii) to compare the osteohistology of multiple long bones of each taxon to assess intraskeletal variation. The results of our study showed that the most basal taxon, *Plateosauravus* exhibited initial rapid rates of azonal growth, which was followed by an unusual cyclical growth pattern comprising of alternating bands of plexiform-reticular and laminar bone tissue (the latter associated with arrests in growth). The two Sauropodiformes taxa grew similarly, i.e., rapid acyclical growth during early ontogeny, and zonal growth in the outer part of their cortices (suggesting decreased growth rates during the later stages of ontogeny). The growth dynamics of the basal sauropod was like the Sauropodiformes taxa, but it showed an even earlier onset of zonal bone formation. Each of the taxa maintained similar histological features in their skeletons, with some variation in the extent of secondary reconstruction. The femur of NMQR 1551 notably exhibited periosteal reactive growth that suggests a pathology. These osteohistological findings reinforces the current hypotheses that the Sauropodomorpha experienced much variation in their growth dynamics. Furthermore, the zonal bone evident in the basal sauropod highlights the fact that a rapid

uninterrupted rate of growth is not essential to attain giant proportions.

Funding Sources Research Funders: National Research Foundation, South Africa, Grant number, 136510 to AC-T; GENUS Palaeosciences grant 86073.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

New dromaeosaurid material from the Upper Cretaceous Nemegt Formation, Mongolia, reveals hidden diversity in the Nemegt Basin

Chinzorig, Tsogtbaatar^{1,2}, Kobayashi, Yoshitsugu³, Napoli, James G.^{1,4}, Currie, Philip J.⁵, Tsogtbaatar, Khishigjav², Barsbold, Rinchen², Zanno, Lindsay E.^{1,6}

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia, ³Graduate School of Sciences, Hokkaido University, Sapporo, Japan, ⁴Stony Brook University, New York, New York, United States, ⁵Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ⁶NC Museum of Natural Sciences, Raleigh, North Carolina, United States

A nearly complete dromaeosaurid theropod skeleton was discovered from the Upper Cretaceous Bügiin Tsav locality in the Nemegt Basin in Ömnögovı Province, southern Mongolia in 2009. Bügiin Tsav is one of the rich fossil localities in the basin and has produced a diverse assemblage of dinosaurs, including ornithopods, sauropods, and theropods. Dromaeosaurid remains are extremely rare from the locality, compared to other contemporary medium- to large-bodied theropod groups, such as ornithomimosaurs and oviraptorosaurs. The recently described dromaeosaurids, *Kuru* and *Shri*, from different localities in the basin, are both from

stratigraphically older Baruungoyot Formation, typically considered Late Campanian in age. *Adasaurus*, described more than 40 years ago, is the only currently valid genus from Bügiin Tsav. Here, we describe a new specimen of dromaeosaurid, diagnosed by several autapomorphies within Dromaeosauridae, including a hump-like structure on the anterior margin of the premaxilla, a ventrally projecting rugose process “chin” on the anterior dentary, an anteroposteriorly large external mandibular fenestra relative to total length of the mandible, a posteroventrally curved articular, a vertically oriented pubis and ischium (an intermediate condition between *Adasaurus* and *Velociraptor*), a hook-like process at the distal edge of the femoral head, and a posteriorly projected surface on the proximal metatarsus. Furthermore, the taxon is characterized by a unique combination of characteristics, such as a ventrally convex dentary, a well-developed ventral keel on the dorsals, a mediolaterally narrow metatarsal (MT) II, absence of a flange along the posteromedial edge of MTIII, a mediolaterally constricted, enlarged “sickle” claw of digit II and less curved unguals of digits III and IV of the same foot. Phylogenetic analysis places this new dromaeosaurid as the sister taxon to *Kuru*. These two taxa are united with *Adasaurus* by a suite of characters, including a narrow MTII with subequal MTIII and MTIV, and *Kuru* and the new taxon are united together by several synapomorphies (e.g., the presence of hypapophysis on the anterior dorsal vertebrae; the absence of a distal extensor fossa of MTII for MTI; an equally extended distal trochlea of MTIII). The new taxon provides a better understanding of dromaeosaurid anatomy, and the evolution of Late Cretaceous dromaeosaurid assemblages in Mongolia, and reveals a hidden diversity of the well-known Nemegt Basin.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Miocene crocodylians from Taiwan

Cho, Yi-Yang¹, Tsai, Cheng-Hsiu²

¹Department of Life Science, National Taiwan University, Taipei City, Taiwan, ²Department of Life Science and Institute of Ecology and Evolutionary Biology, National Taiwan University, Taipei City, Taiwan

No extant crocodylians inhabit Taiwan, but the fossils show otherwise, ranging at least from the Miocene (*Penghusuchus pani*) to the Pleistocene (*Toyotamaphimeia taiwanicus*). However, our understanding of the origin and demise of crocodylians in Taiwan remains poorly known. Here, we report two new materials of crocodylian fossils from the Miocene of Taiwan: one is from Nantou (central Taiwan), and the other is from Penghu. The Nantou specimen, most likely from the Shengkeng Formation (Middle Miocene), is still embedded in rocks, but CT data show the preservation of a series of vertebrae with ribs and osteoderms. Its precise taxonomic assignment remains uncertain, but the vertebral dimension (the centrum lengths range between 600 to 700 mm) indicates this Nantou specimen represents a large crocodylian and the oldest occurrence of Crocodylia from mainland Taiwan, comparable to *Penghusuchus pani* on Penghu Island. Additionally, a newly recovered fossil *in situ* from the Miocene rocks of Shiyu (Penghu) near the original site of *Penghusuchus pani* is a posterior dorsal rib. This Shiyu rib is 350 mm in length, flattened, gently curved, and ventrally constricted, without a prominent enlarged process in the distal end connecting to the gastralia. Given the comparable size, similar morphology, and geological occurrence, this specimen can be tentatively assigned to cf. *Penghusuchus*. Our discovery of two new Miocene crocodylian specimens from disparate localities of Taiwan shows a

widespread and deep origin of this reptilian lineage in Taiwan and the easternmost Eurasia, which went to total extinction in the Pleistocene (even the Holocene). Further research should promise to reveal crocodylian evolution and extinction along eastern Eurasia, as well as other large body-sized fossil vertebrates, to uncover the origin of modern biodiversity.

Funding Sources This project is supported by NSTC 112-2621-B-002-005 and NTU FD107028 to TSAI.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

The skull of a new Early Jurassic theropod from the upper Elliot Formation of South Africa

Choiniere, Jonah¹, Chapelle, Kimberley (Kimi)^{1,2}

¹Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ²Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States

Southern Africa's Elliot Formation has become a world standard for understanding faunal transitions across the Late Triassic–Early Jurassic interval. Despite more than 180 years of palaeontological exploration, with thousands of fossil vertebrate specimens in collections worldwide, its fauna remains heavily biased towards sauropodomorph dinosaurs. Theropod remains are among the rarest Elliot specimens, representing less than one percent of its vertebrate fossils. To date, only one named theropod taxon, *Dracovenator*, has been reported from the Elliot, with other isolated dental and postcranial remains of specimens generally referred to “*Syntarsus* sp.” Here we report on new theropod cranial material discovered in outcrops of the upper Elliot Formation

(Hettangian–Sinemurian) in Golden Gate Highlands National Park, Free State Province South Africa. When discovered, the material was badly weathered and distributed across several square meters of surface as a group of small nodules. By μ CT scanning these nodules, we were able to digitally reconstruct the anatomy of many parts of the skull, including the snout, the braincase, and portions of the roof. Our anatomical findings reveal several cranial autapomorphies, enabling us to recognize it as a potentially new taxon, generically distinct from either *Dracovenator* or the Zimbabwean “*Syntarsus*” material. Of particular interest are the stark differences in maxillary and dentary tooth sizes, the elongated posterior process of the premaxilla, the low, paired ridges along the dorsolateral margins of the nasals, and a highly pneumatized crest-like structure, which we hypothesize projected dorsolaterally above the orbits. A preliminary phylogenetic analysis places the new taxon either within Coelophysoidea or as part of a clade with *Dilophosaurus*. These findings help to elucidate the anatomy of dinosaurian predators of the Early Jurassic, which are globally rare, and to begin to address shortcomings of Elliot Formation sampling.

Funding Sources South African NRF African Origins Platform GUN 136516

DSI-NRF Genus

Stony Brook University

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

An unusual occurrence of fossil vertebrate remains in the lower Eocene Willwood formation of NW Wyoming, USA

Christensen, Jane M.^{1,2}, Bown, Tom¹, Nichols, Kimberly¹

¹Anthropology and Geography, Colorado State University, Tucson, Arizona, United

States, ²Natural Sciences, Colorado State University, Fort Collins, Colorado, United States

Predator assemblages can be valuable windows into the behavior of extinct carnivores, and often contain an unusual mix of fossil taxa and elements, complementing other sources of data about the diversity of animals living in a particular time and place. A large, aerially restricted concentration of vertebrate fossils (350 m from the base of the Willwood Formation) is a probable predator accumulation. It contains a unique assemblage compared to what is typical from surface collected sites in the Bighorn Basin (BHB), consisting of 99 specimens representing a minimum of 15 genera of mammals; the crocodilian *Allognathosuchus*; squamate reptiles; a bird metapodial; and the claw of a raptorial bird. The mammals are dominated by small forms common to the Willwood Formation (e.g., *Hyopsodus*, *Diacodexis*, *Cantius*, and *Microsyops*), unlike similar Willwood concentrations of small mammals, which generally contain a higher proportion of rare taxa. However, the locality does have unusual taxa, as bird material is generally rare. The fossils were collected from a few badland rills over an area of about 20 m² and appear to have weathered from the upper ~30 cm of a stage 2+ paleosol, implying that it formed in a mature soil some distance from the main channel, was not accumulated by water transport. No geologic evidence points to concentration by sedimentary processes, and tooth marks and probable digestive wear on some of the bones are consistent with a predator accumulation in a nest or other retreat such as a tree hollow, a soil crevice, or shrubbery. This could be a food storage cache, or a den for raising young. Most of the bones are gnathic (jaws and teeth), astragali, vertebrae, and a calcaneus, consistent with the meatier bones having been processed during consumption. The avian claw is that of a raptor—either an owl (Strigiformes) or an Accipitriform (hawks,

eagles, kites) but its size and claw morphology suggest it was more likely a prey item than the predator, as a portion of the taxa present are too large to be its prey. In addition, tooth marks in fossils from the locality indicate a mammalian predator. However, it is possible that the cavity or refuge was used by different predators at separate times, as modern animals often reuse abandoned cavities. In all, this site offers a contrast to both typical quarry deposits and surface collected sites from the BHB, giving a rare window into an unusual taphonomic circumstance.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Comparative neuroanatomy of Jurassic sauropods from Niger: disparate sensory adaptations?

Ciudad Real Ballesterro, María¹, Vidal, Daniel^{1,2}, Serrano Martínez, Alejandro³, Keillor, Tyler², Sereno, Paul C.²

¹Grupo de Biología Evolutiva, Universidad Nacional de Educación a Distancia (UNED), Madrid, Spain, ²Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ³Computational Paleobiology Research Group, Institut Català de Paleontologia, Sabadell, Spain

Three contemporaneous basal eusauropods are now known from the presumptive Late Jurassic Tiouraren Formation of Niger, with *Jobaria tiguidensis* being only one described and named. All are represented by distinctive cranial material that includes the endocranial cavity, although their precise taxonomic affinity is uncertain.

The first braincase belongs to a skull with has heart-shaped maxillary crowns and postcranium that suggests a turiasauran affinity. The braincase has two distinctive ridges on the margin of the supratemporal

fenestrae not present in the other skulls. Its inner ear has relatively short semicircular canals of considerable diameter that have a distinct orientation among them. The endocast is quite small relative to the skull size. The second partial skull lacks the supratemporal ridges and has more prominent inner ear anterior and posterior canals that have a smaller relative diameter than the first skull. The hindbrain has a prominent dural peak. A third isolated braincase, which may pertain to *Jobaria*, has a more robust construction. The frontal bone is twice the thickness of the other skulls and exhibits stronger orbital ornamentation. There is also some differentiation of cerebral hemispheres unlike the other two.

Whereas basal eusauropods tend to show less overall disparity in their postcranial skeleton and cervical morphology than later neosauropods, differences in their endocranial volumes and inner ear morphology suggest that they may have occupied different ecological niches.

Funding Sources Daniel Vidal received funding from a MSCA grant (EvoSaurAF 101068861) and Alejandro Serrano-Martínez from the project PID2020-117118GB-100 founded by the AEI

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

New enantiornithine diversity in the Hell Creek and the functional morphology of the avisaurid tarsometatarsus

Clark, Alexander¹, Atterholt, Jessie², Carroll, Nathan R.³, Carr, Thomas⁴, Scannella, John⁵, O'Connor, Jingmai⁶

¹Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois, United States, ²Western University of Health Sciences, Pomona, California, United States, ³Carter County Museum, Ekalaka,

Montana, United States, ⁴Carthage College, Kenosha, Wisconsin, United States, ⁵Museum of the Rockies, Bozeman, Montana, United States, ⁶Field Museum, Chicago, Illinois, United States

Enantiornithines were the most diverse group of birds during the Cretaceous, comprising over half of all known species from this period. The fossil record and subsequently our knowledge of this clade is heavily skewed by the wealth of material from the Lower Cretaceous deposits of China. In contrast, specimens from Upper Cretaceous deposits are rare and typically fragmentary. Late Cretaceous material is critical for understanding the extinction of this clade at the K-Pg boundary. Though Late Cretaceous enantiornithines are known from North America, most specimens consist of very fragmentary materials. The most complete North American Late Cretaceous enantiornithine is *Mirarce*, a member of the diverse clade Avisauridae. With the exception of *Mirarce*, North American avisaurids are known only from isolated hindlimb elements from North and South America. In contrast to typical small and arboreal enantiornithines from the Early Cretaceous, avisaurids were characteristically large and robust. Here we describe three new enantiornithines from the Maastrichtian Hell Creek Formation, two of which represent new avisaurid taxa. These materials represent a significant increase in the known diversity of Enantiornithes in the Latest Cretaceous. Re-examination of material referred to Avisauridae through phylogenetic analysis provides strong support for a more inclusive Avisauridae. Exploration of the functional morphology of unusual features of the tarsometatarsus strongly suggest raptorial behaviors.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Digital rendering of a unique turtle specimen from the Blackleaf Formation, Montana

Clark, Brendan A., Hannebaum, Zakaria, Varricchio, David J.

Earth Sciences, Montana State University, Bozeman, Montana, United States

Compared to much of the Mesozoic's fossil record, the transition between the Early and Late Cretaceous of North America is underrepresented. However, some fossils from this time suggest diverse assemblages of basal and derived turtles in many western North American formations. As with other groups from this time, many of these fossils are fragmentary. This prevents more thorough reconstructions of their morphology, interrelationships, and ecology. Recently, a small turtle specimen was discovered in the Cenomanian-age Vaughn Member of the Blackleaf Formation in southwest Montana. This specimen includes a carapace and plastron surrounding other previously obscured elements, most of which are from the cranium and mandible. To appropriately reveal as much data from this fossil as possible, the specimen was micro CT-scanned and digitally rendered using the software package 3DSlicer. Reconstructions of digital models were made using Blender 3.0.0. Five millimeter-to-centimeter-scale blocks, including the largest 6.5 centimeter block containing the carapace and plastron, were prioritized for scanning and rendering. This permitted subsequent description of the preserved elements. This specimen likely represents one of the most complete mid-Cretaceous North American turtle fossils found. Its small size similar to other juvenile turtles, with an approximately 5-6 centimeter long plastron when complete, and unusual plastral scute morphology are suggestive of an umbilical scar being preserved on this specimen. If further study provides more convincing evidence for this identification, it could represent one of the first of its kind

found in the fossil record. Morphological features such as parasagittally oriented ridges on the carapace suggest an as yet unnamed chelydroid taxon. To further test this identification, a Bayesian phylogenetic analysis was conducted with 29 taxa selected from pan-Chelydridae and pan-Kinosternoidea in another study, both forming the more inclusive clade of Chelydroidea. This current analysis places the Blackleaf Taxon at the base of pan-Kinosternoidea. Furthermore, currently published records of pan-kinosternoids describe material from only as early as the Campanian. This specimen not only extends the lineage back by approximately 25 million years but provides insight into the diversity of the Blackleaf Formation and the evolution of North American ecosystems throughout an underrepresented time range during the Cretaceous.

Funding Sources Funding was provided by the Undergraduate Scholars Program of Montana State University during the Fall of 2023.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Predatory ecomorphology of *Unktaheela specta*, smallest polycotyloid of the Western Interior Seaway

Clark, Robert O., O'Keefe, F. R.

Biological Sciences, Marshall University, Huntington, West Virginia, United States

The holotype of *Unktaheela specta*, a small polycotyloid plesiosaur from the Sharon Springs Member of the Pierre Shale, was originally referred to *Dolichorhynchops osborni*, but numerous autapomorphies set it apart as a distinct genus. Its cranial proportions, neural spine dimensions, and pubis morphology are unique, and its

supraorbital ridge and thin propodial margins are unknown in other polycotyliids.

Certain adaptations in *Unktaheela* are similar to those in other taxa, extant and extinct, shedding light on its possible ecological niche. The flat, triangular process anterodorsal to its orbit resembles that used by raptorial birds to shield their large eyes from sunlight while hunting. This “supraorbital ledge” is part of a suite of cranial adaptations in *Unktaheela* suggesting a visual hunting strategy. Its eyes were among the largest of any polycotyliid and angled forward to potentially facilitate binocular vision. Despite its long rostrum, *Unktaheela*’s field of vision may have been large due to its rostrum’s narrowness, the depressed region just anterior to its eyes, and the distance between its eyes due to its wide skull.

If the supraorbital ledge of *Unktaheela* acted as a sunshade, it may have frequented sunlit habitats just below the water’s surface. There is support for this interpretation in the inferred ecology of metriorhynchid crocodylians. Like *Unktaheela*, metriorhynchids possess a large orbit and a flat supraorbital process, and multiple lines of evidence suggest that their primary habitat was at the very top of the water column.

The postcranial adaptations of *Unktaheela* can help us make further behavioral inferences. As in other polycotyliids, its short neck, streamlined body, and large paddles point to a capacity for high speed and maneuverability. Unlike other polycotyliids, its propodials were more convex ventrally than dorsally. This may imply a diving adaptation emphasizing the upstroke. Frequent dives would also be consistent with its fore-paddles being proportionally among the widest in Polycotyliidae and its hind-paddles being among the narrowest. Considering these features with the visual adaptations mentioned above, we hypothesize that *Unktaheela* employed a visual hunting strategy just below the sea surface, taking

advantage of its small size to pursue prey less accessible to its larger relatives, and commonly diving, either as a means of capturing prey or of avoiding predation.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A new Hadrosaurid nesting site from the Upper Cretaceous (Campanian) Judith River Formation, North Central Montana, with crushed eggs, embryonic and partially articulated hatchling bone elements, and possible mineralized mammary tissues

Clawson, Steven R., Neff, Deanna J., Fowler, Denver

Badlands Dinosaur Museum, Dickinson Museum Center, Dickinson, North Dakota, United States

Complete dinosaur eggs have previously been reported from the Judith River Formation (JRF) of Montana, but not yet formally reported as associated with hatchling or embryonic bone. A Badlands Dinosaur Museum (BDM) crew discovered a new dinosaur egg site (“Deanna’s Baby”) on State Land in Hill County, Montana, in JRF outcrops (lithostratigraphically equivalent to the Upper Oldman Formation of Southernmost Alberta). The eggs are preserved in a smectitic clay-dominated paleosol outcrop with numerous terrestrial gastropods, freshwater molluscs, and ex-situ eggshell fragments, along with an assemblage of taxa typical of a Campanian vertebrate microfossil bonebed (MVB). Dozens of hatchling-sized Hadrosaurid vertebrae and limb bones with characteristic embryonic porous surface textures were collected, including one left tibia/fibula pair still locked in articulation. An excavation of this site conducted in 2023 yielded at least two crushed potential Spheroolithid eggs in situ. Concave crescent-shaped cross sections of eggshell lying parallel to the

ground may also suggest some of these eggs are hatched. The eggs are relatively small, being ~15cm in diameter. A general ovate pattern to the distribution of one grouping of crushed partial eggs may suggest the margin of at least one in-situ clutch. Ultraviolet photography performed on the eggs and surrounding matrix bring additional detail to structures that are, in the visible light spectrum, pinkish-yellow to red films of material inside of the eggshell interpreted as potential mineralized albumen and membrane/mammary tissues. A general ecological reconstruction of the MVB is also possible. Tetrapod burrows and body fossils including a Didelphid mammal lower jaw, Troodontid teeth and bone elements, mature Hadrosaurid postcranial elements, freshwater turtle shell and limb elements, and a host of other microvertebrate fauna have also been identified from surface collection and sieving of matrix collected peripheral to the nest horizon. Upcoming histological analysis of the eggshell and hatchling material will provide a more precise framework to determine the ootaxon, while careful mapping and photogrammetric analysis of the site will clarify its taphonomy.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Reexamination of hypothesized sexual dimorphism in the Early Permian non-mammalian synapsid *Dimetrodon limbatus*

Cochran, Nathaniel¹, Anderson, Jason²

¹Department of Biological Sciences, University of Calgary, Calgary, Alberta, Canada, ²Faculty of Veterinary Medicine, University of Calgary, Calgary, Alberta, Canada

Sexual dimorphism, a phenotypic difference between the sexes of an organism, occurs commonly in extant taxa and previous authors hypothesized its occurrence in

extinct taxa. Previous literature proposed the presence of sexual dimorphism in the Early Permian stem-mammal *Dimetrodon limbatus* due to the presence of two sympatric morphotypes differing in neural spine length, mandibular tooth count, “exaggeration” of the maxillary step, length of the temporal region, length of the postorbital skull, limb bone robusticity, length of the dorsal vertebrae, elongation of the upper dentition, reduction in precanine length, and tooth count anterior to the canines. However, the hypothesized sexual dimorphism was not tested statistically, nor were there controls for stratigraphic or ontogenetic variation in anatomy. We tested whether *D. limbatus* exhibited sexual dimorphism by examining proposed dimorphic character for bimodality. We used an electronic slide caliper to measure mature specimens at the Field Museum of Natural History. We limited the sample to single bonebeds to control for time and mature specimens to control ontogenetic variation in anatomy. The measurements were log transformed then subjected to a Shapiro Wilk’s test and Hartigan’s dip test because a bimodal distribution must be non-normal and multimodal. Dimorphism was then tested independently using agglomerative hierarchical clustering and gap statistic analysis to find the most significant number of clusters and identify which cluster each specimen belonged. Our analysis supports unimodal, normal distributions for all characters previously reported as dimorphic. Agglomerative hierarchical clustering and gap statistic analysis found the sample was best explained with a single cluster, therefore we reject sexual dimorphism as a hypothesis. These results suggest that the sail height of *D. limbatus* is not a result of sexual selection, although future work must increase the statistical strength of the results by expanding the sample.

Funding Sources This research was supported by an NSERC Discovery Grant to Jason S. Anderson.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A new, large specimen of *Brachychampsa* (Archosauria: Crocodylia) from the uppermost Cretaceous Hell Creek Formation, Montana

Cooper, Zachary G.¹, Fowler, Denver², Scannella, John¹

¹Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Badlands Dinosaur Museum, Dickinson Museum Center, Dickinson, North Dakota, United States

The uppermost Cretaceous Hell Creek Formation (HCF) of Montana preserves the last non-avian dinosaurs to roam the region and a range of other vertebrates that inhabited the local river systems, including fishes, turtles, champsosaurs, and crocodilians. In 2008, a Museum of the Rockies (MOR) field crew discovered the remains of a large crocodilian in the upper unit of the HCF of Garfield County, Montana. The specimen (MOR 3023) consists of a nearly complete right dentary, partial splenial, two teeth, and associated fragments. The dentary is robust with a preserved length of 368 mm and a symphyseal length of approximately 64 mm. The anterior margin of the suture for the splenial terminates posterior to the mandibular symphysis. The teeth are not in place, permitting an unobstructed view of alveoli morphology; 17 alveoli are preserved in place with the largest being the fourth and fourteenth (both 17 mm wide). Both recovered teeth are blunt with longitudinal striations; the longer tooth (50 mm) has a pronounced apical wear facet. The lateral

surface of the dentary exhibits extensive neurovascular foramina anterior to the fourteenth tooth position. The mandibular canal is relatively wide (>10 mm). Curvature of the anterior ramus of the dentary is consistent with the morphology of the blunt, broad skull that characterizes *Brachychampsa*. This globodontian crocodilian has been hypothesized to be durophagous, feeding primarily on hard-shelled organisms including turtles. Details of the MOR 3023 mandibular anatomy are consistent with facial sensitivity for detecting prey in water. This specimen represents one of the largest recorded *Brachychampsa* and highlights possible niche-partitioning with other crocodilian taxa in the HCF ecosystem.

Funding Sources Field collection of MOR 3023 was supported by the Smithsonian Institution and donors to the Hell Creek Project.

Colbert Prize Session

A histological survey of a large, sub-adult *Tylosaurus nepaeolicus*

Cope, Carson R.^{1,2}, Wilson, Laura E.^{1,2}

¹Department of Geosciences, Fort Hays State University, Hays, Kansas, United States, ²Sternberg Museum of Natural History, Hays, Kansas, United States

Tylosaurus nepaeolicus is a medium-sized Tylosaurine mosasaur that lived during the late Coniacian and early Santonian in the Western Interior Seaway. Despite being a well-studied species, there is debate over whether *Tylosaurus kansasensis* represents the juvenile form of *T. nepaeolicus*, or if the two species are distinct. To help resolve this debate and to better understand the growth of *T. nepaeolicus*, a histological study was performed. Thin-sections were taken from a humerus, rib, and vertebra of a single individual (FHSM VP-2209). All thin-sections

show parallel-fibered cortical bone and trabecular networks of varying extent with secondarily remodeled bone. Vascular canals are primarily longitudinal in the rib with both longitudinal and radial canals in the humerus and vertebra. Canals are open to the periosteal surface in all bones examined indicating the individual was actively growing at the time of death. Based on lines of arrested growth in the rib, the mosasaur was at least 10 years old at the time of death. Zygapophyseal growth rings support this age estimate, with nine rings observed on the surface of the zygapophysis.

FHSM VP-2209 is interpreted as a sub-adult based on the extensive, but incomplete secondary remodeling, the lack of an external fundamental system, and the presence of vascular canals open to the periosteal surface. FHSM VP-2209 has previously been estimated to be 7.1 meters long and represents one of the largest *T. nepaeolicus* known, implying that the species may have grown larger than previously thought. Because this specimen has been consistently identified as *T. nepaeolicus* and was still growing at the time of death, it is not likely that *T. kansasensis* also represents a juvenile form of *T. nepaeolicus*. Consequently, our histological survey of a large but subadult *Tylosaurus nepaeolicus* specimen supports the validity of *Tylosaurus kansasensis* as a distinct species.

Funding Sources This work received funding support from the Fort Hays State University Graduate Scholarship Experience grant program.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Taxonomic assessment and stratigraphic distribution of *Daspletosaurus* specimens from the Dinosaur Park Formation

Coppock, Colton, Powers, Mark J., Currie, Philip J.

Biological Sciences, University of Alberta, Edmonton, Alberta, Canada

For over a century, the skeletal remains of *Daspletosaurus* have been uncovered in Dinosaur Provincial Park (DPP), Alberta, from the exposed Dinosaur Park Formation (DPFm) and the underlying Oldman Formation (OMFm). Taxonomic identifications for these specimens suffered for the first half of the century as they were referred to *Gorgosaurus libratus*, on the basis of it being the only known large carnivorous dinosaur from the region at the time. This was until Dale Russell's description of a distinct taxon, *Daspletosaurus torosus*, in 1970. In the time following the ability to identify material to either taxon has improved and additional *Daspletosaurus* sp. specimens have been discovered. The well documented record of tyrannosaurid bearing quarries within DPP provides a unique opportunity to place *Daspletosaurus* specimens within the context of the stratigraphic record. Doing so offers invaluable insight into evolutionary patterns of morphological change in *Daspletosaurus* cranial anatomy through time. A biostratigraphic analysis of tyrannosaurid bearing quarries based on amended taxonomic identifications and identifiable isolated bones was completed by measuring the elevation of the quarries relative to the closest underlying OMFm contact. The initial biostratigraphic analysis was constrained to the boundaries of DPP as this area contains the most uniformly deposited DPFm strata. The results of this study reveal a first occurrence to last occurrence range of approximately 5-49 meters above the OMFm contact for *Daspletosaurus* sp. This is a similar distribution to the stratigraphic range of *G. libratus* (0-37m). Within the DPFm, there is a region within the stratigraphic column, approximately 20-31 m above the OMFm contact, where the majority of DPFm

Daspletosaurus sp. specimens are recovered. The *Daspletosaurus* sp. specimens reveal a clear shift in cranial morphologies, rather than a mosaic of intraspecifically variable morphological character states. However, the sample size of specimens referable to the genus remains small (n=15) and as such these results may change as additional specimens are uncovered. Similar evolutionary patterns in changes to cranial morphology were observed in *Daspletosaurus* spp. specimens uncovered from the upper OMFm of southern Alberta and the Judith River and Two Medicine Formations of Montana. However, further work is required on the precise stratigraphic placement of these quarries and correlation with the beds of the DPFm.

Funding Sources Dinosaur Research Institute: Student Research Grant

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Crocodylian hyperdiversity during the early Eocene in the Golden Valley Formation of North Dakota, U.S.A.

Cossette, Adam P.¹, Tarailo, David A.²

¹Biomedical and Anatomical Sciences, NYITCOM at Arkansas State University, Jonesboro, Arkansas, United States, ²Biological Sciences, Fort Hays State University, Hays, Kansas, United States

Rich bone beds from early Eocene strata of the South Heart Locality, Golden Valley Formation, Stark County, North Dakota reveal a speciose sympatric crocodylian fauna. The locality's taxa are consistently differentiated and represent a minimum of four species partitioned by size, bodyplan, and inferred feeding strategy. The presence of a possible fifth crocodylian species is suggested by limited dental and osteoderm evidence. A

new species is described and a previously known holotype is redescribed. The morphology of these taxa gives evidence to divergent feeding strategies and suggests separate ecological niches. Whereas *Chrysochampsia mylnarskii*, a large-bodied alligatorid preserves a generalist morphology, a new small bodied species preserves globular distal dentition and a short, broad snout. This species, morphologically similar and phylogenetically related to species of *Allognathosuchus*, *Procaimanoidea*, and *Arambourgia gaudryi*, is an exemplar of a radiation of small-bodied Paleogene alligatorids and preserves the ancestral feeding strategy for the clade. The locality's crocodylians provide extensive morphological data combining the phylogenetic history and ecological record of the Paleogene North American alligatorid diversity peak. Coincident with this peak, most species recovered from the locality are alligatorids and comparison to other hyperdiverse crocodylian localities reveals the limited phylogenetic diversity here is notable. Shared with many alligatorid species from the Late Cretaceous and Paleogene of North America, the locality's small-bodied taxa preserve globular distal teeth, blunt snouts, massive jaws, and long dentary symphyses indicative of durophagous predators. Trophic dynamics of the locality diverge from modern environments and the abundant crocodylians may have filled the ecological niche of large mammalian carnivores noticeably absent here. This alligatorid-rich crocodylian fauna evolved in swampy lowlands and meandering streams flanked by subtropical forests during one of the hottest sustained intervals in Earth history. The lush, highly productive ecosystems preserved in the Golden Valley Formation inform the evolutionary history of North American alligatorids and preserve significant biodiversity following the Paleocene-Eocene Thermal Maximum.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

New microvertebrate fossils from the Pierre Shale, Manitoba, Canada

Costa, Bruno, Brink, Kirstin, Silva, Ricardo L.

Earth Sciences, University of Manitoba, Winnipeg, Manitoba, Canada

The Upper Cretaceous Western Interior Seaway (WIS) of North America is best known for its diverse assemblage of marine vertebrates, namely marine reptiles, birds, sharks, turtles, and bony fish. The majority of previous studies has been based on macrofossil remains, such as partial cranial and/or post-cranial skeletons. Recent analyses of microvertebrate fossils (partial specimens less than 2 cm), however, have provided new insights regarding WIS ecosystems, with new occurrences of taxa previously unknown from Manitoba, suggesting our knowledge of these systems is still incomplete. In this study, we analyzed microvertebrate fossils collected from sites that are known to produce large macrofossils to reconstruct niche occupancy and mid-level trophic structure of the WIS in Manitoba. Samples were mechanically prepared out of sediment collected from field jackets in association with large macrofossils and surface collected from the Campanian-aged Pembina Member and Millwood Member of the Pierre Shale. Preliminary results suggest that the samples contain new species of fish and embryonic marine reptiles. Two small specimens, preserved in shale nodules, possess an unusual pattern of odontode structures. Scanning Electron Microscopy images and Computed Tomography scans suggest these are neopterygian fish odontodes, belonging to a new taxon. The imaging analyses show labio-lingually compressed, bean-shaped odontodes with a mesial prominent notch covered with superficial enamel; vascular channels with extensive branching; stomata-shaped

resorption sockets; and pulp cavities. The specimens also bear a unique resorption pattern with odontodes replacing in complete alternating rows. The identification of these enigmatic specimens will improve our understanding of the marine vertebrate paleodiversity as well as the trophic structure of the WIS during the Late Cretaceous in Canada.

Funding Sources We thank the MITACS Accelerate Fellowship Program for funding this project and an NSERC-DG to KSB.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Take to the skies: A new type species pushes back the origination of crown group albatrosses (Aves, Diomedidae)

Coultley, Lyzzy N.¹, Clarke, Julia², Ward, Pat¹, Davis, Edward B.¹

¹Earth Sciences, University of Oregon, Eugene, Oregon, United States, ²Jackson School of Geosciences, University of Texas at Austin, Austin, Texas, United States

Historically, there has been much contention over the phylogenetic relationships among modern albatrosses. Neontologists continue to argue over how many distinct species there are among the four modern genera. Similar disagreements are found in the research and descriptions of fossil albatrosses. The fragmentary nature of described extinct albatrosses has obscured the crown group's origination. Insofar, neontologists agree that the modern genera originated during the Pliocene with specific and unique morphologies which distinguish them from earlier albatrosses.

The key morphological characteristics that distinguish crown group albatrosses from those on the stem are found on the cranium and first three cervical vertebrae. These previously proposed traits of the skull are:

lateral facing, well-defined nares; a bulge at the proximal base of the beak; a deep furrow along the length of the beak; and a concave culmen. The proposed characteristics of the cervical vertebrae that define the crown group are: a dorsally opened incisura fossae of the atlas and a relatively developed processus costalis of the axis. Additionally, when compared to other crown group albatrosses, the presence of a fairly developed fovea cranioventralis of the third cervical vertebra differentiates the phoebastrids from the other genera.

Until this study, crown group albatross characteristics have only been found in specimens from the Pliocene into the Recent. Here, we describe a newly identified albatross skull and associated cervical vertebrae (UOMNCH F-47133) found in the Miocene deposits of the Astoria Formation in Oregon, USA that may shift the origination of crown group albatrosses. This specimen expresses many of the proposed key morphologies of the cranium and cervical vertebrae that are shared among crown group albatrosses. A unique combination of these traits also supports its identity as a new species. CT analyses will be used to confirm these observed morphological features and may also illuminate other crown group features in the skull and cervical vertebrae obscured by articulation and matrix. The proposed phylogenetic position of the new species suggests the origination of crown group albatrosses is approximately 5 – 10 million years earlier than previously thought; shifting from the Pliocene to the Miocene. Identifying this new species thus affects our understanding of this dynamic clade's evolutionary history.

Funding Sources University of Oregon Earth Sciences Department

Investigating the foraging behavior of two eastern Beringian Quaternary moose species (*Alces alces* and *Cervalces* sp.) using stable isotopes

Cragun, Benjamin^{1,2}, Wooller, Matthew³, Druckenmiller, Patrick S.²

¹Department of Wildlife and Biology, University of Alaska Fairbanks, Fairbanks, Alaska, United States, ²University of Alaska Museum of the North, Fairbanks, Alaska, United States, ³Alaska Stable Isotope Facility, University of Alaska Fairbanks, Fairbanks, Alaska, United States

Cervalces is an extinct genus of Cervidae (Alceini) that inhabited most of the Holoarctic Region from the Middle Pliocene to the Late Pleistocene. Likely ancestral to modern moose (*Alces alces*), which arose in Eastern Europe, the Eurasian lineage, *Cervalces latifrons* (formerly *Alces latifrons*), gave rise to the North American lineage, *Cervalces scotti*, after crossing eastward through Beringia in the Middle Pleistocene. Although little is known about the paleoecology of *Cervalces* sp., it has been hypothesized that they had a diet similar to *A. alces*, which arrived in North America from Eurasia after the Last Glacial Maximum ~15 kya. *A. alces* is a generalist browser, feeding on both woody and non-woody vegetation, with a preference for plants in riparian habitats, such as shrubs and willows growing along sources of water. Because *Cervalces* sp. had longer nasals and shorter premaxillaries than *A. alces*, it has been hypothesized that it lacked the specialized rostrum for underwater feeding that is present in *A. alces*, and therefore would not have favored the consumption of aquatic plants. We sampled Quaternary *Cervalces* sp. And *A. alces* antler and skull material from eastern Beringia for bulk stable carbon and nitrogen isotope analysis of bone collagen to investigate the dietary patterns of these two species. Our preliminary data suggests that the two groups inhabit similar isospace, with an overlap in $\delta^{15}\text{N}$ values but

revealed higher $\delta^{13}\text{C}$ values for *Cervalces* sp. than *A. alces*. We can infer from the $\delta^{15}\text{N}$ values that *Cervalces* sp. had a similar diet, with a greater proportion of aquatic plants than *A. alces* to account for the difference in their $\delta^{13}\text{C}$ values. New sampling, radiocarbon dating, and the incorporation of potential diet items into isotope mixing models is ongoing. These new data will help refine our understanding of cervid paleoecology in eastern Beringia during a period of dynamic climatic shifts.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Diets of late Neogene notoungulates from northwestern Argentina based on enamel microwear

Croft, Darin A.¹, Armella, Matías A.², Simpson, Scott W.¹

¹Anatomy, Case Western Reserve University, Cleveland, Ohio, United States, ²Facultad de Ciencias Naturales e Instituto Miguel Lillo, Universidad Nacional de Tucumán, San Miguel de Tucumán, Tucumán, Argentina

Mastication of items with different mechanical properties leaves distinctive marks (microwear) on tooth enamel. Dental microwear analysis (DMA) in fossils and extant species of known diet has proven to be a useful method for inferring diet of extinct species. These techniques have been widely applied in extinct mammals but not among South American native ungulates (SANUs). Notoungulates were the most abundant and diverse SANUs throughout the Cenozoic, but only two studies have used DMA to reconstruct their diets: one dealt with late Oligocene Bolivian species, the other focused on Early Miocene species from Patagonian Argentina. We examined three late Neogene taxa from Catamarca province, northwest Argentina (NWA): a toxodontid (*Xotodon*, n = 3), a mesotheriid (*Typotheriopsis*, n = 4), and

a hegetotheriid (*Hemihegetotherium*, n = 4). Wear features were observed on M1/m1 epoxy casts using a stereomicroscope at 35× magnification and a 0.4 mm² reading area. Wear marks were classified as scratches (fine/coarse) or pits (small/large) and standardized using MicroWear, an open-access R package for data acquisition. We used three dietary categories based on data from modern artiodactyls: browsers (*Camelus*, *Cephalophus*, *Tragelaphus*; n = 18), grazers (*Connochaetes*, *Hippotragus*, *Tetracerus*, *Kobus*; n = 34), and mixed feeders (*Gazella*; n = 14). We added three suiforms (*Potamochoerus*, *Sus*, *Tayassu*; n = 12) and two vombatid marsupials (*Lasiorhinus*, *Vombatus*; n = 12) based on previous suggestions about notoungulate ecomorphology. Our modern mammal data are generally consistent with other studies: more scratches than pits correlates with tough food consumption (e.g., grasses), while fewer scratches correlates with brittle, soft foods such as leaves, fruits, and seeds. The suiforms are closer to grazers, while vombatids are between browsers and grazers. *Typotheriopsis* is close to *Camelus* and *Cephalophus*, suggesting browsing. *Hemihegetotherium* is close to *Vombatus*, suggesting a diet of grasses, sedges, and roots of shrubs and trees. *Xotodon* is close to *Connochaetes*, suggesting grazing. Our findings indicate a range of diets among Late Miocene to Early Pliocene notoungulates from NWA despite their similar hypselodont dentitions. They are also compatible with other studies that have used “taxon-free” methods of diet reconstruction in notoungulates and found little or no correlation with hypsodonty, at least among late Oligocene and younger species.

Funding Sources ANPCYT (PICT-2020-1512); UNT (PIUNT G/737); UNCA (PIDI 2024-205-T1); The Paleontological Society (Sepkoski Grants 2021, to MAA); CWRU School of Medicine

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Morphometric approaches to classifying isolated ankylosaur teeth, with implications for identifying ‘nodosaurid’ ankylosaurs

Cross, Emily G.¹, Arbour, Victoria²

¹University of Victoria, Victoria, British Columbia, Canada, ²Royal BC Museum, Victoria, British Columbia, Canada

The presence of a basal cingulum, fluting, and overall size have been used to differentiate nodosaurid and ankylosaurid teeth for decades. However, the taxonomic utility of tooth morphology in ankylosaurs has not yet been quantitatively tested. Additionally, new phylogenetic hypotheses recognize four ankylosaur families (Panoplosauridae, Polacanthidae, Struthiosauridae, and Ankylosauridae), rather than the traditional nodosaurid-ankylosaurid dichotomy. Understanding ankylosaur tooth variation could better help identify taxa with ambiguous phylogenetic affinities, or allow isolated teeth to test paleoecological questions like the potential extirpation of mid Cretaceous ankylosaurids from Laramidia. We analyzed a large sample of ankylosaur teeth from the Cretaceous of Laramidia using traditional and 2D outline geometric morphometrics, and investigated the utility of size and the presence or absence of a cingulum and fluting for differentiating ankylosaur teeth. Morphometric analyses show that ‘nodosaurids’ had the greatest variation in tooth shape and size. Panoplosauridae accounts for a large amount of ‘nodosaurid’ variation, whereas basal ankylosaurs, Polacanthidae, and Ankylosauridae share a similar restricted morphospace. Previously, small teeth were identified as ankylosaurid and large teeth as nodosaurid; teeth with a crown base length or

height over 10 mm are only found in panoplosaurids and *Peloroplites cedrimontanus*, traditionally considered a nodosaurid but recently recovered as a polacanthid, and smaller sizes are found in all clades. A basal cingulum and fluting are associated with Ankylosauridae and Panoplosauridae, but not with other ankylosaur families. Linear discriminant analyses (LDAs) could only accurately identify between 50-75% of the teeth in our sample. LDAs should therefore be used in conjunction with size and discrete traits to identify isolated teeth as panoplosaurids, but not as ankylosaurids or polacanthids, because of overlapping morphology. As such, caution should be used when attempting to use isolated ankylosaur teeth in broader palaeoecological questions.

Funding Sources Funding from Dinosaur Research Institute Student Project Grant, CMN Visiting Student Award, and NSERC Discovery Grant (DGECR- 2020-00149 and RGPIN-2020-04012).

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A diverse microvertebrate site from the Late Cretaceous Williams Fork Formation (Campanian - Maastrichtian) of Colorado and its paleoecological implications for Laramidia

Crothers, Joel P.², Wurtz, Alyssa L.³, Hunt-Foster, Rebecca K.⁴, Foster, John R.⁵, Eberle, Jaelyn J.⁶, Heckert, Andrew B.¹

¹Museum & Field Studies, University of Colorado, Boulder, Colorado, United States, ²Department of Geosciences, Mississippi State University, Starkville, Mississippi, United States, ³Dinosaur National Monument, Jensen, Utah, United States, ⁴Utah Field House of Natural History State Park Museum, Vernal, Utah, United States, ⁵Museum of Natural History &

Department of Geological Sciences,
University of Colorado, Boulder, Boulder,
Colorado, United States, ⁶Geological and
Environmental Science, Appalachian State
University, Boone, North Carolina, United
States

The Williams Fork Formation in northwestern Colorado is an understudied, but richly fossiliferous, fluvial deltaic unit in the upper “Mesaverde” Group on the Douglas Creek Arch, Colorado. Though sparse in macrovertebrate remains, this formation features rich microvertebrate sites, which hold valuable insight into the paleoecology of the Late Cretaceous (‘Edmontonian’) age. The ReBecca’s Hollow locality has yielded a diverse fauna of actinopterygians from a freshwater environment, but chondrichthyans are rare. The most abundant fossils from this site are ganoid scales, bone fragments, and teleost vertebrae, and fish taxa include cf. *Melivius* sp., lepisosteids, *Paralbula casei*, cf. *Coriops amnicolus*, and tentatively identified acipenseriformes, esociformes and pycnodontiformes. A single worn tooth of cf. *Myledaphus* is known from ReBecca’s Hollow. Amphibians recovered from the ReBecca’s Hollow locality are tentatively referred to *Habrosaurus* and *Opisthotriton kayi*. Additionally, reptilian fossils representing squamates and testudines are abundant. Amongst archosaurs, the alligatorid *Brachychampsa*, and the dinosaurs *Paronychodon*, cf. *Saurornitholestes*, cf. *Richardoestes*, tyrannosaurids, hadrosaurids, thescelosaurids, and ceratopsids are represented primarily by teeth. Several of these taxa have not yet been reported in the Williams Fork Formation, but are known elsewhere from Campanian-Maastrichtian localities in Laramidia. The paucity of chondrichthyans is a curious feature of the ReBecca’s Hollow site, as they are abundant in other sites in the Williams Fork Formation. The faunal assemblage is temporally correlative with the Horseshoe Canyon and

Saint Mary River Formations in Alberta and the Prince Creek Formation in Alaska. One of the surprising finds from this locality is a partial hadrosaurid maxilla tentatively identified as neonate based on its tiny size. If confirmed, it represents the first baby dinosaur reported from the Williams Fork Formation. The site preserves at least 21 nonmammalian taxa and extends the known geographic distribution of most of them. The taxa from ReBecca’s Hollow are well known from Lancian and Judithian localities of Montana, Wyoming, and Alberta; thus their appearance in the Williams Fork Formation provides a more complete understanding of the terrestrial environments between these ages.

Funding Sources David B Jones Foundation

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Coprolite ichnotaxa from the Revueltian (Upper Triassic: Norian) age Homestead Site, Garita Creek Formation, east-central New Mexico, U.S.A.

Crouch, Joshua N.¹, Heckert, Andrew B.¹, Lauer, Bruce H.², Lauer, Rene²

¹Geology and Environmental Sciences Department, Appalachian State University, Gastonia, North Carolina, United States, ²Lauer Foundation for Paleontology, Science, and Education, Chicago, Illinois, United States

The Homestead Site (HS) within the Garita Creek Formation of east-central New Mexico is a microvertebrate site of Triassic, specifically Revueltian (Norian) age. In addition to the abundant bones, scales, and teeth, thousands of coprolites make up a significant portion of the rich collection. Just as with the bones themselves, analysis of these coprolites yields insight to the disparity of the represented fauna. Coprolite ichnotaxa

are important indicators of paleoecological relationships. Despite the role coprolites play in understanding trophic relationships, paleoscatology is an understudied field. We have examined a subset (n=496) of HS coprolites, finding that 212 (43%) preserve fossil inclusions, typically ganoid scales, in either external (76%) or cross-sectional (24%) view, 22 (4%) bear abiotic inclusions, and 262 (53%) bear no inclusions. The majority of inclusions are visible externally, indicating that most coprolites would not require CT-scanning to determine their inclusions. However, cutting four complete, presumably barren cylindrical coprolites revealed numerous scales in the cross-section of each.

While understudied, Triassic coprolites have a well defined ichnotaxonomy. We identify four broad categories of coprolites based on ichnomorphology: nondiagnostic (typically fragmentary and/or featureless), striated, spiral, and cylindrical. Of the fossil-bearing coprolites, 7 (3%) are nondiagnostic, 14 (7%) are striated, 91 (43%) are spiral, and 100 (47%) are cylindrical. Among scale-bearing coprolites, some contain ridged scales, sometimes even in articulation. The striated coprolites pertain most closely to the ichnotaxon *Alococoprurus triassicus*, and presumably represent archosauromorph and temnospondyl perpetrators. Spiral coprolites most closely pertain to *Heteropolacoprurus* or *Saurocoprurus*, representing spiral-valved perpetrators such as elasmobranchs, coelacanths, and lungfish. Within the context of HS, coelacanths and potentially lungfish are the only known taxa to have reached sufficient size to perpetrate the majority of the spiral coprolites. Cylindrical coprolites are most similar to *Eocoprurus* and *Falcatocoprurus*, and within the context of HS were most likely perpetrated by fish. Due to the fragmentary nature of the collection, the ichnotaxonomic designations are tentative but strongly supported. Our analysis of HS coprolites confirms the notion of an ample,

diverse assemblage supporting a complex aquatic ecosystem.

Funding Sources Appalachian State University's Department of Geological and Environmental Sciences for an Undergraduate Research Assistantship supporting the senior author.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Functional specializations of the beak and tooth rows in the end-Cretaceous dinosaur *Thescelosaurus neglectus* (Ornithischia: Thescelosauridae)

Crow, George M., Sereno, Paul C.

Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States

Exceptional preservation of upper and lower jaws of the mid-sized herbivore, *Thescelosaurus neglectus*, reveals several unusual masticatory specializations. The snout was preserved with jaws closed, capturing the articulation of upper and lower bony beak platforms and upper and lower tooth rows in natural juxtaposition. The narrow, hook-shaped upper beak of *T. neglectus* has a unique form, with a rugose bony platform of dermal bone fused to the internarial bar and overhanging the narial fossa. The form upper beak suggests that it may have functioned in rasping or hooking in procuring food or possibly digging for subsurface plant matter. The subconical premaxillary teeth have denticles at the anterior end of the snout, and the crowns occlude against the sharp lateral edge of the predatory bill. This tooth-to-bill contact generated flat, low-angle wear facets on the premaxillary teeth. The front end of snout, thus, functioned to puncture-grasp and crop plant matter. The laterally flaring posterior end of the premaxillae are edentulous and form a concavo-convex triturating surface

unique to this species. The function of this surface is not clear. The narial fossa is expansive, its smooth surface covering a large area below the external naris and including a large vascular opening anteriorly that opens ventrally on the premaxillary palate near the upper bill margin.

The first two teeth in the lower jaw show blunt, apical wear and are positioned in opposition to a sharp edentulous edge on the maxilla, the anterior end of the dentary strongly downturned. The remainder of the dentary tooth row and the opposing maxillary tooth row are medially bowed, resulting in tooth rows that form an hourglass shaped in palatal view. Broad, nearly vertical wear facets are present that join to form a nearly continuous plane, with opposing crowns in upper and lower tooth rows nearly aligned one-to-one. The cheek dentition, thus, approaches the shearing verticality present in basal neoceratopsian ornithischians. The buccal space lateral to the cheek teeth is deeply inset and highly vascularized, suggesting considerable oral processing of plant matter.

The partitioning of discrete masticatory functions, from beak to cheek teeth, suggests that there existed several stages in the procurement and mastication of plant matter in this end-Cretaceous herbivore. *T. neglectus* evolved the most specialized dentition among neornithischians outside the ornithomimid radiation.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

The auditory bulla of the Paleocene plesiadapiform *Carpolestes simpsoni* (Euarchonta, Carpolestidae) differs in composition from that of crown Primates

Crowell, Jordan W.^{1,2}, Bloch, Jonathan I.³, Silcox, Mary T.⁴, Chester, Stephen G.^{5,1}

¹Program in Anthropology, The Graduate Center, City University of New York, New York, New York, United States, ²New York Consortium in Evolutionary Primatology, New York, New York, United States, ³Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States, ⁴Department of Anthropology, University of Toronto Scarborough, Toronto, Ontario, Canada, ⁵Department of Anthropology, Brooklyn College, City University of New York, Brooklyn, New York, United States

Primates are typically differentiated from other euarchontans (treeshrews and colugos) by a suite of characteristics including an auditory bulla derived from the petrosal. Plesiadapiforms, an assemblage of Paleogene mammals, have been recovered in some recent phylogenetic analyses as stem primates with Plesiadapoidea (Carpolestidae + Plesiadapidae + Saxonellidae) as the sister group to crown primates in the clade Euprimateformes with a petrosal bulla as a proposed synapomorphy of this clade. Therefore, documenting the composition of the auditory bulla in plesiadapoids is critical. Previous work on several crania of the carpolestid *Carpolestes simpsoni* from the late Paleocene (Cf2-3 interval zones of the Clarkforkian North American Land Mammal 'age') of the Clarks Fork Basin, Wyoming, described an auditory bulla derived from the petrosal, like that of crown primates, and a double-chambered auditory bulla like that of tarsiers, specifically. However, these descriptions relied on physical observations of the external anatomy and/or μ CT data that is lower in resolution than what is currently available. Here, we analyzed higher resolution μ CT scans of *C. simpsoni* crania (USNM 482354; UM 101963) that allowed us to reevaluate anatomical interpretations regarding the composition of the auditory bulla of this taxon. Unlike previous interpretations, we document a single tympanic chamber in *C. simpsoni*, and a

bullae that is not fully composed of the petrosal. The 'platform bone' that was inferred to divide the tympanic chamber is identified as the ectotympanic that was displaced dorsally into the tympanic chamber. Three elements contribute significantly to the tympanic floor: the basisphenoid tympanic process, ectotympanic, and the rostral tympanic process of the petrosal. In this way, the configuration of the auditory bulla differs from that of crown primates and that which is inferred for plesiadapids where the tympanic chamber is fully enclosed by petrosal outgrowths. The lack of a petrosal bulla in other euarchontans suggests that *C. simpsoni* preserves a more plesiomorphic condition relative to crown primates. Assuming the monophyly of Plesiadapoidea, these observations suggest that the plesiadapid bulla evolved in parallel to crown primates or that plesiadapids might not have a petrosal bulla as previously described.

Funding Sources This study was supported by the U.S. National Science Foundation (SBE 2216582), a Leakey Foundation Research Grant, and a PSC CUNY Award, City University of New York.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

A new specimen of *Barosaurus* sp., from the Late Jurassic Morrison Formation, Bone Cabin Quarry, Wyoming

Curtice, Brian¹, Hunter, Rick J.²

¹Arizona Museum of Natural History, Phoenix, Arizona, United States, ²Museum of Ancient Life, Lehi, Utah, United States

Preparation of a remarkably complete specimen of *Barosaurus* sp. from the Late Jurassic Morrison Formation Bone Cabin Quarry, Wyoming, provides new information on the genus. It is referred to *Barosaurus*

based on the overall similarity of cervical, dorsal, and caudal vertebrae to the genotype, YPM 429. The axial skeleton of NAMAL-106 consists of eight cervical (C9-C16), nine dorsal (D1-9), five sacral, and forty-one caudal vertebrae. The majority of the elements were articulated with the remainder in close association. Cervical 11 had been displaced and discovered nestled against the right side of the dorso-sacral vertebra. Its serial position is positively known, however, as the condyle of C12 was found in its cotyle. The last cervical rib (here assigned C16) and first dorsal rib were found in articulation with their respective centra. The two ribs have markedly different morphologies. The dorsal rib articulated to D9 is short. This is the first specimen preserving the actual dorsal vertebral count for *Barosaurus*, though nine have been presumed for some time

Preserved pelvic elements include the sacral complex with four articulated sacral vertebrae, S1-4, with the caudo-sacral (S5) preserving the ilia attachments on the flared sacral ribs' lateralmost edges. The ilia rest atop the sacral ribs, which are exposed on the right side. The pubes are complete and fused to the pubic peduncles. The ischia are present but not fused to the peduncles. A coprolite fragment 4 cm by 3 cm was found centered between the ischia

Limb material includes both femora (right is complete), tibiae (right is complete), both fibulae (left is complete), both astragali, right MT I, II, III, V, and partial right MT IV; left phalanx I, left ungual I, right ungual I; left MT I, II, III, and IV. A complete right scapulocoracoid is preserved.

Seven dorsal ribs and thirty-one chevrons are prepared, with additional elements of each in prep. Each cervical vertebra has at least one articulated cervical rib. Numerous cervical rib fragments await preparation.

Appendicular material known from *Barosaurus* includes YPM 429 (holotype):

sternal plate, fragments of scapula, ilium, ischium, pubis, femur, tibia, fibula; YPM 419 - 2 metatarsals; AMNH 6341- partial pelvis, scapulocoracoid, humerus, femur, tibia, fibula, partial foot; CM 11984 - ribs and possible foot; SDSM 25210 - partial scapulocoracoid and pelvis, SDMS 25217 partial forelimb and hand; DINO 2921 - partial ilium, ischium, pubis.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

New insights into the lower jaw disparity in rhabdodontid ornithopods and their taxonomic implications

Czepinski, Lukasz, Madzia, Daniel

Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland

Rhabdodontidae is a peculiar group of small to medium-sized ornithischian dinosaurs endemic for the Late Cretaceous European archipelago. Eight to nine distinct species are currently recognized based on specimens collected from eastern Austria, southern France, western Hungary, western Romania, and northern Spain. Still, the diversity of Rhabdodontidae and their intrarelationships remain incompletely understood. Recent studies focusing on the histology of long bones suggested that the taxic diversity within the clade may be greater than traditionally thought, with possible co-occurrences of multiple sympatric taxa at least in the sample from southern France.

Owing to the fact that the type specimens of six of the rhabdodontid taxa (*Mochlodon suessi*, *M. vorosi*, *Rhabdodon priscus*, *R. septimanicus*, *Zalmoxes robustus*, and *Z. shqiperorum*) are known from well-preserved and distinctive dentary bones, determining the diagnostic features present in these elements has the potential to provide crucial information improving the knowledge of their

distinguishability and phylogenetic affinities. A thorough reevaluation of the dentary bone morphologies of these taxa, including a multivariate assessment of their character distribution, unveiled a greater morphological disparity in rhabdodontid dentaries than usually assumed. Intriguingly, our results show that the type specimen of *Rhabdodon septimanicus* from southern France represents a morphological outlier among rhabdodontids, occupying a different morphospace than the remaining members of the clade. For instance, the unusual position of the coronoid process behind the alveolar row and the absence of the buccal platform in *R. septimanicus* clearly distinguish the specimen from all other members of the Rhabdodontidae, and even from earlier-diverging rhabdodontomorphs, possibly indicating a distinct feeding ecology. Although often considered a junior synonym of *Rhabdodon priscus*, the new results demonstrate that *R. septimanicus* represents a distinct taxon that cannot be referred to any of the currently recognized rhabdodontid genera. Our observations highlight the need for a complex reevaluation of the postcranial anatomy of the rich assemblages of rhabdodontid specimens from France and a reassessment of their taxic diversity.

Funding Sources This project is supported by the National Science Centre, Poland, grant no. 2020/37/B/NZ8/01321.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024, 1:45 PM)

How to tell a tail: a review of the taxonomic utility of *Diplodocus* caudal vertebrae

D'Angelo, John E.

Gantz Family Collections Center, Field Museum of Natural History, Chicago, Illinois, United States

Diplodocus is one of the most abundantly represented sauropods in the fossil record, and two of its species, *D. carnegii* and *D. hallorum*, are known from relatively complete skeletons. However, the taxonomic status of its type species *D. longus* is disputed and most *Diplodocus* specimens have not been reliably identified to species. As many of the characters proposed to be diagnostic of *Diplodocus* or its species pertain to the caudal vertebrae, and the holotype of *D. longus* consists of an incomplete tail, a detailed survey of variation in the tail of *Diplodocus*, and comparison with its sister taxon *Barosaurus*, is warranted.

D. hallorum is characterized by four caudal autapomorphies that can be recognized in isolated mid-caudal vertebrae: the neural spines remain nearly vertical throughout the caudal series, the anterior vertebral notch is reduced to approximately 10% or less of the centrum length, the prezygapophyseal processes exceed 33% of the centrum length, and the centrum articular faces exhibit a strongly trapezoidal profile beginning at approximately caudal 15.

Other *Diplodocus* specimens, including the type specimens of *D. carnegii* and *D. longus*, are intermediate in morphology between *Barosaurus* and *D. hallorum*. Taxonomic delineation within the *carnegii*–*longus* complex is made more difficult due to the lack of specimens with relatively complete, articulated caudal series. However, within this complex, there appears to be potentially taxonomically informative variation in several characters, such as neural spine shape, centrum elongation, and the position of the transition point between anterior caudals with ribs and lateral pneumatic foramina and middle caudals without.

These observations reinforce the distinctiveness of diplodocine caudal anatomy, particularly that of *D. hallorum*, but the adaptive significance of these apomorphies, and to what extent

specialization of the tail played a role in driving the evolution of *Diplodocus*, remains unclear. The species diversity of *Diplodocus* is likely higher than has previously been recognized, though further research is needed to determine whether any *Diplodocus* species were sympatric. *D. hallorum* and the *carnegii*–*longus* complex occur over wide, overlapping areas, suggesting that the species were not geographically segregated. However, the species may have been separated in time, and the hypothesis that all known *Diplodocus* species represent a single anagenetic lineage cannot currently be rejected.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Bone and tooth histology of the large-bodied pantodont *Coryphodon* from the Western Interior of North America

D'Emic, Michael D.¹, Unruh-Friesen, Evan G.¹, Smiley, Tara M.², Hoffmann, Simone³

¹Biology, Adelphi University, Garden City, New York, United States, ²Ecology and Evolution, Stony Brook University, Stony Brook, New York, United States, ³Anatomy, New York Institute of Technology, Old Westbury, New York, United States

The fossil record holds great potential to understand how mammals have responded to rapid climate change events in the past in order to better forecast changes in the future. One particularly rich and understudied fossil record is that of the large-bodied semiaquatic pantodont *Coryphodon*, which had a Holarctic distribution through much of the Paleogene. *Coryphodon* is known from thousands of specimens including several mass-death assemblages thought to represent social groups, allowing for a detailed understanding of ontogenetic change and sexual dimorphism. Over the

course of a several million years, *Coryphodon* ranged through multiple hyperthermal events in western North America (ca. 57–52 Ma), providing a dense sample for investigating how climate may have spurred ecological and evolutionary change. Unlike many mammalian lineages, dwarfing is not documented in *Coryphodon* through any of the three hyperthermal events. Instead, it dwarfed during an intervening cooler period before speciating into larger and smaller forms.

To understand the developmental changes underpinning the complex evolutionary history of *Coryphodon*, we thin sectioned over 30 teeth and bones from several basins across the Western Interior through the Paleogene. We employed skeletochronology and cementochochronology to age *Coryphodon* individuals and characterize tissues and their associated growth rates. Long bone histology demonstrates predominantly reticular neurovascular canal organization with a transition to longitudinal vascularization towards the cortex. Bone tissue is predominantly fibrolamellar in long bones, with a more laminar component near the cortex. Abundant annual cortical growth marks punctuate the outer third of long bone cortices, culminating in external fundamental systems, whereas their inner portions are remodeled or resorbed. Thoracic ribs and fibulae preserve a poor growth record owing to expansive medullary cavities full of trabecular bone. Dentine histology indicates daily apposition rates that are higher than expected for a similarly sized mammal, suggesting rapid odontogenesis. Cementochronology demonstrates that *Coryphodon* lived for multiple decades with prolonged and slow development. The rich dataset documented herein demonstrates that ongoing sampling in phylogenetic and spatiotemporal contexts will allow for characterization of the developmental mechanisms that *Coryphodon* evolved in response to dramatic climate change.

Funding Sources Funding for this work was received from the Keck Geology Consortium, Toomey Foundation for Natural Sciences, and Eppley Foundation for Research.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Pit wear and tear: unearthing taphonomic trends at Rancho La Brea Tar Pits

Dallmer, Josiah R.¹, Lopez de Cardenas, Paola¹, Cohen, Joshua E.², Binder, Wendy¹

¹Biology, Loyola Marymount University, Camarillo, California, United States, ²California State University Northridge, Northridge, California, United States

The Rancho La Brea Tar Pits' diverse fossil deposits include the largest collection of fossils from the Late Pleistocene Epoch. Analyses of taphonomy, which is defined as the processes of bone fossilization from death to excavation, provide us with crucial information about the history of environmental conditions over time. We measured three taphonomic variables, which include weathering, abrasion, and pit wear on isolated elements from both large and small mammals from seven separate asphaltic deposits: Project 23 Box 1, pits 3, 9, 13, 61/67, 77, and 91. These asphaltic deposits each represent different time periods between 40–12kya. This is the first study collecting taphonomy from Project 23, and also the first study that scaled pit wear at Rancho La Brea, which allows for the comparison of degree of pit wear, much like weathering and abrasion. We analyzed weathering, abrasion, and pit wear data from 14 mammalian species in order to identify trends across the seven deposits. We expect taphonomy to reflect climate conditions, including the presence of water either before or during burial. Pit wear and abrasion were scored on a five point standardized scale

system, with increasing scores indicating higher increments of total element coverage. Weathering was also scored on a five point standardized scale system, with different scores representing different stages of the weathering process. We hypothesized that pit wear and abrasion would co-occur in higher rates in Project 23 Box 1, as previously found in Pit 13. However, results demonstrated that while Project 23 Box 1 had higher rates of pit wear, there was not the expected accompanying high rates of abrasion. Additionally, weathering and abrasion remains low, but does not reflect the expected distributions based on climate alone. There are high levels of pit wear in Pit 13 and Project 23 Box 1 relative to the other pits, which may be due to increased sedimentary and bone on bone interactions. In order to gain a broader understanding of this project, future work can include sedimentary data and spatial analyses to identify the specific factors leading to these taphonomy trends.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Osteohistology, probable chimerism, and taxonomic revision of *Saurophaganax maximus*

Danison, Andy¹, N. Woodward, Holly¹, Barta, Daniel E.⁴, Wedel, Mathew³, Lee, Andrew H.², Flora, Holley¹, Snively, Eric⁴

¹Department of Anatomy and Cell Biology, Oklahoma State University, Tulsa, Oklahoma, United States, ²Department of Anatomy and Cell Biology, Oklahoma State University College of Osteopathic Medicine at the Cherokee Nation, Tahlequah, Oklahoma, United States, ³College of Osteopathic Medicine of the Pacific and College of Podiatric Medicine, Western University of Health Sciences, Pomona, California, United States, ⁴Department of Integrative Biology,

Midwestern University, Glendale, Arizona, United States

Saurophaganax maximus is the current designation of a massive Jurassic allosaurid theropod found in the Brushy Basin Member of the Upper Jurassic Morrison Formation in Cimarron County, Oklahoma. Since its initial description in 1995, the status of *S. maximus* has been uncertain because referred material is fragmentary and poorly preserved. Some phylogenies omit *Saurophaganax* because of this uncertain status and because morphological analyses find its long bones consistent with those of *Allosaurus* except for their size. In contrast, other phylogenies maintain *Saurophaganax* as a separate genus from *Allosaurus*. Here we present a new evaluation of the material referred to *Saurophaganax maximus* including a paleohistological analysis of its metatarsal, a description of the material, and a phylogenetic reassessment of *S. maximus* to resolve some uncertainty surrounding the taxon.

We histologically sampled a left metatarsal IV assigned to *Saurophaganax* to evaluate the hypothesis that the material could belong to an old skeletally mature *Allosaurus*. While much of the metatarsal is diagenetically modified, a structure likely representing an External Fundamental System (EFS) is present which suggests that the individual was attaining or had attained skeletal maturity. However, the prevalence of plexiform bone in the metatarsal indicates that it reached massive size while still growing relatively quickly, rather than through many years of protracted growth. Assuming the appositional rate of the metatarsal is representative of the whole animal, our results support the hypothesis that *Saurophaganax* is distinct from known specimens of *Allosaurus*.

A total of 227 elements have been referred to *S. maximus* from the bone beds preserved in the Kenton quarries, largely consisting of

postcranial material. The scarce cranial material and much of the postcrania are largely consistent with *Allosaurus* except for the axial material used to describe *Saurophaganax* in 1995, including the holotype neural arch, an atlas vertebra, and unique chevrons. Our reanalysis of this material suggests that each of these three elements is more consistent with sauropod material from the same quarry, suggesting that *Saurophaganax maximus* may be a sauropod rather than a theropod and possibly a junior synonym of a known taxon. However, the appendicular elements that clearly belonged to a large theropod warrant closer examination.

Funding Sources Robberson Summer Dissertation Fellowship, Distinguished Graduate Fellowship, Oklahoma State University Department of Biomedical Sciences

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Examining Late Cretaceous (Maastrichtian) North American dinosaur teeth and their palaeoecological implications in the Hell Creek Formation of Carter County, Montana

Davis, Hudson B., Wilson, Mark

Geology, College of Wooster, Fort Bragg, California, United States

The Hell Creek Formation is an iconic Late Cretaceous formation that is found throughout the states of Montana, Wyoming, and the Dakotas. Even though it has been studied for over 100 years, questions about the paleoecosystem it represents still need further research. I here examine dinosaur teeth from the Hell Creek of Carter County, Montana, a section that is understudied compared to other exposures of the formation. While many studies focus on the

dinosaur fauna of this ecosystem, most of these studies focus on skeletal material. Dinosaur teeth are abundant within microvertebrate sites in the Hell Creek, and these teeth can tell and confirm similar information to that of the skeletal remains, while also providing information that preservation bias might otherwise obscure. By conducting a tooth census comprised of 1,522 dinosaur teeth from ~10 microsites outside Ekalaka, Montana and comparing that to Hell Creek skeletal censuses (Horner et al. 2011; Stein 2019), I hypothesize that while certain fauna like *Triceratops* will have abundance levels within the tooth and skeletal censuses, other fauna, such as dromaeosaurs, will be more common within the tooth survey, as their hollow bones are subject to preservation bias, while others, such as *Tyrannosaurus rex* will be less common in the tooth survey.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

The Late Pleistocene avifauna of coastal Texas, USA

Davis, Sarah N.^{1,2}, Bader, Kenneth S.²

¹Vertebrate Paleontology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ²Jackson School of Geosciences Museum of Earth History, University of Texas at Austin, Austin, Texas, United States

The Texas Gulf Coast, United States of America, is known for historically significant localities of Middle–Late Pleistocene (Rancholabrean; 250,000 – 12,000 BP) mammal fossils. These localities have also produced bird and reptile fossils, but due to the lack of screen washing or systematic excavation collection was historically biased toward larger, more robust skeletal elements. Here we report the avifauna from four coastal localities collected between 1939 to 2015:

Aransas Pass in Aransas County, the Ingleside Pit in San Patricio County, Nada Mucho in Wharton County, and the Wright Materials North Quarry in Nueces County. The Aransas Pass locality produced a fragmentary anatinid humerus (cf. *Oxyura*) and an *Aythya* tarsometatarsus. The extinct asphalt stork (*Ciconia maltha*) and turkeys (*Meleagris gallopavo* and *Meleagris* sp.) are the most common bird fossils from the Ingleside Pit. Additional taxa represented include Odontophoridae, Anatidae (*Branta*, *Oxyura*, *Spatula* cf. *discors*, Podicipedidae (*Podilymbus*), Gruidae, Charadriiformes, Phalacrocoracidae (*Phalacrocorax*), and Passeriformes (*Corvus* and *Quiscalus*). A complete tarsometatarsus of a gruid, intermediate in size between *Grus canadensis* and *Grus americanus*, was the only avian material recovered from the Nada Mucho locality. The Wright Materials North Quarry also produced multiple *Meleagris* bones, as well as a gruid ulna and the tarsometatarsus of *Haliaeetus*. Apart from *C. maltha*, the Pleistocene avifauna of the Texas Gulf Coast is composed of species commonly found in the freshwater wetlands and terrestrial environments of modern coastal Texas and is similar in composition to other contemporaneous gulf coast localities. The absence of common species in these environments likely reflects the small sample size and collecting bias, but may also be a result of preservational factors or shifts in habitat use over time. Despite the fragmentary state of these fossils, these avian records provide insight into the formation of the modern gulf coast avifauna and help better understand the ecology of these communities.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A paleontological resource inventory of Permian, Triassic, and Jurassic rocks at

Canyonlands National Park: An update of significant vertebrate fossil discoveries

DeBlieux, Donald D.¹, Kirkland, James I.¹, Warner-Cowgill, Ethan¹, Thomson, Tracy J.², Milner, Andrew³, Santucci, Vincent⁴

¹Utah Geological Survey, Salt Lake City, Utah, United States, ²Earth and Planetary Sciences, University of California, Davis, Davis, California, United States, ³St. George Dinosaur Discovery Site, St. George, Utah, United States, ⁴Geological Resources Division, National Park Service, Washington, District of Columbia, United States

The Utah Geological Survey (UGS) has been partnering with the National Park Service (NPS) for over twenty years to inventory and monitor paleontological resources in the national parks of Utah that contain significant vertebrate fossils. This systematic program of paleontological resource inventory and monitoring has allowed the NPS to be at the forefront of paleontological resource management on public lands. These inventories have focused on Mesozoic rocks because of the large area of outcrop exposed in the parks and high potential for scientifically significant vertebrate fossils. Although many parks have received baseline surveys and more targeted follow-up surveys, the fossil resources of Canyonlands National Park were virtually unknown until the UGS began a survey in 2020. We have previously reported on some of our work in the Middle Triassic Moenkopi and Late Triassic Chinle Formations in the Island in the Sky District (ISKY). Subsequent work has included the Permian Cedar Mesa Formation in the Needles District (NEED), and Early Jurassic Kayenta Formation and Navajo Sandstone in the Horseshoe Canyon Unit of the Maze District (MAZE) along with additional work in the Triassic formations of ISKY. Tracksites in the Cedar Mesa Formation of NEED include ichnotaxa assigned to *Ichnoterium* or *Tambachichnium*. Dinosaur tracksites were documented from the Kayenta Formation and

Navajo Sandstone of MAZE and tracks include those of *Eubrontes*, *Grallator*, *Kayentapus*, and *Otozoum*. In the northern region of ISKY we have discovered over 50 vertebrate tracksites in the Torrey Member of the Moenkopi Formation, making this the largest concentration of tracksites known for this formation. Numerous localities were found that contain small terrestrial tracks confidently assigned to *Procolophonichnium*, and tentatively to *Rotodactylus*, and *Synaptichnium*. A reevaluation of localities that preserve small traces with triangular “digits” and a wide gait thought to be attributable to *Chelonipus* (turtles) are shown to be *Kouphichnium* and were made by xiphosurans (horseshoe crabs). Dozens of sites preserve chirotheriid-type swim tracks, some of which are quite spectacular and include hundreds of traces. The sheer number of swim traces and their morphology suggests that the trace makers were not floating on the surface of the water (requiring a consistent depth), but rather, were submerged and punting along the bottom in a manner similar to many modern semi-aquatic vertebrates.

Funding Sources Canyonlands National Park, National Park Service Geologic Resources Division, Utah Geological Survey

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

It's habit forming: examining the origins of prolonged and habitual use of powered flight in non-avian theropods

Dececchi, Thomas A.¹, Larsson, Hans C.², Habib, Michael B.³, Hartman, Scott⁴, Pittman, Michael⁵

¹Biology, Dakota State, Vermillion, South Dakota, United States, ²McGill University, Montreal, Quebec, Canada, ³UCLA, Los Angeles, California, United States, ⁴UW-Madison, Madison, Wisconsin, United

States, ⁵The Chinese University of Hong Kong, Shatin, Hong Kong

The origins of bird flight have long been a topic of intense investigation, often in association with the origin of birds themselves. One risk of such focus is coupling evolutionary hypotheses of the origins of the avialan clade with the origins of flight behavior, overlooking possible diversity in wing-based locomotion within Pennaraptora. Thus, the origins of wings, flapping, wing-assisted locomotion, flight capacity and habitual flight use should be separate points of investigation. Herein we attempt to address when and how powered flight became a major factor in the life history of feathered theropods. Using non-avian and avialan theropod body proportions derived from previous modeling and imaging, we examine the effect of altering factors such as air density, physiology, flap angle, flight muscle power on both flight potential and ability to sustain powered flight. Using estimations of available power output to determine flight efficiency and cost of transport, we find it is highly unlikely that non-paravians, larger (>5 kg) paravians or *Anchiornis* – and probably other anchiornithines – were volant at all. Within *Microraptor* and *Archaeopteryx*, we observe a reduction in both flight potential and flight efficiency with increasing body size. Even small changes in mass estimates greatly increase the cost of transport while significantly reducing efficiency scores down to levels where flight is less efficient than terrestrial locomotion. These changes across size classes within *Microraptor* and *Archaeopteryx* could signal an ontogenetic variation of degrees of aerial locomotion. Combined, these findings suggest that by the Early Cretaceous a multitude of flying avialan lineages were exploiting a variety of body sizes and niches with *Microraptor* perhaps occupying the small, volant predator niche. In *Microraptor*, we predict the use of flight for individuals less than 1 kg was relatively

habitual. In larger individuals, as the energetics shift so that flight is costlier in shorter journeys, we predict that flight would be reserved for more impactful situations, such as hunting and escape. These findings help refine our understanding of how, when and in what capacity early paravians took to the skies, how ecological roles could shift with ontogeny. This raises intriguing questions about their ecological dynamics with the already established and cosmopolitan flying pterosaurs across the later Jurassic and into the Early Cretaceous.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Addition of morphospaces on the polar section modulus plot to determine the niche of *Antarcticavis capelambensis*

Deckhut, Joseph T., Case, Judd A.

Biology, Eastern Washington University,
Glassboro, New Jersey, United States

When it comes to shallow marine fossil deposits of Late Cretaceous age, the avian fossils present are few and specific. The fragmentary avian fossils that are excavated almost exclusively show a foot-propelled diving lifestyle. Other lifestyles, such as flying, running, soaring, or flapping birds, are not represented. Late Cretaceous avian fossils that show a foot-propelled diving lifestyle include *Vegavis iai* from Antarctica, *Polarornis gregorii* from Antarctica, *Neogaeornis wetzeli* from Chile, and a grebe-like tarsometatarsus from New Jersey. It is odd that avians are only showing this specialized lifestyle when the members of Enantiornithes were also present during the Late Cretaceous and they occupied many different niches, as the neornithine birds of today do. While enantiornithines were abundant and diverse, they did not survive the K-Pg mass extinction event. Adding to this phenomenon are the Late Cretaceous

Hesperornithiformes, which are a group of foot-propelled divers that, for the most part, have no wing elements. The hesperornithiforms also failed to survive the K-Pg extinction. For an unknown reason, the neornithines present at the time, did survive. Living an aquatic lifestyle is not the deciding factor on neornithines survival due to the hesperornithiformes extinction, perhaps other lifestyles were present that would give an edge to survival? When looking for avian fossils in a shallow marine deposit, one would expect to find a mix of shore birds, sea birds, and foot-propelled divers rather than only one of those groups. *Antarcticavis capelambensis*, discovered in Antarctica, could be a 'missing link' fossil in regards to lifestyles present, and finding the lifestyle will give greater insight as to what niches were present within Neornithes during the Maastrichtian. To find the lifestyle, this study is examining and comparing the *Antarcticavis* bones with the bones of birds that represent different lifestyles, such as the *Mergus merganser* as well as ground birds, wading birds, and shore birds. So far, morphospaces representing generalist ground birds and generalist foot-propelled divers (i.e. ducks) have been added to that of a previous study. Currently, as more species are added with additional lifestyles, more morphospace polygons will be generated. These additional morphospace polygons will assist in the assessment of the niche of *Antarcticavis*, as well as progressing our understanding of avian evolution and survival.

Romer Prize Session (Thursday, October 31,
2024, 8:00 AM)

Wing movement and joint mobility within Ornithurae: Insights into the evolution of avian flight

Demuth, Oliver E.

Department of Earth Sciences, University of
Cambridge, Cambridge, United Kingdom

The evolutionary origin of avian flight has intrigued scientists for well over a century, yet it remains poorly understood and the precise timing and mechanisms behind the emergence of active, flapping flight remain elusive. Birds can morph their wings with exceptional precision for a variety of tasks. When airborne, birds can employ a range of different flight styles to move through the air, modifying their wing shape and area to generate lift and to adjust air flow for maneuverability, while also maintaining the capacity to fold and store the wings when perched. However, the complex interplay of the wing bones during flight, simultaneously involving multiple rotational and translational degrees of freedom (DOF) at each joint, remains obscure. To be able to draw justified inferences of potential wing movement and flight capabilities in extinct species and thereby clarify our understanding of avian flight origins, the relative movement of the wing bones in extant species during different behaviours first needs to be better understood. Here, I generated a phylogenetically broad *ex vivo* X-ray Reconstruction of Moving Morphology (XROMM) dataset of extant birds, with specimens representing most major clades, spanning a wide range of ecological niches and flight styles, to quantify their wing joint mobility. For each species, the cadaveric three-dimensional ranges of motion (ROM) across the wing joints were quantified for each rotational DOF (i.e., long-axis rotation, abduction/adduction, and flexion/extension). The shapes of the resulting mobility boundaries were then quantitatively analysed, yielding the first ecologically and phylogenetically informed framework for quantitative comparisons of joint mobility data, which I dub the ‘*EcoPhyloMobilitySpace*’. This enabled links between wing joint mobility, flight behaviour, and ecology to be drawn among extant birds. This dataset was then supplemented with the simulated ROM envelopes of the stem bird *Ichthyornis dispar*, providing crucial insight

into the evolution of flight in birds due to its phylogenetic position just outside the avian crown group. This allowed me to infer its locomotory behaviour and retrace the evolution of bird flight ecology and locomotor specialisations through time. The results highlight that a flight style comparable to that seen in modern seabirds had already evolved in the Cretaceous period before other bird characteristics, such as a toothless beak, originated.

Funding Sources European Association of Vertebrate Palaeontologists (EAVP) Research Grant

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

The complete royal flush: A fully-sampled phylogeny of Ceratopsia

DeNarie, Shawn

Biological Sciences, The George Washington University, Washington, District of Columbia, United States

The evolutionary history of ceratopsians has been a subject of keen interest among paleontologists for nearly as long as the group has been known, with investigation of their phylogenetic relationships well predating modern cladistic methods, and continuing to the present day as more species have been named. In recent years, inquiries into the phylogenetic relationships among ceratopsians have largely been conducted as accompaniments to new or revised species descriptions, and only rarely as dedicated enterprises unto themselves. Most have been conducted with updated permutations of preexisting matrices, with limited revisions presented alongside each iteration but with little or no comprehensive reevaluation, redescription, and reassessment of previously used characters. Most have also been limited in scope, with

most focusing largely on a single focal lineage or subclade. This study conducted a new set of phylogenetic analyses, based on a newly constructed data matrix featuring over 700 morphological characters, and including every taxonomically valid and accepted species of ceratopsian named as of 2023. Both parsimony-based and model-based methods were employed. All analyses consistently recovered monophyletic Chaoyangosauridae, Psittacosauridae, Neoceratopsia, Protoceratopsidae, and Ceratopsidae clades whose member taxa largely conform to previous findings, and all recovered certain previously recovered putative ceratopsians all falling well outside the group. However, a novel result was found in the consistent recovery of a deep split between Leptoceratopsidae and Coronosauria extending nearly to the base of Neoceratopsia, with a far more inclusive Leptoceratopsidae than previously recognized. Resolution within Centrosaurinae and Chasmosaurinae was found to vary between analyses following different assumptions about how character states evolve throughout the evolution of Ceratopsia, though some consistent patterns of relationship were found after pruning labile taxa, and some tree arrangements were found to have much higher node support than others. These results altogether suggest that inference of evolutionary relationships among particularly later ceratopsids is sensitive to differing assumptions about how morphological characters evolve, possibly reflective of the homoplastic distributions of certain skull characters, and that care should be taken in interpreting deeply-nested relationships within Ceratopsia from any one analytical paradigm.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024,
1:45 PM)

Inferring the dietary ecology of extinct shrews using a multifaceted approach

den Ouden, Derek J., Samuels, Joshua X.

Geosciences, East Tennessee State
University, Johnson City, Tennessee, United
States

Numerous analytical approaches have been utilized to infer feeding biology in fossil organisms, with multiple methods often combined to develop a more holistic view. Despite broad application, some groups have not yet been thoroughly explored, including the shrews (Soricidae; Mammalia). Often considered strict insectivores, direct observation reveals substantial dietary diversity among shrews. Many species appear to have preferences for prey of specific hardness, while others have been documented including notable amounts of plant or vertebrate material into their diets. Dietary diversity has influenced craniodental morphology in other mammal clades, so similar patterns are hypothesized to be detectable in shrews. Here, we examine the link between known dietary and morphological diversity in extant shrews and use that framework to infer the dietary ecology of fossil taxa. A linear morphometric approach utilized a series of linear measurements which characterize shrew craniodental morphology and examined how that reflects dietary specializations. Extant taxa included over 20 species and represent a phylogenetically diverse sample with documented dietary information. Taxa were classified using two distinct schemes: 1) based on the hardness of the most abundant documented prey items (hard, intermediate, and soft bodied feeders), and 2): functional morphology of their dentition (slicing, crushing, and mixed processing). In addition to the extant sample, three fossil taxa from the early Pliocene Gray Fossil Site (GFS) of east Tennessee were also characterized: "*Blarinella*", *Crusafontina*, and *Tregosorex*. The results of a principal component analysis

reveal substantial morphological variation among extant shrews and suggest dietary and functional differences are evident within clades. Within this context, soft feeders have generally more elongate shearing surfaces and reduced grinding areas compared to hard or mixed feeders. A discriminant function analysis found the studied metrics can differentiate extant shrews with different diets (63.2 % correct classification) and classified the GFS shrews as soft and intermediate feeders. Findings from this method support the utility of linear morphometrics for dietary inference in fossil shrews. To compliment the linear morphometric approach, ongoing finite element analysis of mandibles will inform the food processing capabilities of extant and fossil shrews, providing a more complete understanding of their paleoecology.

Funding Sources Funding was provided by the East Tennessee State University Center of Excellence in Paleontology.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

**Comparing dental microwear textures:
prioritizing functional similarity over
phylogenetic relatedness**

DeSantis, Larisa^{1,2}

¹Department of Biological Sciences,
Vanderbilt University, Nashville, Tennessee,
United States, ²Earth & Environmental
Sciences, Vanderbilt University, Nashville,
Tennessee, United States

Dental microwear texture analysis (DMTA) is widely used to investigate the dietary ecology of both modern and fossil taxa, including mammals with herbivorous to carnivorous diets. In carnivorans, teeth with distinct functions capture dietary behaviors differently. For example, sheering and crushing facets are not equivalent or

comparable. However, if dental forms are similar, comparisons across different tooth positions or between phylogenetically distinct taxa might be valid, although this has not been extensively tested. This study examines DMTA variability across diverse mammalian taxa to test two hypotheses: (1) dental microwear is recorded similarly in functionally similar teeth, regardless of phylogenetic relationships; and, (2) phylogenetic relationships are not necessarily predictive of dental microwear texture attributes preserved on tooth wear surfaces. To test these hypotheses, DMTA was analyzed in taxa with either functionally similar or different facets/teeth. Results reveal that while different tooth forms can produce distinct DMTA attribute values, similar forms can also yield comparable DMTA attribute values across a wide range of taxa. For instance, bilophodont teeth in possums, kangaroos, and phylogenetically distinct tapirs have analogous DMTA patterns. This finding suggests that when teeth are functionally similar, phylogenetic corrections to DMTA data are unnecessary. Consequently, one can reasonably compare the bilophodont teeth of diprotodons with those of tapirs and the shearing teeth of thylacines with the shearing carnassial blades in canids. Most notably and contrary to phylogenetic expectations, DMTA results reveal that the American lion exhibited dietary behavior more akin to modern leopards, tigers, and jaguars than to African lions. Instead, *Panthera atrox* has significantly lower complexity values than African lions, jaguars, mountain lions, and all hyenas examined, suggesting that the American lion does not engage in significant carcass sharing, bone processing, or scavenging. High anisotropy values in *Panthera atrox* also indicate the consumption of tough foods, with values significantly higher than those in cheetahs, African lions, and hyenas. Similar forms can be compared between phylogenetically disparate taxa, while care should be taken to avoid comparisons of

facets/teeth with different functions, even if homologous.

Funding Sources Vanderbilt University and the National Science Foundation (1757545).

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Inspiring young minds through STEM: The “Who Me?” Project

DeSantis, Larisa^{1,2}, Weintraub, David³

¹Department of Biological Sciences, Vanderbilt University, Nashville, Tennessee, United States, ²Department of Earth & Environmental Sciences, Vanderbilt University, Nashville, Tennessee, United States, ³Communication of Science, Engineering, and Technology Program, Vanderbilt University, Nashville, Tennessee, United States

The “Who Me?” book series features inspirational biographies of scientists, aiming to show young readers that scientists are ordinary people with a passion for discovery. Written by the scientists and edited by experts in science communication at Vanderbilt University, these books help young readers understand the importance of hard work and perseverance in achieving scientific careers while also communicating science content. Each book introduces fundamental scientific concepts in an engaging and accessible way, showcasing the exciting research scientists are conducting today. This project addresses the lack of diverse role models in STEM fields. By presenting autobiographical accounts of scientists from various backgrounds, the series seeks to break down stereotypes and encourage children to envision themselves in STEM careers. The inclusion of personal stories makes the achievements of these scientists more relatable and inspiring to young readers. The series features an astronomer,

bioarcheologist, cancer biologist, radiation oncologist, quantum dot chemist, mathematician, immunologist, biomedical informatics expert, and a vertebrate paleontologist. Scientists of diverse ethnic backgrounds, females, and individuals with disabilities are included. Given that writing a children’s book for children can be challenging for scientists with little formal training in science communication, undergraduate science communication students, as part of their work in classes about communicating science to children, interviewed each of the featured researchers about their research, childhood, and more. These students then outlined and wrote first drafts, which were provided to the primary authors/scientists as the starting points for writing their stories. The “Who Me? I’m a Vertebrate Paleontologist Now” book, authored by Larisa DeSantis, chronicles her journey from aspiring politician to vertebrate paleontologist, detailing her research on fossil teeth to understand the ancient ecology of saber-toothed cats and other Ice Age mammals. Additionally, she shares her experiences managing childhood epilepsy, highlighting resilience and determination. Sabertoothed cats, diprotodons, and dental microwear methods are all featured, while also discussing stratigraphy, fossilization, and the trophic pyramid. Collectively, these books can change the way children see and view scientists—as themselves.

Funding Sources Vanderbilt University College of Arts and Science and Vanderbilt Medical Center

Technical Session 18: Carnivora & Co (Saturday, November 2, 2024, 8:00 AM)

Myological and osteological approaches to gape and bite force reconstruction in *Smilodon fatalis*

Deutsch, Ashley R, Berger, Arin, Martens, Lara L, Smith, Rachel LJ, Hartstone-Rose, Adam

Department of Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

Gape and bite force are important variables for understanding diet, social behaviors, and ecological context, yet these variables are difficult to assess for extinct taxa given that they relate not only to the osteological components preserved in fossils, but also the architecture of the soft-tissues, especially the mandibular adductor muscles that are lost in fossilization. While much has been written about the highly derived masticatory anatomy of *Smilodon fatalis*, there remains a great deal of debate about their masticatory capabilities. In particular, previous literature largely speculates that *Smilodon* was capable of producing a particularly large angular gape in order to clear its very long canines; however, the extent of this gape is unclear, and, as gape and bite force production are generally inversely correlated, there is debate about the bite force capabilities of this large predator. To that end, we establish osteological proxies for masticatory adductor fascicle length (FL; a correlate of masticatory gape) based on extant felids and apply these along with previously validated techniques to *S. fatalis* fossils from the La Brea Tar Pits to provide estimates of fascicle lengths (FL), maximum osteological gapes, and bite force. The best correlated FL proxies in extant felids predict FLs only slightly larger than comparably sized modern felids in *S. fatalis*; however, a proxy that accounts for the reduced coronoid process of the mandible predicts a temporalis FL 15% longer than that of *Panthera tigris*. This discrepancy may be due to the highly derived skull morphology of *S. fatalis* relative to extant felids. While *S. fatalis* skulls are capable of larger angular maximum bony gape than extant felids, linear gape at the canine tip and carnassial notch were not significantly different from those of extant felids, suggesting similar ingestion capabilities. Average anatomically derived

bite force estimates for *S. fatalis* were 1283.74N at the canine and 4671.41N at the carnassial, which are similar in magnitude to estimates for the much smaller *P. onca*, with *S. fatalis* producing slightly less force at the canines and more at the carnassials. These estimates support previous predictions that if *S. fatalis* killed large prey with canine shearing bites, it likely would have produced the necessary force, in part, by contributions from the postcranial muscles.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Let it snow: A deep dive into Minnesota's Pleistocene–Holocene Transition faunal assemblage

DeVault, Grace¹, Hastings, Alex K.¹, Iverson, Charlie², Brandel, Marcus G.¹

¹Paleontology, Science Museum of Minnesota, St Paul, Minnesota, United States, ²Science Museum of Minnesota, St. Paul, Minnesota, United States

While Minnesota's Pleistocene–Holocene Transition (PHT) faunal record is not wholly unknown, new fieldwork at the Science Museum of Minnesota (SMM), new digitization efforts at SMM and the Bell Museum (University of Minnesota), and collaborations with over 35 small museums in and around the state have warranted new discussion of this material. These digitization efforts will also result in increased accessibility and knowledge of these materials online by both researchers and the general public across the world.

The Minnesota PHT faunal assemblage contains material roughly 10,000–30,000 years old; and includes fish such as Amiidae, Catostomidae, and Esocidae; amphibians such as Ranidae; reptiles including Trionychidae, Chelydridae, Emydidae, and unidentified Serpentes; birds such as

Phasianidae, Phalacrocoracidae, Anatidae, Ardeidae, and Strigidae; and many mammals, including Megalonychidae, Elephantidae, Mammutidae, Equidae, Cervidae, Bovidae, Suidae, Erethizontidae, Sciuridae, Cricetidae, Castoridae, Geomyidae, Leporidae, Felidae, Canidae, Mustelidae, Mephitidae, Procyonidae, and Ursidae. Some Pleistocene invertebrate and floral material is also known. While the distribution of these fossils covers all but the northeast corner of the state, the volume of material found in the southern half of the state far outweighs that from the northern half. This may be in part caused by the northward recession of the glaciers out of Minnesota, but it also likely indicates undersampling in the northern part of the state. Radiocarbon dates for the Pleistocene material in Minnesota are few, but include a 26,900-year-old *Homotherium* skull near Chatfield, a 22,000-year-old *Mammuthus* tusk in New Ulm, and a recalibrated date of 11,320-years-old for a *Castoroides ohioensis* skeleton in St. Paul.

As part of new digitization efforts tied to Minnesota PHT material, specimens held at SMM and the Bell Museum are being entered into SMM's database and photographed, and these data will then be made available through iDigBio and ultimately through SMM's website. In supplement to these data pathways, select specimens are also shared through SMM's paleontology department Instagram page (@SMMPaleo). Additionally, an SMM volunteer has been compiling data and images of Minnesota PHT materials held at other museums and universities around the state and the Midwest to supplement the occurrences known through the materials held by SMM and the Bell Museum.

Funding Sources Funding for this work was received from the Minnesota Clean Water, Land and Legacy Amendment.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Tiny dinosaur from the Kayenta Formation (Early Jurassic: Pliensbachian) of northern Arizona implicates dwarfing and insectivory at the base of the heterodontosaurid radiation

DeVries, Raina P., Sereno, Paul C.

Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States

The partial skeleton of a tiny dinosaur, collected on a slab of claystone from the Gold Springs locality of the Kayenta Formation (Pliensbachian, ca. 185 Mya), pertains to a new subadult heterodontosaurid. Portions of the skull, axial column, and limbs are preserved, with some bones retaining their natural articulation. The immaturity of the specimen is shown by the separation of several neural arches and centra, and histological cross-sections of a long bone from the hind limb show two distinctive lines of arrested growth. The individual was likely in its third year of growth with estimated skull and skeletal lengths of 4 cm and 30 cm, respectively, or about two-thirds the size of the diminutive Asian *Tianyulong*, one-half that of North American *Fruitidens*, and one-third that of southern African *Heterodontosaurus*.

Heterodontosaurid affinity is established by the presence of an arched premaxilla-maxilla diastema accommodating a large, serrate dentary caniniform tooth, a series of premaxillary caniniform teeth of increasing size, a median depression between the nasals, and other features. Like *Tianyulong*, it has a relatively large skull and short forelimbs, although the tail is not especially long or stiffened by ossified tendons. Its basal position among heterodontosaurids is shown by the presence of four (rather than three) premaxillary teeth, a predentary with distinctive lateral and ventral processes, and

a dentary of slender proportions. The premaxillary caniniform teeth slot into grooves on the external surface of the prementary, and the cheek teeth increase markedly in size and lack wear facets or any well-formed denticles or surface ornamentation.

The dentary, with a length of only 2.3 cm, is comparable to that of the contemporary Jurassic triconodont mammal *Dinnetherium*, which has a similar heterodont dentition with an anterior dentary canine and distally increasing crown size. The Kayenta heterodontosaurid, potentially the basal-most member of the radiation, appears to have downsized to a degree not seen before among early dinosaurs. It is a tiny obligate biped with a dentition suited for insectivory, unlike later herbivorous heterodontosaurids that have denticulate, more uniform-sized crowns with wear facets, a wedge-shaped prementary, and stoutly proportioned dentary.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Reassessment of tetradactyl theropod ichnotaxa and a new large ichnospecies from the Early Cretaceous Gething Formation of northeastern British Columbia

Dickson, Logan T.^{1,2}

¹School of Earth and Ocean Sciences, University of Victoria, Shawnigan Lake, British Columbia, Canada, ²Royal BC Museum, Victoria, British Columbia, Canada

While the majority of theropod footprints display a tridactyl morphology, rare tetradactyl theropod tracks are known from Asia, North America, and Europe, represented by the ichnogenera *Saurexallopus*, *Ordexallopus*, and (contentiously) *Xiangxipus*. New large tetradactyl tracks discovered in the Lower

Cretaceous (Aptian-Albian) Gething Formation in the Peace Region of British Columbia, Canada, prompted a reassessment of currently identified tetradactyl theropod ichnotaxa. The presence of a functional digit I impression in *Xiangxipus* is contested, as the holotype trackway includes both tridactyl and tetradactyl tracks. *Saurexallopus* is defined by four slender digits with digit I either medially or postero-medially oriented; three species are currently recognized. *Ordexallopus* is diagnosed by its larger and more robust size compared to *Saurexallopus*. The new Gething Formation tracks are large (48.9 cm long and 50.3 cm wide) with four slender, long digits with laterally compressed claw marks. All four digits radiate from a rounded distal metatarsal impression with a total divarication angle of 108 degrees. Digit I is straight and medially oriented, thus it is a functional digit and not a reversed hallux. The Gething Formation tracks represent a new species of *Saurexallopus* that is significantly larger than all previously described occurrences. This new ichnospecies bridges the size gap previously used to differentiate *Ordexallopus* from *Saurexallopus*; we amend the diagnoses of both ichnogenera in light of the new morphology represented by the Peace Region tracks. The Peace Region *Saurexallopus* also provide evidence for the presence of a previously unknown large (approximately 2.35 m at the hip) theropod in Early Cretaceous Laramidia, further informing our understanding of the biodiversity in western Canada during the time.

Funding Sources Dinosaur Research Institute, Natural Sciences and Engineering Research Council of Canada

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Filling in the gaps: determining ranges of fossil birds with machine learning

Dickson, Meig C.

Biology, New Mexico State University, Las Cruces, New Mexico, United States

The geographic range of a particular species is a fundamental component of their macroecology, and one that has received increased focus in paleontological research. The heightened mobility of most avian taxa makes their range one of the first traits to change in response to ecological shifts, such as climate change. The Paleocene-Eocene Thermal Maximum, the most recent rapid warming event in the geologic record and the one most comparable to modern global warming, remains understudied in birds, primarily due to their poor fossil record. Methods of extrapolating range from poorly known fossil taxa, such as early Paleogene birds, are receiving increased interest due to the necessity of understanding this macroecological component in even obscure fossil organisms. One such method, the MInOSSE machine learning model, uses the fossil record of better known cooccurring ecologically connected species to reconstruct the ranges of poorly sampled taxa. While this model has been well tested on Quaternary and Neogene age organisms, its ability to reconstruct older ranges requires more investigation. Here I present the results of using MInOSSE with Paleocene and earliest Eocene avian taxa, using pollen, invertebrates, and mammals as cooccurring taxa where appropriate. I compare these reconstructed ranges with ranges determined from center-of-abundance or alpha-hull reconstruction methods, which do not attempt to fill in fossil record gaps. The utility of MInOSSE to determine the ranges of organisms throughout deep time is largely connected to the detail of the cooccurring organism's fossil record. Future usage of this model will require increased holistic study of prehistoric ecosystems and collaboration between different fields of paleontology to best understand cooccurring candidates for target organisms. Such efforts will allow

researchers across the discipline to extrapolate more information from those organisms with poorer fossil records.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

An enigmatic sauropod specimen from the Morrison Formation of northern Wyoming provides insight into the evolution of diplodocoids

Diepenbrock, Julian E.¹, Schmude, David², Weege, Chris², Tamez-Galvan, Evan², Petermann, Holger², Toth, Natalie G.², Lyson, Tyler², Clementz, Mark T.¹

¹Geology and Geophysics, University of Wyoming, Laramie, Wyoming, United States, ²Department of Earth Sciences, Denver Museum of Nature and Science, Denver, Colorado, United States

Diplodocid sauropods are taxonomically diverse and well represented in the fossil record in North America. Despite this, the origins of the North American clades are still not particularly well resolved. Here, we report on a moderately complete diplodocid skeleton (the Moffett Saddle Sauropod, DMNH EPV 95000) from the Late Jurassic Morrison Formation east of the Bighorn Mountains in Wyoming. The specimen consists of much of the appendicular skeleton, an assortment of ribs and chevrons of indeterminate position as well as two cervical vertebrae, seven dorsals, and twenty-three caudal vertebrae. The absence of duplicated material, consistency in size and lack of other dinosaur taxa from the Moffett Saddle indicate that the material pertains to a single individual. The specimen is notable for a perplexing combination of anatomical traits that have been used to characterize distinct taxa, which suggests it either belongs to a new taxon, or warrants the re-evaluation of the systematic informativeness and distribution of several morphological

characters present in other Morrison sauropods. The well preserved mid-cervical vertebra (likely C8) is elongate, with low neural spines and morphologically similar to those elements of *Barosaurus*, a diplodocine. Conversely, anterior caudal vertebrae have robust, heart-shaped centra, similar to apatosaurines. More posterior caudal vertebrae are relatively elongate with paired dorsolateral and ventrolateral ridges along the centrum, and rounded articular surfaces, morphologically similar to material that has been referred to the diplodocine *Galeamopus*. Finally, the limb anatomy of this specimen is overall slender, with the femoral head reaching its apex above the maximum curvature of its ventral edge and the tibia subtriangular in proximal view, morphologically similar to that of *Diplodocus*, another diplodocine. This unique mix of anatomical features from different subfamilies of diplodocids precludes definitive taxonomic assignment, and is thus highly relevant for our understanding of the evolution of Late Jurassic sauropods in North America. Radiometric dating suggests Moffett Saddle is one of the oldest Morrison quarries and therefore the specimen may represent an early diplodocid and therefore provide remarkable insights into the mosaic assembly of the diplodocid bodyplan in their early evolution.

Funding Sources The University of Wyoming Department of Geology and Geophysics DMNS Grant Funding provided by: Institute of Museum and Library Services (IMLS), Museums for America (MFA)

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Finite element analysis supports the potential for niche partitioning between a contemporaneous lambeosaurine and hadrosaurine (Ornithopoda: Hadrosauridae)

Dudgeon, Thomas^{1,2}, Evans, David^{1,2}

¹University of Toronto, Toronto, Ontario, Canada, ²Royal Ontario Museum, Toronto, Ontario, Canada

Lambeosaurine hadrosaurids exhibited extreme modifications to the facial skeleton, where the premaxillae, nasals, and prefrontals were modified to form prominent supracranial crests that developed early in ontogeny. The crests are hypothesized to have facilitated intraspecific communication via sound production and sociosexual visual display. Oddly, these crests are extensions of the premaxillae and nasals onto the skull roof, where stress from feeding is usually dissipated in amniotes. Their sister group, the hadrosaurines, lacked hollow crests and had proportionately longer skulls. It has been suggested that these differences may have forced lambeosaurines to feed on softer vegetation, but it is unknown exactly how these differences in skull shape affected feeding mechanics. To test this, we applied finite element analysis (FEA) to the skull of the hadrosaurine *Gryposaurus notabilis* and an ontogenetic series of the contemporaneous lambeosaurine *Corythosaurus casuarius* during simulated feeding. A subadult *Gryposaurus* and four *Corythosaurus* (two juvenile, one subadult, one adult) were CT scanned and segmented to generate 3D models of the skull and lower jaws, which were retrodeformed to repair missing or damaged areas. Jaw muscles were reconstructed to calculate muscle input forces, and restraints were placed to simulate biting at four points along the jaw. The reconstructed models were subjected to FEA to map the distribution of stress throughout the skulls. Mechanical efficiency (ME) and adjusted strain energy (ASE) were calculated to evaluate skull performance. We found *Gryposaurus* had higher bite forces and ME than similarly sized *Corythosaurus*, suggesting this taxon was better able to process tough foods, and *Corythosaurus* may have had a more limited diet. Conversely,

Gryposaurus had much higher ASE than *Corythosaurus*, meaning the skulls of *Corythosaurus* are structurally more resistant to bending. Furthermore, *Gryposaurus* exhibited concentrated stress in the snout and braincase, as is typical for amniotes, whereas *Corythosaurus* concentrated stress laterally in the facial skeleton and braincase. These results suggest *Corythosaurus* had a lower bite force and mechanically less efficient skull than *Gryposaurus*, with adaptations to limit bending, supporting the potential for niche partitioning between these contemporaneous hadrosaurids.

Funding Sources This research is funded by an Ontario Graduate Scholarship and NSERC Vanier Canada Graduate Scholarship to TWD, and a NSERC Discovery Grant to DCE.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Rethinking therapsid phylogeny: Bayesian and cladistic analyses of early-diverging Therapsida

Duhamel, Alienor¹, Wynd, Brenen², Wright, April², Moopen, Atashni¹, Benoit, Julien¹, Rubidge, Bruce S.¹

¹Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ²Department of Biological Sciences, Southeastern Louisiana University, Hammond, Louisiana, United States

The origin of classically mammalian is often traced back to the Therapsida, a clade of diverse synapsids that emerged during the early-middle Permian from “pelycosaur” grade ancestors. The six major therapsid groups (Biarmosuchia, Dinocephalia, Anomodontia, Gorgonopsia, Therocephalia, and Cynodontia) evolved rapidly between the early and middle Permian. This radiation has generated uncertainties at the base of the Therapsida phylogenetic tree, resulting in

conflicting topologies that make it difficult to assess the order and timing of the acquisition of classically mammalian traits.

We performed both cladistic and tip-dated Bayesian phylogenetic analyses using a new morphological character matrix, which includes both external and internal cranial characters, determined through the application of micro-CT scanning. Bayesian phylogenetics was done using Revbayes and MrBayes, where a Fossilized Birth-death (FBD) model was employed. In both cladistic and Bayesian analyses, *Biseridens* is more closely related to the newly recovered monophyletic clade that includes Biarmosuchia and Dinocephalia, rather than to the Anomodontia. *Sinophoneus*, a basal dinocephalian, questions the monophyly of the “Anteosauria”. Additionally, Therocephalia is recovered as paraphyletic, which serves as a transitional group filling the mid-Permian ghost lineage at the base of the Cynodontia.

Our investigation into the Therapsida challenges previous reconstructions of largely monophyletic groups branching off the mammalian stem. The FBD estimates an origin time for Therapsida of 280.5 Ma, which was 2.5 Ma prior to Olson’s Gap (278 to 268 Ma), hypothesized to be a period of extinction. A rapid radiation of synapsid lineages following the origin of Therapsida suggests that Olson’s Gap may have actually been a period of adaptive radiation.

Funding Sources The University of the Witwatersrand (PMA, URC-Centennial Postdoctoral Fellowship), GENUS, NRF grant holder, NRF-NSI-AOP platform, and the NSF (DEB 2045842, CIBR 2113425).

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Ontogenetic analysis of skull structure in *Dryosaurus elderae* (Dinosauria: Ornithopoda) from the Upper Jurassic

Morrison Formation (Dinosaur National Monument, Utah, USA): new behavioral implications from the brain endocast and inner ear

Dunfee, Daniel R.¹, Ridgely, Ryan², Lamanna, Matthew³, Witmer, Lawrence M.²

¹Geological Sciences, Ohio University, Athens, Ohio, United States, ²Heritage College of Osteopathic Medicine, Ohio University, Athens, Ohio, United States, ³Section of Vertebrate Paleontology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States

Analyses of the early-diverging iguanodontian ornithopod dinosaur *Dryosaurus elderae* from the Upper Jurassic Morrison Formation of Dinosaur National Monument (Utah) yield new information about ontogenetic changes in the ornithischian brain endocast and sensory systems with implications for dryosaurid phylogeny and behavior. Three skulls referred to *D. elderae* comprise an intraspecific growth series of three ontogenetic stages: a juvenile (CM 11340), a subadult (CM 3392), and an isolated adult basicranium (CM 87688). CM 11340 represents one of the youngest and most complete examples among non-hadrosauroid ornithopods. Our CT-based analyses reveal new details of cranial anatomy, especially brain structure and shape. Slice thicknesses were 25µm for CM 11340, 50µm for CM 87688, and 300µm for CM 3392. The CT data were analyzed using both automated and manual segmentation in Amira, while the juvenile and adult endocasts were generated using manual segmentation. Segmented cranial elements of the juvenile were reassembled in Maya to allow endocast generation in Amira. The juvenile endocast better reflects brain structure, clarifying numerous endocranial structures including brain regions, blood vessels, nerves, and semicircular canals. Notably, it confirms that blood vessels in the cerebrum region were pressed against the endocranial surface of

the frontals, and shows that a well-developed cerebellar flocculus occupied the space bounded by the rostral semicircular canal. A well-developed floccular recess was found in all three *D. elderae* specimens, suggesting that the species had relatively rapid visual reflexes that would benefit a small, unarmored animal. Additionally, the presence of endosseous cochlear ducts in all three specimens allows an ontogenetic investigation of auditory capabilities in *D. elderae*, and comparison with other dryosaurids such as the Tanzanian *Dysalotosaurus*. Additional findings have phylogenetic implications for Dryosauridae, such as the ontogenetic exclusion of the supraoccipital from the foramen magnum and the potential ontogenetic enclosure of the trigeminal foramen by the prootic. The generation of new endocasts for all three specimens enables an intraspecific ontogenetic investigation of changes in brain shape, cranial anatomy, and sensory capabilities, and further reconstruction of the skulls supports the taxonomic separation of *D. elderae* from *Dryosaurus altus* while enabling further phylogenetic analyses.

Funding Sources DRD—Ohio Univ. College of Arts & Sciences, Honors Tutorial College. LMW & RCR—NSF IOB-0517257, IOS-1050154, IOS-1456503; SRC 2021-02973 & OU Heritage Coll. of Osteo. Med.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Super Charger Heaven: A freshwater microvertebrate assemblage from the Upper Cretaceous (Edmontonian), Williams Fork Formation of northwestern Colorado

Dunn, Renee¹, Heckert, Andrew B.¹, Foster, John R.², Hunt-Foster, ReBecca K.³

¹Geological and Environmental Sciences, Appalachian State University, Acworth,

Georgia, United States, ²Utah Field House of Natural History State Park Museum, Vernal, Utah, United States, ³Dinosaur National Monument, Vernal, Utah, United States

Super Charger Heaven (SCH) is a freshwater microvertebrate site in northwestern Colorado in the lower half of the Williams Fork Formation (WFF). This formation, and thus the site is part of the Mesaverde Group and is of Late Cretaceous, late Campanian to early Maastrichtian (Edmontonian) age. Original surface collecting at an adjoining site, ReBecca's Hollow (RH), led to the discovery of SCH and its collection of microfossils. Sediment was collected from SCH and brought back to be screenwashed, soaking the sediment in agitated water for 24 hours to facilitate breakdown. Adding hydrogen peroxide (H₂O₂) to the screenwashing process greatly increased the sediment breakdown allowing for increased visibility of SCH concentrate. The concentrate was then picked under magnification by undergraduate students at Appalachian State University in a group called Finding Fossils on Fridays (FFF). We confirm that SCH was a freshwater environment based on the nonmarine and terrestrial taxa that have been identified. The assemblage thus far includes osteichthyans (bony fish), salamanders, crocodiles, turtles, lizards, and dinosaurs from the more than 2,100 microfossils. Osteichthyans are represented by lepisosteid (gar) scales, teeth and vertebral fragments, an amiid (bowfin) vertebra and tooth fragment, a *Belonostomus* jaw fragment, unidentifiable skull bone fragments, three crusher plates, and one fin spine fragment. Gar scales are the most common microfossil found at SCH with a current sample size of 1,041 scales. Crocodiles are the second most common organism found next to fish from the number of teeth, osteoderms, and a singular claw fragment that has been identified. *Brachychampsia* is likely present and is represented by one crusher tooth fragment. Other reptile microfossils from SCH include

trionychid turtles represented by two shell fragments and one possible skull bone fragment. The crocodile-like reptile, *Champsosaur*, is represented at this site through one tooth fragment and lizards have been identified by two jaw fragments and osteoderms. Dinosaur microfossils consist of one indeterminate ornithischian tooth fragment and a possible tyrannosaur tooth fragment. Two salamander jaw fragments have been recovered from this site, proving that amphibians were also present at this locality. Chondrichthyans are the only group not represented at SCH which is significant because they have been seen in similar units in the WFF.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A re-analysis of Reeds Allosaur, applying new methods to a historic specimen

Durrant, Kameron L.¹, Diepenbrock, Julian E.¹, Vietti, Laura A.^{1,2}

¹Geology and Geophysics, University of Wyoming, Laramie, Wyoming, United States, ²Geology and Geophysics, University of Wyoming Geological Museum, Laramie, Wyoming, United States

During the late 19th century, the University of Wyoming hired American fossil finder William Reed to find fossils for their newly opened geological museum. During his tenure at the University of Wyoming, Reed's search in the late Jurassic Morrison Formation led to the discovery of a quarry on the Wyoming—Colorado border where he excavated UW-20511, a partial skeleton of the theropod dinosaur *Allosaurus*. The specimen was briefly displayed in the University of Wyoming Geological Museum before being moved into collections. The study of UW-20511 is hampered by heavy historical restoration, making proper examination difficult. Here, we present the results of a study to reexamine

UW-20511 using CT-imaging to identify real vs. reconstructed bone and to generate 3D models from which to compare this specimen with other known *Allosaurus* specimens. Our results indicate that UW-20511 consists of three dorsal, five sacral, and one caudal vertebra, ilia, ischia, and pubes, the left hindlimb, including the distal femur, the tibia, proximal fibula, much of the pes, and other fragmentary remains. The sacral vertebrae and the neural arches of the 12th dorsal vertebra remain unfused, suggesting the specimen was not at full skeletal maturity. Only the distal end of the femur is preserved in UW-20511; however, we estimate femur was around 80 cm in length by using previously established methods to estimate femoral length based on tibia size. The pubes of the specimen exhibit a shorter proximal anterior and posterior length and a smaller obturator notch; this, alongside the tibia morphology, suggests the specimen is assignable to *Allosaurus fragilis*. UW-20511 is also notable in size, with the interpreted femur length comparable to that of the Dinosaur National Monument specimen DINO-2560, making this specimen among the largest *Allosaurus* specimens known. Reed's allosaur remains a testament to how even the oldest specimens in a collection can still surprise us with secrets from the past.

Funding Sources Wyoming Research Scholars

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

A method for conservation of waterlogged material: A case study using fossil tusk

Dzenowski, Nicole

Paleontology, Science Museum of Minnesota, St Paul, Minnesota, United States

Waterlogged subfossil and poorly mineralized fossil vertebrate material is notably difficult to conserve due to its susceptibility to damage during the drying process. Techniques have been developed to conserve waterlogged subfossil material; however, each method presents its own problems and no cohesive solution resulting in minimal damage currently exists. Tusks present a unique problem due to their density and layered growth and are more likely to crack or delaminate while drying, highlighting the need for a reliable conservation method.

In 2020, a 1.3m-long section of mammoth tusk was discovered at a local gravel pit and brought to the Science Museum of Minnesota for conservation. The tusk was approximately 12m below the water table, and the tusk itself was waterlogged, requiring immediate treatment to prevent uneven drying and subsequent damage. Current guidance on conservation of waterlogged materials suggests various methods of air-drying, unless the specimen has experienced loss or degradation of the original organic material; however, the condition of the material may be hard to determine initially and degradation may not be obvious until warping or cracking occurs.

In an attempt to minimize the damage caused during the vulnerable drying process, consolidation, dewatering, and drying were combined into a single multi-step process. Typical adhesives used in fossil preparation react poorly with water, plasticizing and preventing penetration, so a water-based adhesive was chosen for initial consolidation. The tusk was placed in an initial bath (10% water-based adhesive to water) and left loosely covered for a month, after which the adhesive was emptied, properly disposed of, and a new batch mixed. The adhesive to water ratio was increased by 10% monthly, up to 50:50. Once consolidation was complete, the dewatering process began and the tusk was placed in a bath of 10% isopropyl alcohol to water. The alcohol was also chosen to

assist in further dilution and penetration of the adhesive. The alcohol to water solution was also increased 10% monthly and the final bath of 100% isopropyl alcohol was allowed to evaporate naturally, as a final proxy for the necessary slow-dry. Once evaporated, the tusk was able to be further consolidated with Butvar B-76 and has been stable for approximately 2 years.¹

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

The Late Cretaceous neornithine *Asteriornis maastrichtensis* and avian olfactory bulb evolution

Early, Catherine M.¹, Giles, Sam², Ksepka, Daniel³, Field, Daniel J.⁴

¹Biology Department, Science Museum of Minnesota, Saint Paul, Minnesota, United States, ²University of Birmingham, Birmingham, United Kingdom, ³Bruce Museum, Greenwich, Connecticut, United States, ⁴University of Cambridge, Cambridge, United Kingdom

Size changes in the olfactory system are a hallmark of avian brain evolution, along with expansion of the visual system and cerebrum. As brains almost never fossilize, cranial endocasts provide the best evidence of brain morphology in deep time. However, interpreting transitions in the relative volume of different brain regions throughout the evolutionary history of birds is hindered by the sparse fossil record of three-dimensionally preserved Mesozoic bird fossils. Studying avian olfactory bulb evolution is further complicated by the fact that avian olfactory bulb fossae are incompletely ossified. To assess the quality of olfactory bulb fossae measurements available from fossils as proxies for olfactory bulb size, we regressed published olfactory bulb volumes generated from histology on olfactory bulb diameters and on olfactory

bulb fossae volumes generated from cranial endocasts. These regressions indicate that olfactory bulb fossa volume generated from an endocast correlates more strongly with olfactory bulb volume generated from histology than does olfactory bulb diameter. At the same time, olfactory bulb fossae volumes cannot be measured on as many avian cranial endocasts as can olfactory bulb diameter, so both measurements remain valid proxies for olfactory bulb volume depending on context. Towards clarifying the evolutionary history of the avian olfactory system, we generated a digital cranial endocast of the type specimen of *Asteriornis maastrichtensis* (NHMM 2013 008), a Late Cretaceous neornithine. This specimen preserves the anterior portion of the braincase, including the olfactory bulb region. Because the posterior portion of the skull of *Asteriornis* is not preserved, precluding unambiguous estimates of its total endocranial volume, we regressed brain volume against body mass for >1,900 extant birds, and used the resulting relationship to predict the brain volume of *Asteriornis* from its estimated body mass. We then regressed olfactory bulb volume (n=30) and diameter (n=40) against brain volume for both our sample of extant birds and *Asteriornis*. We found that the relative size of the olfactory bulbs of *Asteriornis* fell within the range of relative olfactory bulb size seen in extant birds. These values support earlier findings that relative olfactory bulb sizes seen in extant birds arose early in the evolutionary history of crown birds, and may have preceded the origin of crown birds themselves.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The life history of the early camel *Poebrotherium* as inferred from paleohistology

Ehler, Kara M.¹, Peacock, Brandon R.^{2,3}, Kaye, Thomas G.⁴, Whitney, Megan¹

¹Department of Biology, Loyola University Chicago, Chicago, Illinois, United States, ²Idaho Museum of Natural History, Idaho State University, Pocatello, Idaho, United States, ³Department of Biological Sciences, Idaho State University, Pocatello, Idaho, United States, ⁴Foundation for Scientific Advancement, Sierra Vista, Arizona, United States

The White River Group (WRG) of the Great Plains (USA) records faunal, depositional and paleoclimatic changes across the Eocene-Oligocene boundary. The period preserved by the WRG was significantly impacted by a rapid shift to a cooler, dryer climate with higher seasonality. Among WRG fauna, *Poebrotherium*, a stem member of Camelidae, serves as a particularly useful species to better understand the environmental pressures experienced by mammals during this time. *Poebrotherium*'s herbivorous diet was reliant on available vegetation, making it susceptible to any changes in the local environment. Any fluctuations in diet may be reflected in its bone microstructure, thus giving *Poebrotherium*'s biology the potential to reveal how climate, geography and life history played a role in the evolution of camels. In June of 2023, our field team recovered an articulated forelimb of *Poebrotherium* from the WRG of Eastern Wyoming. Here, we report on the paleohistology of *Poebrotherium* to provide insight into the growth and life history of this early camel. We developed our life history inferences based on thin-sections from multiple elements of this single individual to account for intraskeletal variation.

Our results reveal that at juvenile stages of growth, *Poebrotherium* exemplified high growth rates based on the presence of highly vascularized fibrolamellar bone. These histological features continue through the

mid-cortex, indicating that *Poebrotherium* grew rapidly into adolescence. Regular lines of arrested growth (LAGs) are present throughout the cortex of *Poebrotherium*, which suggest seasonal cessation of growth. The rapid growth apparent in juvenile-to-adolescent bone slows considerably towards the periosteum as evident by the increased contribution of lamellar bone and a significant decrease in vasculature. The periosteal surface lacks vasculature all together, indicating that our individual has essentially reached skeletal maturity. In all, our findings show that *Poebrotherium*'s rapid growth into sub-adulthood was impacted by seasonality, potentially linked to the subtropical to semi-arid/temperate climatic shift that occurred during this time. Further, the presence of LAGs shows that it took multiple seasons for these animals to reach skeletal maturity. Lastly, this study suggests that the ancestral rapid growth rates for Camelidae might have allowed for extant camels to reach the large sizes seen today.

Funding Sources Funding for this work was provided through the Women In Science Enabling Research (WISER) internship and the Mulcahy Scholarship at Loyola University Chicago.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A Late Cretaceous (Campanian) chelydroid turtle from the Ellisdale Fossil Site, New Jersey, USA

Ehret, Dana¹, Langel, Christopher¹, DeMar, David G.², Denton, Robert K.³, Carrano, Matthew T.⁴

¹Natural History, New Jersey State Museum, Trenton, New Jersey, United States, ²Burke Museum, Seattle, Washington, United States, ³Terracon, Ashburn, Virginia, United States, ⁴Vertebrate Paleontology, Smithsonian National Museum of Natural

History, District of Columbia, District of Columbia, United States

The Ellisdale Fossil Site was discovered in the 1980s along Crosswicks Creek in Monmouth County, New Jersey, USA and occurs within the basal portion of the Campanian Marshalltown Formation. To date, it has produced the largest and most diverse vertebrate fauna of non-marine tetrapods from the Late Cretaceous of Appalachia including frogs, salamanders, lizards, turtles, dinosaurs, and mammals. Taphonomic data suggests that the Ellisdale Fossil Site may represent a transgressive lag deposit containing fossils and sediments from both tidal freshwater estuarine and fluvio-deltaic environments and a marine, continental shelf environment.

Collections at the Ellisdale Fossil Site occurred during the mid-1980s through 1990s, and the site was reopened in August 2018 and collecting continued through 2019. Of note, the oldest Appalachian record of a chelydroid turtle (snapping or mud turtle) was identified from these new collections and during recent reevaluation of the preexisting collections from the site. Isolated elements including peripherals, neurals, costals and plastral elements of numerous individuals have been identified for this new taxon. To date, most of these elements are relatively small, suggesting a turtle with a carapace of ~18-20 cm. The carapace exhibits three keels, a median present on the neurals and a lateral keel on either side of the median keel present on the costal bones. These keels are more fully developed on the posterior half of the carapace along with small ridges or carinae found in between the keels. In visceral view, peripheral II exhibits a scar for the insertion of the costiform process of costal I. Peripherals II–VIII or IX exhibit a low gutter that is continuous. The plastron is reduced and cruciform based on a well-preserved hypoplastron. This hypoplastron exhibits the sulci for the humeral-femoral and abdominal-inframarginal scales. The entoplastron is

triangular to diamond-shaped with a strong gular sulcus extending down the midline. Based on the available elements, this new taxon most closely compares with the kinosternoid *Hoplochelys*. The presence of *Hoplochelys* in northern and southern Laramidia, *Hoplochelys clark* and *Hoplochelys* sp. respectively, demonstrates that kinosternoids were established by the Late Cretaceous the western subcontinent. The presence of the Ellisdale taxon from Appalachia reveals that kinosternoids were more widespread during that time in North America than previously thought.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Palatal foramina in artiodactyls and their relation to baleen

Ekdale, Eric G.^{1,2}, El Adli, Joseph J.^{2,3}, Michael, McGowen R.⁸, Demere, Thomas A.², Lanzetti, Agnese^{4,5}, Boessenecker, Robert⁶, Gatesy, John⁷

¹Department of Biology, San Diego State University, San Diego, California, United States, ²Department of Paleontology, San Diego Natural History Museum, San Diego, California, United States, ³Paleontology Department, Bargas Environmental Consulting, San Diego, California, United States, ⁴Department of Vertebrate Zoology, Smithsonian National Museum of Natural History, Washington, District of Columbia, United States, ⁵School of Geography, Earth and Environmental Science, University of Birmingham, Birmingham, United Kingdom, ⁶Imaging and Analysis Center, The Natural History Museum, London, United Kingdom, ⁷University of California Museum of Paleontology, Berkeley, California, United States, ⁸Division of Vertebrate Zoology, American Museum of Natural History, New York, New York, United States

The baleen organ of Mysticeti (baleen whales) is supported by blood vessels and nerves that are transmitted through the neomorphic lateral palatal foramina (LPF) and associated sulci on the maxilla that connect internally to the infraorbital (IOC) and superior alveolar canals (SAC). Palatal foramina with internal connections to the IOC and SAC in the late Oligocene mysticete *Aetiocetus weltoni* are putatively homologous to LPF in extant mysticetes and thus have been interpreted to indicate the presence of baleen (or proto-baleen) in this toothed taxon. Using CT data, multiple LPF with direct internal connections to the IOC and SAC are revealed in an additional *Aetiocetus* species, *A. cotylalveus*. This provides further support that LPF optimize on mysticete phylogeny at the ancestor of Kinetomenta (*Aetiocetidae* + *Chaeomysticeti*), suggesting evolution of baleen (or proto-baleen) prior to tooth-loss in mysticetes.

More broadly, palatal foramina, have been described for a variety of extinct and extant odontocetes, archaeocetes, and terrestrial artiodactyls. Homology between the LPF of aetiocetids with the palatal foramina in extant terrestrial species that lack baleen (such as hippos, peccaries, and llamas) would weaken the inference of both teeth and baleen in stem mysticetes. However, the internal connections of these superficially-similar foramina are largely unexplored. Using publicly available CT datasets, we demonstrate that prominent palatal foramina within the maxilla of examined non-kinetomentan artiodactyls do not connect directly to either the IOC or SAC, but instead connect to canals that carry branches of the greater and lesser palatine neurovasculature. Thus, the palatal foramina of non-kinetomentan artiodactyls are not homologs of LPF in extant mysticetes. Given this result, it remains the simplest explanation to interpret the phylogenetically, positionally, and structurally homologous LPF of

kinetomentan mysticetes as indicators of baleen.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Evidence of predation in vertebrate fossils from the Late Devonian (Famennian) Catskill Formation of Pennsylvania: further insight into the ecological context of the fin-to-limb transition

Eliezer, Adam I.^{1,2}, Daeschler, Edward B.^{2,1}

¹Biodiversity, Earth, and Environmental Science, Drexel University, Philadelphia, Pennsylvania, United States, ²Vertebrate Zoology, Academy of Natural Sciences of Drexel University, Philadelphia, Pennsylvania, United States

Trophic interactions among the vertebrate taxa of the Late Devonian Period (383–359 Ma) can illuminate the ecological context of the vertebrate fin-to-limb transition. The Catskill Formation of northcentral Pennsylvania, USA, has provided some of the best insights into the freshwater environments that played host to this transition. Fossils collected from many different sites across the region have produced a diverse assemblage of gnathostomes including ‘placoderms’, ‘acanthodians’, chondrichthyans, actinopterygians, and a variety of sarcopterygians including multiple distinct tristichopterid species and fragmentary remains of early limbed forms. To understand paleo-trophic interactions in the Catskill Formation, we looked at direct evidence in the form of bite traces known as dentalites. Here we analyze twenty-eight bone deformations in vertebrate fossils that fit the criteria we used to identify direct evidence of predation. Smaller species of ‘placoderm’ studied here are inferred to sit at a lower trophic level in these paleoecosystems than their larger osteichthyan counterparts. We

now have direct evidence for this conclusion. Preserved alongside the ‘placoderm’ elements under study are additional tetrapodomorph elements bearing dentalites, suggesting potential evidence of ontogenetic niche shifts and intraspecific combat/cannibalism amongst higher trophic level vertebrates was probable within the Catskill Formation ichthyofauna. With this information, we establish novel paleo-trophic data that offers additional ecological context to the Late Devonian freshwater ecosystems of Pennsylvania, and the important evolutionary changes that took place at this time.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**New materials of the family Palaeophiidae
(Order Squamata) from the Eocene of the
Fayum Depression, Egypt**

El-Saka, Hossam A.¹, Antar, Mohamed S.^{1,2},
Gohar, Abdullah S.^{1,3}, El-Sayed, Sanaa^{1,4},
Sallam, Hesham^{1,5}

¹Mansoura University Vertebrate Paleontology Center (MUVF), Mansoura University, Mansoura, Egypt, ²Nature Conservation Sector, Egyptian Environmental Affairs Agency, Cairo, Egypt, ³Department of Anatomy and Cell Biology, Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma, United States, ⁴Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ⁵Institute of Global Health and Human Ecology (I-GHHE) School of Sciences and Engineering, American University in Cairo, New Cairo, Egypt

The Palaeophiidae is a group of colossal aquatic snakes with an extensive geographic distribution across Africa, America, Europe, and Asia, spanning from the Late Cretaceous to the Eocene. However, the fossil record of palaeophiid snakes in Africa is scarce and

patchy. Only four distinct species of palaeophiids have been identified: *Palaeophis maghrebianus* from the early Eocene of Morocco, *Palaeophis colossaeus*, from the early to middle Eocene of Mali, *Palaeophis africanus* from the middle Eocene of Nigeria and Angola, and *Pterosphenus schweinfurthi* from the middle-late Eocene of Egypt and Libya. Here we present new palaeophiid materials (QSR23-106) consisting of two isolated precloacal vertebrae recovered from the middle Eocene of the Midawara Formation (Lutetian) in the Fayum Depression of Egypt. The preliminary study suggests the presence of new species tentatively assigned to the genus *Pterosphenus*, based on several diagnostic features such as laterally compressed vertebrae, a thick and triangular-shaped zygosphenon, reduced prezygapophyses, postzygapophyses facets, and neural spine originating from the anterior border of the zygosphenal roof. The two new Fayum palaeophiid snake vertebrae collectively retain unique features that differ from *Pterosphenus schweinfurthi* in having shorter pterapophyses, a shorter neural spine and a distinctive subcentral fossa, and a condyle positioned much lower than the cotyle, contrasting with the dominant characteristics observed in most of Palaeophiidae. Additional field work in the area and further investigations into the morphology and phylogeny of this family will help in understanding the diversification of African palaeophiids and provide insights into adaptations to different aquatic environments over time, confirming the high ophidian diversity during the Eocene.

Funding Sources This research received supported from Mansoura University, the American University in Cairo and the Science and Technology Development Fund (STDF), project 38284.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Getting to the point of sabre teeth: functional optimality underpins the repeated evolution of extreme ‘sabre-tooth’ morphology

Evans, Alistair R.¹, Deakin, William J.², Chatar, Narimane^{3,4}, Milla Carmona, Pablo², Rovinsky, Douglass⁵, Parker, William¹, Adams, Justin W.⁶, Donoghue, Philip², Rayfield, Emily², Pollock, Tahlia^{2,1}

¹School of Biological Sciences, Monash University, Clayton, Victoria, Australia, ²Palaeobiology Research Group, University of Bristol, Bristol, United Kingdom, ³Department of Integrative Biology, University of California Berkeley, Berkeley, California, United States, ⁴UR Geology, Université de Liège, Liège, Belgium, ⁵Exhibitions, Australian Museum, Sydney, New South Wales, Australia, ⁶Monash Biomedicine Discovery Institute, Monash University, Clayton, Victoria, Australia

“Sabre teeth” – elongate blade-like canines – are a classic example of convergence, having evolved repeatedly throughout mammalian history. Within canine teeth there is a trade-off between the aspects of shape that improve food fracture and those that increase tooth strength. Optimal morphologies will strike a balance between these antagonistic functional criteria. The extreme sabre-tooth morphology is thought to confer functional advantage for more specialised predatory adaptations and optimisation; however, the adaptive bases underpinning their evolution remain unclear. To determine whether sabre-tooth shape reflects selection for functionally optimal morphologies we generated a morphospace of the 3D shape of 70 non-sabre and 25 sabre-toothed species, a subset of which were used to quantify functional metrics of puncture performance and breakage resistance. These data were combined using a Pareto rank-ratio algorithm

to evaluate optimality. We demonstrate that extreme sabre-tooth morphologies are functionally optimal, sitting atop a local peak in our optimality landscape. Unlike other optimal canine morphologies, extreme sabre teeth optimise puncture performance at the expense of breakage resistance. This identifies functional optimality as a key driver underpinning the repeated evolution of this iconic tooth.

Funding Sources John Templeton Foundation JTF 62574 (to EJR and PCJD); Australian Research Council Discovery Project Grants (DP180101797 and DP230100613) (to ARE).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Domain expansion: New occurrences of phorusrhacids, cariamids, and rheiformes (Aves) in the late Middle Miocene of Bolivia

Evenden, Robert¹, Anaya, Federico³, Croft, Darin A.²

¹Biology, Case Western Reserve University, Cleveland, Ohio, United States, ²Ingeniería Geológica, Universidad Autónoma "Tomás Frías", Potosí, Potosí, Bolivia, Plurinational State of, ³Anatomy, Case Western Reserve University, Cleveland, Ohio, United States

Avian fossils have been widely documented throughout the Cenozoic of South America. This includes relatives of modern lineages, such as the rheas and seriemas, as well as ones from fully extinct clades. Among these, one of the most charismatic is the family known as Phorusrhacidae, more colloquially known as the “terror birds.” These terrestrial predators are some of the most iconic of South America’s paleofauna, however, most described material comes from Argentina, (particularly southern Argentina), obscuring their geographic distribution. This lack of described material from much of the rest of the continent limits our understanding of

their biology and ecology. The new material corresponds to nine specimens from the Quebrada Honda, Rio Rosario, and Casa del Ministro local areas that include bones of the mandible, an articulated atlas and axis, a distal femur, and pedal phalanges and unguals, among other elements. They are referred to Cariamiformes (Cariamidae and two size classes of Phorusrhacidae) as well as Rheiformes (stem Rheidae). These specimens bridge the circa 5 million-year gap in the phorusrhacid fossil record between the early Middle Miocene Collón Curá Formation and the Late Miocene site of Arroyo Chasicó. The remains from Quebrada Honda are only the second pre-Pleistocene avian fossils described from Bolivia, contributing important new spatial and temporal distribution data for each of these families.

Funding Sources National Geographic Society (NGS 8115-06), National Science Foundation

(EAR 0958733, EAR 1423058)

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Morphological correlates for herbivory in extant lizard skeletons

Faulkner, Benjamin, Motani, Ryosuke

Earth and Planetary Sciences, University of California, Davis, Davis, California, United States

Herbivory has independently evolved multiple times within Diapsida, a group that includes living reptiles and birds. Although the presence of proportionally larger digestive tracts in herbivores compared to omnivores and carnivores has been established in diapsids, a skeletal reflection of this soft-tissue pattern has yet to be quantitatively demonstrated. Limited understanding of the skeletal adaptations associated with herbivory in diapsids hinders the accurate

identification of diet in fossil taxa in which tooth/skull data may be equivocal. In this study, we tested the hypothesis that herbivorous lizards would exhibit larger body cavities relative to head size and trunk length, reflecting the need for proportionally increased gut volume to accommodate plant-based diets. We took linear and curve measurements from 3D models and museum specimens of 94 extant lizard taxa spanning 20 families, encompassing both cranial and postcranial skeletal features. We found statistically significant differences in the ratio of simplified body volume (based on skeletal proxies from the precaudal postcranium) to simplified head size (based on cranial and mandibular dimensions) and trunk length between herbivorous and non-herbivorous lizards, with herbivores displaying proportionally larger body cavities. These findings establish the viability of multivariate analysis of skeletal morphology to discriminate herbivory within diapsids, supporting the accommodation space hypothesis and providing a methodology for distinguishing the diets of extinct taxa using fossilizable material. The findings have implications for understanding the morphological correlates for diet in diapsids and will inform future investigations on the macroevolutionary patterns of diet transitions in this clade.

Funding Sources Funding for this work was provided by the UC Davis Dean's Graduate Summer Fellowship and the Durrell Fellowship.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The phylogenetic relationships of *Stratodus*, *Prionolepis* (*Aspidopleurus*), and *Cimolichthys* among Late Cretaceous genera of the order Aulopiformes (Teleostei: Neoteleostei)

Fielitz, Christopher, Jackson, Hayden,
DeWees, Zoe

Biology, Emory and Henry College, Emory,
Virginia, United States

Stratodus apicalis is a rare aulopiform fish from the Late Cretaceous Western Interior Seaway. It has been collected in various localities including the Niobrara Formation of Kansas (Coniacian to Early Campanian) and South Dakota (Coniacian to Santonian), and the Mooreville Formation of Alabama (Campanian). It is represented by several skulls, a poorly preserved but nearly complete specimen, and numerous isolated palatine bones. They are distinct among Cretaceous aulopiform fishes by the small, numerous teeth on its palatine, upper jaws, and mandible. *Cimolichthys* is a common Late Cretaceous genus found in a number of formations in North America and Europe and is represented by well-preserved specimens. *Prionolepis* (*Aspidopleurus*) is found in Lebanon (Cenomanian) and recently from the Coahuila State of Mexico (Turonian, Eagle Ford Formation). Historically, these three genera were thought to either be closely related or unrelated. Furthermore, they have been individually placed within or sister to the family Dercetidae. The arguments for both their close relationship to each other and their relationship to the Dercetidae are based on a number of shared cranial and post-cranial characteristics. Our study objectives were to test the hypothesis that these three genera are related and reassess the characters of *Prionolepis*, comparing them to previous studies. After examining specimens of the three genera, we reassessed the characters and their states particularly for *Prionolepis* and *Cimolichthys*. We then performed a heuristic search of 36 taxa and 86 characters. A strict consensus of 24 equally parsimonious trees shows that *Stratodus* is a sister to dercetid genus *Pelargorhynchus*. In turn, this clade is sister to clade of the remaining members of the Dercetidae. *Prionolepis* is the sister to

Rhabrichthys (which has been historically assigned to several different families). They, in turn, are basal to a large polytomy that includes *Cimolichthys*. Additionally, the phylogenetic position of *Prionolepis* from our character assessment differs from that of previous studies that places it within that polytomy that includes *Cimolichthys*.

Funding Sources Funding was from the Appalachian College Associate Ledford Grant and the Emory & Henry College McConnell Chair in Biology.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

Evolution of tooth replacement rates in sauropod dinosaurs

Finch, Stephen², Wilson Mantilla, Jeffrey A.³,
Britt, Brooks⁴, D'Emic, Michael D.¹

¹Biology, North Carolina State University, Raleigh, North Carolina, United States, ²Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ³Geology, Brigham Young University, Provo, Utah, United States, ⁴Biology, Adelphi University, Garden City, New York, United States

Sauropod tooth morphologies and replacement patterns provide important insights into the feeding ecology and evolution of the clade. Sauropod cranial morphology is conserved relative to that of many archosaur clades, but tooth replacement rate and tooth slenderness vary substantially. Titanosaurs and diplodocoids independently evolved narrow-crowned teeth and high tooth replacement rates. Brachiosaurids also evolved somewhat narrower-crowned teeth, but the few that have been sampled have relatively low tooth replacement rates. Details surrounding the evolution of these traits are poorly understood due to sporadic inference of

tooth replacement rates across Sauropoda, especially for Early Cretaceous taxa. To examine the evolution and possible relationship between tooth slenderness and replacement rate in greater detail, we integrated histological, computed tomographic, and literature-based data to estimate tooth replacement rates for 16 sauropod genera, doubling the number of sampled taxa. Ancestral state reconstruction on a time-calibrated consensus phylogeny suggests the earliest macronarians and brachiosaurids mostly retain the ancestral sauropod condition of relatively low tooth replacement rates (2–3 months to replace a tooth in each alveolus), whereas all diplodocoids evolved much higher rates (2–5 weeks to replace a tooth in each alveolus). Early somphospondylans had a broad range of tooth replacement rates, whereas titanosaurs evolved high rates on par with those of diplodocoids. Broad-crowned teeth exhibit some correlation with decreased tooth replacement rates, whereas narrow-crowned teeth display a more variable relationship with replacement rate, indicating a complex interplay between tooth breadth and tooth replacement rates in sauropods.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

A rich record of dinosaur tracks from an unnamed Cretaceous rock unit along the Yukon River in west-central Alaska

Fiorillo, Anthony¹, Kobayashi, Yoshitsugu², McCarthy, Paul³

¹NM Museum of Natural History & Science, Albuquerque, New Mexico, United States, ²Hokkaido University, Sapporo, Japan, ³University of Alaska - Fairbanks, Fairbanks, Alaska, United States

We report on a rich, new record of vertebrate tracks from Cretaceous rocks exposed along

the Yukon River of west-central Alaska. In August 2023, we undertook an investigation of unnamed middle Cretaceous sedimentary rocks in the Yukon-Koyukuk Basin that may be as much as 8000 m thick. Our survey covered approximately 120 river miles and we recorded 93 new occurrences of vertebrate tracks in an area where none had been documented previously. The age of these rocks is approximately 100–86 Ma. Ten stratigraphic sections were measured which display primarily fluvial-delta plain facies. Main fluvial channels, up to 18 m thick, consist of well-developed fining-upward successions of medium- to fine-grained, trough cross-bedded, and ripple cross-laminated sandstones. Main channels may be single-story or multi-story and are interpreted as meandering river deposits. Smaller channels, consisting of lenticular, fine- to very-fine, trough cross-bedded sandstones up to 2 m thick, represent crevasse or distributary channels. Sandstones are typically bioturbated and moderately rooted with plant leaf impressions and woody stems at the base. Interbedded, fine-grained sandstones, siltstones, and mudstones are interpreted as distal floodplain deposits. Root traces are pervasive throughout floodplain mudstones and crevasse splays. Organic fragments on thin sandstones, plant detritus, and leaf impressions are common. Thin coals or coaly shales represent peat swamps, and thick mudstone deposits represent small ponds or lakes. Small coarsening-upward successions of interbedded tabular sandstone and mudstone probably represent crevasse deltas and/or crevasse splays into interdistributary bays. The broad ichnotaxonomic groups represented in our survey are non-avian theropods, at least three examples of avian theropods, hadrosauroids, nodosaurids, and a crocodylomorph. Of these ichnotaxa, the most encountered track type was tridactyl with rounded, broad digits, tracks attributable to young to adult hadrosauroids, a frequency

pattern like that found in a roughly correlative study several hundred kilometers north in the Nanushuk Formation of North Slope, Alaska. Our study not only provides new insights into a biologically productive ancient, high-latitude, terrestrial ecosystem, but also demonstrates the need for additional high-latitude studies to expand our knowledge of ancient biodiversity in the Cretaceous Arctic.

Funding Sources Friends of ISEM Paleo, Wintrust Bank, Robert Vladem

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Pterosaur femoral anatomy elucidates the evolution of Lagerpetidae (Panaves: Pterosauromorpha)

Fitch, Adam J.

Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Lagerpetids are a group of Triassic-endemic stem-avians representing the sole sister lineage to Pterosauria, the first flying vertebrates. Lagerpetid fossils are usually partial in representation, with the femur being the only element represented across all lagerpetid taxa and that upon which nearly all lagerpetid ingroup relationships are determined. The femoral anatomy of the lagerpetid outgroup (Pterosauria) is thus key to understanding the evolution of Lagerpetidae. The femora of lagerpetids and early-diverging pterosaurs are here reexamined, specifically in the context of features having to do with lagerpetid phylogeny. Several features once thought exclusive to lagerpetids, particularly of the distal femur, are found to also be present in Pterosauria. Among lagerpetids, those typically considered part of the genus *Dromomeron* possess femora most similar to those of pterosaurs, with pterosaurs

possessing all previous synapomorphies of the genus. The result is a shift in the polarity of lagerpetid ingroup character optimizations, revealing a paraphyletic *Dromomeron* around a deeply-nested clade consisting of other lagerpetids (e.g., *Lagerpeton*, *Ixalerpeton*, *Veneteraptor*). Of particular note is that Lagerpetidae, like Pterosauria, is recovered as plesiomorphically lacking an ossified development of the insertion of m. caudofemoralis (i.e., the fourth trochanter). The development of a prominent crestlike fourth trochanter in later-diverging lagerpetids highlights a shift in hindlimb function in lagerpetid evolution. This, along with the elongate distal hindlimbs, pedal digit reduction, and hooflike pedal unguals found in all lagerpetids, suggest increasing specialization for terrestrial locomotion in Lagerpetidae, in particular contrast to the Pterosauria.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Late Cretaceous marine vertebrates from the uppermost Greenhorn Limestone in Russell County, Kansas, USA

Fitzpatrick, MJ, Shimada, Kenshu

DePaul University, Chicago, Illinois, United States

The Pfeifer Shale is a late early Turonian sedimentary rock unit representing the uppermost stratigraphic member of the Greenhorn Limestone broadly distributed throughout central Kansas. It formed in the offshore environment of the Western Interior Seaway, a Late Cretaceous epicontinental seaway in North America, particularly when it was approaching its maximum transgression about 93 million years ago. Previously, fossil vertebrates from the lower part of the Pfeifer Shale were investigated, illuminating the presence of at least three chondrichthyan and six osteichthyan taxa, but the vertebrate

fossil record for the rest of the stratigraphic unit remains poorly known. Here, we describe fossil marine vertebrates collected from the middle–upper portion of the Pfeifer Shale in Russell County, Kansas, USA, based on surface collected materials as well as bulk sampling from two separate horizons within the stratigraphic interval. Collected vertebrate fossils are dominated by remains of fossil fishes, consisting of a minimum of eight chondrichthyan taxa (*Ptychodus anonymus*, *P. mammillaris*, *P. whipplei*, *Cardabiodon* sp., *Cretoxyrhina mantelli*, *Dallasiella willistoni*, *Squalicorax falcatus*, and *S. pawpawensis*) and nine osteichthyan fishes (five types of possible non-teleostean actinopterygian fishes as well as Plethodidae indet., *Pachyrhizodus minimus*, *Enchodus shumardi*, and one other type of teleost). In addition, the collected material also includes a possible avian tooth. The vertebrate assemblage consists of representatives of a variety of trophic regimes, such as small fishes presumably in the lower trophic level (e.g., most bony fishes), durophagous forms (e.g., *Ptychodus* spp.), medium-sized piscivores or opportunists (e.g., *Dallasiella* and *Squalicorax* spp.), and top predators (e.g., *Cretoxyrhina* and *Cardabiodon*). There are other marine vertebrate taxa found from other members of the Greenhorn Limestone as well as from the conformably overlying Fairport Chalk Member of the Carlile Shale (e.g., pachycormiform and ichthyodectiform fishes and dolichosaurid lizard), indicating that the fossil record of the Pfeifer Shale is still incomplete. However, the recognition of at least 18 vertebrate taxa through this study has doubled the total number of known vertebrates from the Pfeifer Shale, elucidating a better picture of the faunal composition and paleoecology of the offshore region of the Western Interior Seaway during its deposition.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Can you dig it? A lawyer's advice on securing permission to excavate fossils exemplified by a recent Miocene mysticete excavation in Santa Barbara County, California

Flint, Elizabeth G., Hoffman, Jonathan M.

Earth Science, Santa Barbara Museum of Natural History, Santa Barbara, California, United States

The laws regarding fossil excavation on public lands can be complicated and confusing, especially when attempting to obtain permission to dig at a new site. Navigating the permitting process can also be time-consuming, endangering fossils that are subjected to high erosion rates. Further, increased legal protections for vertebrate fossils underscore the importance of excavating with the appropriate permissions.

We present a universal (i.e., not specific to any one jurisdiction) framework to guide paleontologists on how to address permitting issues efficiently and effectively. Topics include how to determine the applicable law, identify relevant agencies, draft a persuasive permit application, and expedite consideration. The framework is based on our recent success in securing permission to excavate from two state commissions and one county agency in a relatively short two months. By following this guide, paleontologists can better assist governments with the preservation of paleontological resources on public lands.

Our permitting odyssey began in late February 2024. A local rockhound contacted the Santa Barbara Museum of Natural History regarding a fossil whale skull he found in the tidal zone of a nearby beach. Upon inspection, a well-preserved Miocene mysticete skull encased in Monterey Shale

was clearly visible with post-cranial elements partially discernable. The fossil had been exposed after a winter storm and the tide was further eroding the specimen on a daily basis. The Museum wanted to collect the whale as soon as possible to spare it from destruction. However, California's regulatory environment, especially in the Coastal Zone, is notoriously complex. Applying the principles discussed in this presentation, the Museum was able to start excavation by early May 2024.

Funding Sources This work was funded by the Santa Barbara Museum of Natural History.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Species taxonomy and biogeography of the Dinocerata (Mammalia)

Flora, Geoffrey W.

Biology, Adelphi University, Garden City, New York, United States

The Dinocerata (uintatheres) are an extinct order of relatively large early eutherian mammals of bizarre appearance. Uintatheres lived during the Late Paleocene and Middle Eocene of both North America and Asia. The later North American taxa are distinctive for their three pairs of bony horn-like protuberances crowning the skull combined with saber-tooth canine tusks. The earliest uintatheres appear simultaneously in the Late Paleocene (Tiffanian/ Noshanian) of North America and Asia (60Ma). These early uintatheres were relatively unspecialized plantigrade tapir-sized (100 kg, 220lbs) omnivorous forms. By the Middle Eocene (45Ma), uintatheres were the size of today's largest rhinoceros (3500kg, 7800lbs) with graviportal elephant-like limbs and adaptations for browsing.

The study reevaluates the species level taxonomy of uintatheres based primarily

upon craniodental materials combined with a few skeletal materials. Previous taxonomic studies suggest canine size, inframandibular flange size, horn size, and premolar morphologies are generally polymorphic within a species and were generally avoided when delineating species.

19 genera and 67 species were considered for revaluation. The uintathere species found to be valid include: *Prodinoceras matyr*, *P. plantigradum*, *P. turfanense*, *P. lacustris*, *Probathyopsis harrisorum*, *Pr. praecursor*, *Bathyopsis fissidens*, *B. middleswarti*, *Gobiatherium mirificum*, *Uintatherium insperatus*, *U. anceps*, and *Eobasileus cornutus*. The usage of *Probathyopsis* was retained for the earliest North American uintatheres due to the shared characters of the two species, although generic distinction from *Prodinoceras* remains uncertain. Strong evidence for sexual dimorphism is observed in most uintathere taxa, including cranial protuberance development in the later uintatheres and sagittal crest development in the earlier forms. The genus *Tetheopsis* was not supported and fossils identified to the genus are reclassified under *Eobasileus cornutus*.

Two intercontinental dispersal events are implied by the cladistic results. The first is the arrival of *Probathyopsis* to North America, most likely from Asia during the Tiffanian/Noshanian (60Ma). The second dispersal is of *Uintatherium insperatus* and *Gobiatherium* into Asia, presumably from high latitude populations of North American large uintatherids during the Bridgerian/Arshatan (50Ma).

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Screenwashed vertebrate assemblage from Campbell Ranch, Oregon, reveals additional small mammal diversity

Flores, Deanna¹, Famoso, Nicholas A.^{2,1}, Hopkins, Samantha¹

¹Earth Sciences, University of Oregon, Lenoir, North Carolina, United States, ²John Day Fossil Beds National Monument, US National Park Service, Kimberly, Oregon, United States

The John Day Fossil Beds, in central and eastern Oregon, contain a remarkable record of the Cenozoic stretching from the Eocene to the Miocene. Northeast of Lonerock Creek, there are several small outcrops which are relatively unknown. This locality was named Lonerock/Campbell Ranch by Ted Fremd and David Whistler. The locality has previously identified remains that suggest a biostratigraphic age similar to the Upper Turtle Cove and Kimberly Members of the John Day Formation. Composite materials collected from Lonerock, specifically the microsite "Site 50", have undergone screenwashing which resulted in hundreds of microfossils from a single site approximately 10 meters in diameter. The number of microfossils from Lonerock is unlike anything else in the John Day Fossil Beds National Monument (JODA) collection. While Lonerock is a critical site within the John Day fossil beds it has received little attention. A preliminary faunal list was published by past workers, but in-depth study and description of the material has not been previously undertaken. The Lonerock site has been mentioned in some publications about the John Day fossil assemblage and some specimens from this locality have been published on individually, but the majority remain unstudied. From our preliminary analysis approximately 25 mammalian taxa have been identified in the previously collected material. Large vertebrates include oreodonts, *Hypertragulus*, *Marshochoerus*, equids, *Diceratherium*, nimravids, and other carnivores. Out of the identified taxa, 16 are small vertebrates. These small vertebrates include *Copedelphys*, aplodontids, *Protoscurius*, *Leidymys*, *Proscalops*, and *Domnina*. Small vertebrates, particularly

rodents, are key indicators of local climate and environmental change throughout time and compose almost half of modern mammalian diversity, but they are generally underrepresented in the John Day, where screenwashing has not previously been possible. The diverse and well preserved microvertebrate fauna at Campbell Ranch is critical to understanding the finer details of long-term climate and biota changes in western North America.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024,
1:45 PM)

Osteological evidence for supraorbital salt gland fossae in a new Middle Triassic cymbospondylid ichthyosaur from the Anisian Fossil Hill Fauna of Nevada

Florsheim, Lucas Y.^{2,1}, Klein, Nicole³, Gelatt, Kaia¹, Cox, Joseph¹, Sander, Martin^{3,4}, Schmitz, Lars^{1,4}

¹Biology Department, Pomona College, Claremont, California, United States, ²Kravis Department of Integrated Science, Claremont McKenna College, Claremont, California, United States, ³Bonn Institute of Organismic Biology, University of Bonn, Bonn, Germany, ⁴Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States

Secondarily marine tetrapods feature many evolutionary adaptations to full-time life in the ocean, involving changes to morphology, physiology, and behavior. The ability to osmoregulate when feeding in the saline sea is critical. Reptiles have evolved accessory organs that excrete excess electrolyte independently multiple times. Sea turtles possess paired salt glands within their orbits, whereas squamates and avians feature nasal to supraorbital salt glands. Haline adaptations may have preceded aquatic adaptations in secondary transitions to

marine life, but tracing the evolution of glands in the fossil record is difficult. We present osteological evidence for the presence of supraorbital salt glands in ichthyosaurs, observed in a new and well preserved cymbospondylid from the Anisian Fossil Hill Fauna of the Augusta Mountains (Nevada, USA). Together with a new longirostrine ichthyosaur, this brings up the number of ichthyosauriform species in the Fossil Hill Fauna to ten.

3D laser scanning enabled detailed comparisons with other cymbospondylids, revealing several unique features. The new taxon differs from other cymbospondylids in having supraorbital ridges and a medial extension of the prefrontal that eliminates nasal-postfrontal contact and excludes the frontal from the upper temporal fenestra. Clearly delineated anterior terraces are located in front of the upper temporal fenestrae. These terraces are trough-like depressions with lobed surfaces that extend anteriorly to the frontal-nasal suture. The position and shape of the terraces are analogous to the supraorbital salt gland fossae in avians and marine iguana. Muscle attachments as alternate explanation for the terraces are biomechanically implausible, and we interpret the terraces of the new specimen as supraorbital salt gland fossae. Anterior terraces have been described for many Early and Middle Triassic ichthyosauriforms, even though their size and position vary. If all terraces were to represent salt gland fossae, extra-renal excretion of salt via supraorbital glands was present in early ichthyosauriforms already. Most post-Triassic ichthyosaurs lack anterior terraces, but lacrimal and narial structures hint at more anteriorly positioned salt glands. Since excess salt secretion is essential for all secondarily marine reptiles, analyses of the temporal sequence of haline and aquatic adaptations promise to improve understanding of evolution at the interface between land and water.

Funding Sources DFG Project number 470103987 to NK

DFG Project number 440685415 to PMS

DFG Project number 388659338 to PMS

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Jurassic Park and its consequences: the impacts of popular media on science communication and paleoart

Fogelsong, Anne S., Gay, Robert J.

Idaho Museum of Natural History, Idaho State University, Pocatello, Idaho, United States

Paleontology has been greatly affected by the 1993 film *Jurassic Park*. Many modern paleontologists have been inspired by the film and the general public holds views of dinosaurs today that are widely divergent from pre-*Jurassic Park* depictions. Many modern skeletal mounts, especially those of tyrannosaurs, have been mounted in a “*Jurassic Park* Pose,” inspired by the scene of the tyrannosaur breaking out of its enclosure. While every depiction of an organism after its extinction is by necessity an exercise in narrative creation and fiction, *Jurassic Park* starkly shows how we choose to depict these creatures as monsters rather than as animals. Here we quantify the impact of this media on both the science-based outreach and popular culture portrayal of these animals.

We define a distinctive *Jurassic Park* Pose (JPP) based on the 1993 film where the *Tyrannosaurus* breaks out of its enclosure. Elements of the JPP are a) a body held roughly horizontally with a b) head held below the level of the hips, bringing the head to human-eye level with the c) mouth held open at ~40° and d) the hindlimbs held in a wide stance, resulting in a pose designed to provoke a human response as opposed to representing

a naturalistic behavior in the taxon. In a survey of 12 *Tyrannosaurus rex* mounts in museums, erected since 1993, 7 of these fully match the JPP. No mount analyzed had less than 3 of the four characteristics of the JPP, suggesting an artistic basis for the pose of these mounts. Testing body position vs head position, mouth gape, and stance with T-tests all rejected the hypothesis that these mounts replicate naturalistic behaviors. Conversely, the head position was strongly correlated with mouth gape.

Dinosaur skeletal mounts serve narrative roles which are often overt and can play on elements of anatomy or taphonomy that museums wish to highlight. The narrative can also reinforce monstrous tropes brought about through media such as *Jurassic Park*, which then work against broader public understanding of extinct creatures as once-living, complex animals. In creating non-naturalistic displays, we assign extinct creatures a distinct morality when morals are not something these animals were capable of having. This limits uptake of accurate information as the morality of the display colors the audience's reception of the information.

Funding Sources Idaho Museum of Natural History Education Department

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Using palaeogenomics to identify chameleon subfossils to species and determine community turnover in Madagascar

Forcellati, Meghan R.¹, Salis, Alexander T.¹, Benson, Roger B.², Raxworthy, Christopher¹

¹Herpetology, American Museum of Natural History, New York, New York, United States, ²Vertebrate Paleontology, American

Museum of Natural History, New York, New York, United States

The discovery that subfossil material can be a reservoir for ancient biomolecules, such as ancient DNA (aDNA), has revolutionized systematic hypotheses of Madagascar's charismatic megafauna, from large, flightless ratites to extinct 'horned' crocodiles. Although aDNA degrades faster at subtropical and tropical latitudes because of greater temperatures and UV radiation, subtropical caves may still act as refugia to preserve significant quantities of DNA. Humans likely first arrived in Madagascar between 10,500 and 1,000 BP, and so cave subfossils often predate human contact. In this study, we successfully extract and employ state-of-the-art single-stranded library preparation methods to get ancient DNA from <1 g of bone material from 11 subfossil chameleons, largely comprising isolated maxillary, mandibular, and vertebral material, from Andrahomana Cave in southeastern Madagascar (dated 7,000 BP – 600 CE). These specimens were originally identified morphologically as belonging to *Furcifer*. We then use mitochondrial and nuclear genomic material from the subfossils to place them phylogenetically and identify them to the species-level. We compare photographs of the subfossil material to a new dataset we assemble of CT scans of chameleons from Africa and Madagascar (N≈60) to identify new morphological characters supporting their identification. We have retrieved ancient DNA from a warm environment, with >10% endogeneity estimates for some of our elements based on nuclear genome mapping, supporting that isolated subfossil elements from caves in subtropical environments can harbor large quantities of endogenous DNA. Our preliminary results support their original identification as belonging to *Furcifer*, suggesting that within the last ~10,000 years, there has not been substantial turnover of chameleon species within this area of Madagascar, and that

isolated bones can be reliably assigned at the generic level using a combined approach including both ancient DNA and morphological characters, even within a diversity hotspot such as Madagascar.

Funding Sources The Richard Gilder Graduate School Fellowship, the National Science Foundation (DBI-2029955 and DEB-1931213), the American Museum of Natural History

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

***Edmontosaurus*/*Anatosaurus*/*Anatotitan*, one into three or three from one?**

Ford, Tracy L.

Paleofile, Poway, California, United States

Edmontosaurus, *Anatosaurus*, and *Anatotitan* are Late Cretaceous saurolophine hadrosaurs from northern North America. The three were synonymized into one genus, *Edmontosaurus*, because that is the oldest named hadrosaur of the three. But do they all belong to one genus or three? Are there differences in the skulls that suggest either way?

Hadrosaur skulls are unique. Lambeosaur hadrosaurs have elaborate skull crest ornamentation, and saurolophine hadrosaurs generally lack these elaborate crests. However, this is incorrect; the orbital region in some 'flat' headed hadrosaurs did have ornamentation in the area above the orbit. The frontal over the orbit is not flat; it is raised and forms an orbital crest. This is a feature that has not been recognized before. The orbital crest is a raised area above the outer ridge of the orbit, and the actual orbit is smaller. In fact, this is generally an unnoticed physical structure in hadrosaur skulls in general and, to some degree, in both lambeosaurs and saurolophines. This orbital crest is extremely large in *Edmontosaurus*

and looking anteriorly, the crest has a 'U' shape. Under the crest the frontal has an indentation that extends to some degree below the crest and into the orbit. This is the true orbital edge. This indentation is in both saurolophine and lambeosaurine hadrosaurs. The type *Edmontosaurus regalis* (NMC 2288) skull is nearly complete, though one side of the skull is more complete than the other. The skull and referred skulls have been depicted for over 100 years. They show a large orbit and a short, tall skull with a very wide bill. *Anatosaurus saskawinensis*, the left side of skull is similar to *Anatosaurus* while the right side of the skull has a more typical large orbital crest, as seen in *Edmontosaurus regalis*. The skull is crushed obliquely, with the left side of the skull. This crushing is seen in other hadrosaur skulls, which complicates hadrosaur taxonomy.

The differences between *Edmontosaurus*, *Anatosaurus*, and *Anatotitan* are: *Edmontosaurus* has a shorter, taller skull with a broader bill, and tall orbital crest, and coming from the late Campanian; *Anatosaurus* has a longer, shorter skull with a shallower bill, and short or nonexistent orbital crest, and *Anatotitan* has an elongate, short skull with shallower bill, and short or nonexistent orbital crest and comes from the late Maastrichtian, it is here theorized that the three of the genera belong to valid separate genera.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

Comparative functional morphology and intramandibular biomechanics of *Alligator*, *Majungasaurus*, and *Tyrannosaurus*

Fortner, John D.¹, Middleton, Kevin^{2,1}, Holliday, Casey¹

¹Pathology & Anatomical Sciences, University of Missouri, Columbia, Missouri, United

States, ²Biological Sciences, University of Missouri, Columbia, Missouri, United States

In archosaurs and many other tetrapods, the intramandibular joint (IMJ) separates the rostral, dentigerous bones from the caudal, jaw adductor-bearing bones. Because excessive feeding stress may disarticulate the bones about the IMJ, the IMJ may create an inherent “weak spot” that constrains mandibular performance. Archosaurs may have consequently modified IMJ articulations in order to build more robust – or more flexible – mandibles for feeding, with IMJ form subsequently reflecting its mechanical function in resisting or facilitating excursion. We assessed form-function relationships of the archosaurian intramandibular joint by comparing two carnivorous, nonavian theropods – the putatively kinetic *Majungasaurus* and putatively akinetic *Tyrannosaurus* – and the extant, akinetic crocodilian *Alligator*. We built finite element models of their mandibles with IMJs to assess intramandibular articular surface areas and mandibular performance metrics (bending moments, bone strain, and ligament strain) of these three taxa. *Majungasaurus* possesses the comparatively smallest IMJ, followed by *T. rex* and then *Alligator*. Size-adjusted bending moments, bone strain, and ligament strain are greatest for *Majungasaurus* in comparison to *T. rex* or *Alligator*. Performance metrics also show greater sensitivity to differential muscle activation in *Majungasaurus* compared to *T. rex* or *Alligator*, with *m. intramandibularis* (mIM) activity reducing ligament strain the most by as much as 15%. *Majungasaurus* and *Alligator* also better resist mediolateral forces than *T. rex*, though *T. rex* proves best at resisting dorsoventral forces. Our results suggest greater kinetic competency for *Majungasaurus*’ IMJ, which we attribute to its comparatively low intramandibular articular surface area. Moreover, mIM appears to play an especially important postural role by limiting excessive IMJ excursion in this taxon. *Majungasaurus* – and by extension, other

abelisaur – may have possessed fairly permissive IMJs and utilized specialized jaw muscles to maintain joint coherence. In contrast, *T. rex* and *Alligator* have reduced the kinetic competency of their IMJs by increasing articular surface areas, with the dorsoventrally taller mandible of *T. rex* further optimizing it against dorsoventral forces. However, its relatively poor performance against mediolateral forces suggests that thrashing behaviors – as seen in extant *Alligator* – were not possible.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

New dinosaur discoveries from the Judith River Formation of Montana: biostratigraphy, impacts on correlation, taxonomy, and hypotheses of biogeography and anagenesis

Fowler, Denver¹, Freedman Fowler, Elizabeth^{2,1}, Wilson, John¹, Barrera Guevara, Daniela^{1,2}, Woodruff, Cary³

¹Badlands Dinosaur Museum, Dickinson, North Dakota, United States, ²Natural Sciences, Dickinson State University, Dickinson, North Dakota, United States, ³Phillip & Patricia Frost Museum of Science, Miami, Florida, United States

Despite being one of the first dinosaur-bearing geological units identified in the United States, the Judith River Formation (JRF) of Montana has yielded relatively few diagnostic fossils. Recent JRF fieldwork by Badlands Dinosaur Museum (2016-; on US public lands administered by the Bureau of Land Management) and Frost Science (2023-) along the international border with Canada has recovered substantial new remains, increasing knowledge of the fauna, facilitating regional correlation, and addressing hypotheses of biogeography and evolution. Outcrop mapped as JRF at Havre, Hill County, is identified as the equivalent of the upper

Oldman Formation (UOF) of Alberta. The Havre UOF has yielded two partial cf. *Centrosaurus apertus* skulls (one of which includes the diagnostic parietal), and a cf. *Chasmosaurus "russelli"* partial skull (both Ceratopsidae), permitting correlation of the Havre UOF with the *Ce. Apertus* biozone in southern and central Alberta. The UOF is incised up to 5m at its upper contact by the overlying Dinosaur Park Formation (DPF) equivalent, which has a thin (~10 cm) clam-pebble lag indicating a depositional hiatus at its base, overlain by distinctive Inclined Heterolithic Strata. Sites in the basal Havre DPF have yielded a fine *Lambeosaurus lambei* (Hadrosauridae) skull and skeleton, c.f. *Styracosaurus albertensis* (Ceratopsidae) parietal spike, the pachycephalosaur *Foraminacephale*, and partial skeletons of a troodontid and pterosaur, suggesting correlation with the *S. albertensis* biozone of Alberta. ~200km to the east, JRF outcrop near Glasgow, Valley County, has yielded four partial cf. *Daspletosaurus* (Tyrannosauridae) skeletons (including the *D. wilsoni* holotype), mass-death-assemblages and isolated *Brachylophosaurus* sp. (Hadrosauridae), a centrosaurin partial skull, and a juvenile nasutoceratopsin (Ceratopsidae). The centrosaurin is immature, lacking fusion at epiparietal locus 1, but the parietal and postorbitals are most consistent with *Ce. apertus*. JRF exposures east of Havre (at Malta and Glasgow) thus deposition during regression of the Western Interior Seaway during the *Ce. Apertus* biozone. The Glasgow JRF may represent a basinward correlative conformity of the depositional hiatus at the erosive contact of the UOF and DPF at Havre. Timing of the regression has taxonomic implications since the holotype of *Brachylophosaurus canadensis* is from the Comrey Sandstone at the base of the UOF, ~500ky older than Malta and Glasgow specimens.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Quantitative reassessment of the carbon isotope record of Neogene and Quaternary paleoecology and environments in eastern Africa

Fox, David L.¹, Lukens, William², Nockerts, Rebecca³

¹Department of Earth & Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States, ²Department of Geology and Environmental Science, James Madison University, Harrisonburg, Virginia, United States, ³Department of Evolution, Ecology, and Behavior, University of Minnesota, St. Paul, Minnesota, United States

The Neogene and Quaternary sedimentary and volcanoclastic record of eastern Africa preserves numerous vertebrate faunas and paleosols that document the evolution of terrestrial communities and their habitats. The taxonomic and ecological structure of these faunas and the carbon isotopic composition of fossil herbivore tooth enamel and paleosols have been used to reconstruct a long-term pattern of environmental change from mostly wooded habitats in the Early Miocene to more open, grass-dominated habitats by the Quaternary and the widespread appearance of habitats dominated by isotopically distinct C₄ grasses beginning about 10 Myr ago. These environmental changes have been proposed as drivers of faunal change, but recently published isotopic and plant microfossil data indicate that open habitats with C₄ grasses were present episodically at multiple Early Miocene sites in the region. Here we reassess the carbon isotopic record from eastern Africa using a new, global compilation of >11,600 modern plant $\delta^{13}\text{C}$ values that includes local climate and geographic data, plant taxonomy, and plant characteristics. We use a Monte Carlo mixing model to

quantify fraction C_4 biomass (fC_4) for measured $\delta^{13}C$ values of mammalian tooth enamel and paleosol archives over the past ~20 Myr. This approach incorporates uncertainty in plant endmember $\delta^{13}C$ distributions based on the modern reference data, paleo-atmospheric CO_2 $\delta^{13}C$ estimates using various proxies, and fractionation factors in each isotope system. This data-driven method, which yields lower threshold $\delta^{13}C$ values for non-zero fC_4 than earlier approaches, confirms the recent Early Miocene records of C_4 grass in mammal diets and local habitats and extends these records to multiple Middle Miocene sites as well. When the modern plant compilation is filtered to only semi-arid to sub-humid hydroclimates, fC_4 decreases in reconstructed diets and paleosols due to the exclusion of C_3 endmembers with low $\delta^{13}C$ values typically found in closed-canopy forests, however even this conservative approach results in diets and paleosols with non-zero fC_4 throughout the Early and Middle Miocene. Our results indicate that C_4 grasses were important parts of ecosystems in eastern Africa throughout the Miocene prior to the marked increase in abundance beginning at about 10 Ma, implying that local ecological feedbacks were dominant controls on C_4 plant emergence and proliferation compared to global drivers such as atmospheric CO_2 .

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Quantifying bone weathering using surface texture modeling

Franseth, Roya, Laker, Rachel M., Miller, Joshua H.

Geosciences, University of Cincinnati, Cincinnati, Ohio, United States

The amount of time recorded within fossil assemblages (i.e., “time-averaging”)

influences its species richness and many other fundamental characteristics, but our ability to assess time within fossil records, or compare time-averaging between records, is poorly developed. Bone weathering characteristics (e.g., “weathering stages”) are often used as a proxy for time-averaging, but semi-quantitative assessments of bone weathering can be challenging to keep consistent among researchers. Further, the relationship between bone weathering stages and weathering duration is nonlinear and inconsistent between environmental settings. To evaluate more quantitative and automated metrics for characterizing bone weathering, and to more fully quantify the relationship between weathering duration and taphonomic state, we evaluated how metrics of bone surface roughness change across >300 years of weathering in an Arctic setting. We also tested for differences between sky-facing and ground-facing sides of the weathering bone, which has been previously observed qualitatively. We evaluated these relationships using 47 radiocarbon-dated shed antlers of caribou (*Rangifer tarandus*) collected from the Arctic National Wildlife Refuge (Alaska) and Ivvavik National Park (Canada), all of which had been weathering on tundra surfaces for between 4 and ca. 327 years. We used a Keyence VR-6000 optical profilometer to generate high-resolution (40x to 120x) 3D models of each antler, from which we calculated ISO metrics of surface roughness (e.g., average roughness, Dale void volume). We found that surface roughness generally increases with weathering duration, but does so in a punctuated fashion, with periods of rapid (sub-decadal) change followed by stasis over multiple decades. This aligns with, and provides a more quantitative framework for, similar findings based on changes in bone weathering stage over time. Comparisons between sky-facing and ground-facing surfaces show that initial surface roughness can be broadly similar, but that sky-facing surfaces show significantly higher surface roughness after ca. 25 years of

Arctic weathering. Variance in surface roughness is also positively correlated with weathering duration. High-resolution surface roughness analyses are useful for quantitatively characterizing bone weathering. These methods have potential to provide new insights into fossil records and the time they represent.

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Mammal dispersal among tectonically active and quiescent regions of North America

Fraser, Danielle^{1,2}, Hunter-Moffatt, Blue²

¹Palaeobiology, Canadian Museum of Nature, Ottawa, Ontario, Canada, ²Earth Sciences, Carleton University, Ottawa, Ontario, Canada

In North America, biodiversity in the tectonically active, topographically complex west is nearly double that of the east. Such topographic gradients form via short-term ecological (e.g., climate filtering) and long-term macroevolutionary processes (e.g., speciation and extinction). On long timescales, species also move into and out of tectonically active and quiescent regions in response to climatic and ecosystem changes. In particular, topographically complex regions may act as both cradles and sources of biodiversity, donating species to adjacent regions. In a deep time, however, the direction and frequency of dispersals among topographically complex and less complex region remain poorly understood. We apply a historical biogeography approach to understanding patterns of large mammal (i.e., Artiodactyla, Perissodactyla, and Carnivora) dispersal between tectonically active and quiescent regions during the Miocene, a period of significant increase in tectonic activity, change in topographic complexity, and climate change in western North America. We downloaded Miocene and

Pliocene mammal occurrence data from the MIOMAP and FAUNMAP databases, taxa that occurred within at least one of five biogeographic regions (i.e., Southwest, Columbia Basin, Rocky Mountains, Great Plains, and Gulf Coast) between 30 – 2 Ma. We constructed a timescaled semiformal supertree at the species level based on published tree topologies and taxonomy. We then used the maximum likelihood approach in BioGeoBEARS to fit an array of biogeographic models (e.g., Dispersal–Extinction Cladogenesis (DEC), DEC+jump dispersal) and stochastic character mapping to infer the number of biotic interchange events. We show that the number of dispersal events varied considerably through time. Notably, dispersal was not consistently higher from one biogeographic region to the others. However, dispersal from the Great Plains to the Rocky Mountains dominated the middle Miocene, peaking between 14 – 12 Ma, the highest observed for the entire Miocene, and exceeded dispersals in the opposite direction from 20 – 10 Ma. Neither period of intensified dispersal coincides with the mid Miocene Climatic Optimum but may reflect ongoing intensification of tectonic activity. We hypothesize, based on regional climatic and paleovegetation records, that long-term variations in dispersal reflect the complexity of regional climatic and ecosystem change and do not necessarily reflect global-scale climatic changes.

Funding Sources NSERC RGPIN-2018-05305

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Stratigraphic revision of *Coahuilaceratops magnacuerna* as the first dinosaur from the Lower Maastrichtian Cerro Huerta Formation

Freedman Fowler, Elizabeth^{1,2}, Barrera Guevara, Daniela^{1,2}, Espinosa Chávez, Belinda³, Serrano Brañas, Claudia Inés^{3,4},

Posada Martinez, Daniel⁵, de León Dávila, Claudio⁶, Fowler, Denver²

¹Natural Sciences, Dickinson State University, Dickinson, North Dakota, United States, ²Badlands Dinosaur Museum, Dickinson, North Dakota, United States, ³Benemérita Escuela Normal de Coahuila, Saltillo, Coahuila, Mexico, ⁴National Museum of Natural History, Smithsonian Institution, Washington, District of Columbia, United States, ⁵Olga Moreno 396, Ignacio Zaragoza 3ra Amp, 25016, Saltillo, Coahuila, Mexico, ⁶Santa Engracia 257, Fraccionamiento Santa Elena, 25015, Saltillo, Coahuila, Mexico

The Difunta Group of the Parras Basin, Coahuila, Mexico, has provided a substantial proportion of the known fossil record from the Late Cretaceous of Southern North America, including a number of new taxa described within the past two decades. However, fundamental stratigraphic issues require resolution before these fossil assemblages can be properly compared and correlated. Although the basal Cerro del Pueblo Formation has been relatively well-sampled, formations overlying it remain poorly understood.

Chasmosaurines are a diverse group of ceratopsid dinosaurs in the Late Cretaceous formations of the U.S. and Canada, yet to date only one chasmosaurine has been described from Mexico: *Coahuilaceratops magnacuerna*, attributed to the upper Campanian Cerro del Pueblo Formation. To compare the preservation and stratigraphy of newly discovered chasmosaurine specimens in the Cerro del Pueblo Formation, we revisited the *Coahuilaceratops* locality whereupon it was discovered that distinctive red silt-dominated lithologies bound the bone bearing horizon, demonstrating that it actually occurs within the overlying Cerro Huerta Formation (Lower Maastrichtian). This younger age is consistent with the more derived phylogenetic position of

Coahuilaceratops, which exhibits a number of characteristics also seen in the Triceratopsini (more anterior nasal horn, relatively massive postorbital horns, retention later into ontogeny of raised bumps on the anterior midline parietal bar). These shared characters were unexpected if *Coahuilaceratops* had been from the older Cerro del Pueblo Formation, but the corrected placement in the younger Cerro Huerta Formation offers concordance between the stratigraphic and phylogenetic positions of these taxa. This supports the proposal that the final surviving clade of chasmosaurines, the Triceratopsini, may have originated in southern Laramidia - derived from a subpopulation of the *Pentaceratops*-lineage that became separated from a northern subpopulation (which would lead to *Regaliceratops* in the upper Maastrichtian).

Coahuilaceratops is therefore the first and only known dinosaur from the Cerro Huerta Formation and the youngest dinosaur from Mexico. The Cerro Huerta Formation holds great potential for important new fauna from the relatively poorly represented Lower Maastrichtian, possibly including already collected specimens that may have actually been recovered from the Cerro Huerta Formation but attributed to the Cerro del Pueblo Formation.

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

Methods for describing paleoecological change in the Late Cretaceous Oldman, Dinosaur Park, and Horseshoe Canyon Formations of Alberta, Canada

Freeman Peters, Galadriel¹, Stock, Jordan C.², Raun, Gorm S.², Morley, Nathaniel E.¹, Brinkman, Donald³, Leighton, Lindsey R.¹

¹Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ³Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

Vertebrate microfossil assemblages, called microsites, are useful paleoecological resources as they preserve high numbers of small (mm-cm scale) fossil elements, such as teeth or fish scales, that are otherwise uncommon in the fossil record. The inclusion of rarely preserved taxa makes microsites ideal for studying community paleoecology, however, few studies have quantitatively examined microsites for this purpose. There are competing arguments in the literature for how best to treat microvertebrate data, including using raw abundance, using presence/absence (p/a), or using relative abundance. In this study we use Non-metric Multidimensional Scaling (NMDS) ordinations to test which data treatment method best captures changes in communities through time. To facilitate this test, we used 38 microsite samples collected from the Oldman Formation (OF), Dinosaur Park Formation (DPF), and Horseshoe Canyon Formation (HSC), of the Late Cretaceous (Campanian-Maastrichtian) of Alberta, Canada. The DPF was split into three informal faunal assemblage zones, designated lower DPF, middle DPF, and upper DPF. These formations are well studied, and prior evidence supports a faunal change through these units at both macro- and microfossil scales. Given this, we expect that not only should an ordination capture these changes, but that the best data treatment will show the greatest differences between units. Kruskal-Wallis tests were used to determine if the differences between formations reported from the NMDS were significant. The ordination using raw abundance data showed differences between the formations, but it also showed artificial separation between sites based on the number of fossil elements

present at each locality. The ordination using p/a data was able to significantly differentiate ($p < 0.01$) the HSC from the others but was unable to differentiate between the OF and the three DPF subdivisions. Many of the taxa were present in both the OF and DPF, but had different abundances; using p/a data removed information that could potentially identify gradients between them. The ordination using relative data showed significant differences ($p < 0.01$) between all three formations, as well as differences between the lower DPF and middle DPF. From these results we conclude that relative abundance is the strongest of the tested methods for use in paleoecology studies. The broad applicability of these results should be investigated using microsite data from other localities.

Funding Sources Funding for this work is from an NSERC Discovery Grant (NSERC DG2021-02744) awarded to Leighton.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Population-level variation in osteohistology and growth trajectories in the therizinosaurian theropod *Falcarius utahensis*

Freimuth, William J.^{1,2}, Erickson, Gregory M.³, Zanno, Lindsay E.^{2,1}

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ³Department of Biological Science, Florida State University, Tallahassee, Florida, United States

High intraspecific variation in growth trajectories and developmental plasticity characterize crocodilians and the earliest non-avian dinosaurs, whereas extant birds exhibit comparatively lower variation and

channelized developmental trajectories. Recent work suggests variation and plasticity in growth were also present in later-branching non-avian theropods. Nevertheless, most histological samples from these taxa derive from variable stratigraphic and geographic locales, potentially conflating individual intraspecific variation in growth with climatic, environmental, or interspecific influences. The Crystal Geyser Quarry from the Early Cretaceous of Utah records a population-level mass death assemblage of the early therizinosaurian, *Falcarius utahensis*, offering a large, spatiotemporally constrained dataset to investigate ontogenetic dynamics and test hypotheses of individual developmental variation in this early maniraptoran.

Histologically eligible femora ($n = 22$) demonstrate a strong correlation between length (103–390+ mm) and midshaft circumference ($R^2 = 0.95$), allowing for longitudinal comparisons through a well-represented ontogenetic series. With increasing specimen size, there are general shifts from woven-fibered to parallel-fibered matrix, high-density reticular-plexiform to low-density laminar vascularity, and an increasing number of preserved cyclical growth marks (CGMs, e.g., Lines of Arrested Growth (LAGs)). Endosteal lamellar bone first appears in individuals ~67% of the maximum known femur length (FL) and multi-LAGs appear more frequently in individuals larger than ~74% of maximum FL. Although larger specimens exhibit features of slowed growth, an external fundamental system has not yet been observed in any sampled femora, indicating a predominantly skeletally immature age profile in the assemblage. Initial analyses of inter-CGM spacing hint at high variation in thicknesses of comparable growth zones, particularly in estimated years 3–6, akin to the developmental plasticity seen in other non-avian dinosaurs. Continued sampling of this important *F. utahensis* dataset will provide the means to further test hypotheses of individual variation in growth

patterns with potential physiological, paleobiological, and macroevolutionary implications.

Funding Sources This material is based upon work supported by the National Science Foundation award #1925973 to LEZ.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Morphometric diversity in early archosauromorph brains illuminates the origins of archosaurian sensory evolution

Freisem, Lisa S.¹, Sobral, Gabriela²

¹Department of Earth and Planetary Sciences, Yale University, New Haven, Connecticut, United States, ²Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany

As the only two living archosaurian lineages, crocodiles and birds evolved to occupy a diverse range of ecological niches and habitats and exhibit highly disparate dietary, social, and locomotor adaptations. Since their origin in the early Triassic, archosaurs have undergone major evolutionary radiations and adaptations to changing environments and climates, diversifying into a wide range of specialized body plans, including multiple radiations into aquatic and aerial environments. Alongside this disparification, they evolved a uniquely diverse suite of sensory adaptations, including relative enlargement of the forebrain and establishment of the avian wulst and elongation of the olfactory lobes in pseudosuchians. Avian sensory adaptations are directly linked with their increased cognitive ability and therefore pose as a key factor in their evolutionary success. However, relatively little is known about the evolutionary origins of archosaurian sensory and neurological diversity. As relative brain size and markedness of individual brain regions heavily correlate with reliance on

sensory organs and cognitive ability, brain morphology offers a unique window into sensory and neurological adaptations and behavioral patterns, providing valuable information on lifestyle in extant and extinct archosauromorphs. In this study, we explored the origins of the archosauromorph brain through a morphometric lens. For this, we created a dataset of archosauromorph brain endocasts and analyzed their morphological evolution through a 3D geometric morphometric approach. Preliminary results reveal strong morphological divergence between dinosaurs and non-dinosaurian archosauromorph endocasts while displaying a high degree of morphological conservation along the archosauromorph stem and throughout the crocodilian line. Dinosaurs are marked by a high degree of flexure along the brain axis and relatively shorter forebrains compared to pseudosuchians and early archosauromorphs. A strong dietary signal hints towards a direct correlation between brain morphology and dietary preferences, separating herbivorous from animalivorous taxa throughout all major archosauromorph clades. Our data align with previous hypotheses on the correlation between sensory and dietary adaptations and offer new insights into potential lifestyle and behaviors of early archosauromorphs, illuminating the history of the clade before the crocodile-bird divergence.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Interpreting stable isotope ratios of dinosaur tooth enamel: how to reduce ambiguities by considering results in a larger geochemical context

Fricke, Henry C.

Colorado College, Colorado Springs,
Colorado, United States

Carbon and oxygen isotope ratios of fossil tooth enamel have long been used to study the biology and behavior of ancient vertebrates. This utility stems from the fact that carbon in enamel is sourced from diet, and oxygen is sourced from drinking water. Application of isotopic methods to the study of dinosaurs, however, is complicated by the lack of modern analogs available for ground-truthing and a paucity of isotopic studies from environments commonly occupied by dinosaurs, in particular low-lying, seasonally-inundated floodplains. Therefore interpretations of isotopic data from dinosaur tooth enamel alone can be difficult to make. To overcome these limitations, it is necessary i) to measure isotope ratios of materials other than tooth enamel, in particular tooth dentine, paleosol carbonates and plant remains and ii) to compare isotopic between different locations. Doing so constrains how tooth enamel data can be interpreted, and has the additional benefit of placing dinosaurs in a broader ecological context.

As an example of this approach, carbon ($\delta^{13}\text{C}$) and oxygen ($\delta^{18}\text{O}$) isotope ratios were measured for hadrosaurid tooth enamel, tooth dentine, soil carbonates, and leaf wax alkanes from six fossil microsites in the Kaiparowits Formation (Late Cretaceous/Campanian, Utah, USA). One set of sites is characterized by higher average $\delta^{13}\text{C}$ of enamel (-6.5‰) of dentine (-2‰) and of soil carbonates (-7.9‰, when present), while another set of sites has lower average $\delta^{13}\text{C}$ of enamel (-8.7‰) of dentine (-7.4‰) and of soil carbonates (-9.6‰). $\delta^{13}\text{C}$ of alkanes are similar at all sites (average -30.3‰). Differences in $\delta^{13}\text{C}$ of dentine and soil carbonates can be interpreted as reflecting differences in soil processes, in particular production of soil gases via organic matter oxidation or methanogenesis. Differences in $\delta^{13}\text{C}$ of enamel provide evidence for niche partitioning among dinosaur populations at small spatial scales, while the uniformity in $\delta^{13}\text{C}$ of leaf wax

alkanes suggests these niches differ based on forest structure. Taken together, these isotopic data provide a more complete, and interesting, picture of ecosystems and environments of the Late Cretaceous than could be inferred from tooth enamel data alone.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Results of an extensive surface-scanning project of Idaho's Cretaceous fossil record

Fridel, Miriam C.¹, Peacock, Brandon R.¹, Krumenacker, L.J.^{1,2}, Gay, Robert J.¹

¹Idaho Museum of Natural History, Idaho State University, Pocatello, Idaho, United States, ²College of Eastern Idaho, Idaho Falls, Idaho, United States

The Albian-Cenomanian Wayan Formation, predominantly exposed in eastern Idaho (USA) preserves a unique upland assemblage, including: dinosaurs, crocodylians, turtles, mammals, and fishes, as well as gymnosperm and angiosperm remains. The Wayan Formation has been understudied compared to broadly contemporaneous units in surrounding states (i.e. Cloverly and Cedar Mountain formations). In 2024 the Idaho Museum of Natural History (IMNH) completed an ambitious program to digitize via surface laser scanning the Wayan Formation vertebrate record in order to provide digital specimen security during exhibit creation, create a comprehensive and accessible digital public collection, and create new education and outreach materials. The IMNH achieved these goals, and this project provides a roadmap for other institutions. There are two main steps for digitization; scanning the specimens, and processing the scans into 3D files for use. Specimens take

between 5 minutes and an hour to scan, depending on their complexity. Each object received a minimum of 18 scan passes, with more complicated shapes requiring additional passes. A medium-sized, geometrically-simple specimen would take approximately an hour and a half to fully scan and process: processing the raw scans includes trimming background data and aligning all the scan passes. This takes a minimum of 15 minutes; specimen alignment time varies by size (with large pieces usually aligning overnight). Processing a specimen into a manifold 3D object requires another minimum of 15 minutes.

In total, approximately 500 individual fossils were surface scanned between 2023 and early 2024. This represents all specimens suitable for surface scanning, >80% of Idaho's Cretaceous fossils at the IMNH, with >120 hours spent on scanning and post-processing. 25% of scanned specimens have been partially post-processed in alignment software, and 14% have been fully processed into manifold 3D objects suitable for upload to a database or 3D printing. 2% have been printed for use in education and outreach, with this number expected to reach over 10% by the start of 2025. As of May 2024, over 2,000 K-12 students in Idaho have interacted with these 3D prints, across 9 counties. Additionally, nearly 6,000 visitors have interacted with touchable Wayan 3D prints in the IMNH's gallery.

Funding Sources USFS 20-CS-11041563-031
Mod 1: Caribou-Targhee National Forest
Paleontological Resource Preservation

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

The *Miocyon* species complex and the first evolution of a large omnivore morphotype in carnivorous mammals

Friscia, Anthony¹, Poust, Ashley W.², Tomiya, Susumu³

¹Integrative Biology & Physiology, University of California, Los Angeles, Los Angeles, California, United States, ²Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska, United States, ³Center for International Collaboration and Advanced Studies in Primatology, Center for the Evolutionary Origins of Human Behavior, Kyoto University, Inuyama, Aichi, Japan

Miocyon is a carnivoramorph genus known from all major Uintan NALMA (middle Eocene) sites - the Uinta Basin in Utah (type sequence for the Uintan), southern California, and the Big Bend area of Texas, in addition to Bridgerian through Duchesnean sites in Wyoming and Saskatchewan. We review the relationship and synonymies between the four named species, *M. bathygnathus* (Wyoming), *M. scotti* (Utah), *M. vallisrubrae* (Utah), and *M. magnus* (Saskatchewan), and describe a new species, represented by multiple specimens, from southern California that provides new data to bear on this taxonomically thorny group. The genus is probably related to the Bridgerian *Uintacyon* and the various species show some provincialism across North America. Besides the taxonomy, the taxon is interesting ecologically. Aside from the mesonychids, whose diet is disputed, they are usually the largest carnivorous mammal in the faunas where they are found, and are the first carnivoramorph ("miacoid") to display post-carnassial teeth with a grinding morphology while retaining enhanced shearing function of the carnassial teeth and developing large body size. The genus gradually attained enlarged and flattened carnassial talonids and second molars on the lower teeth, anteroposteriorly longer upper molars, and anteroposteriorly shortened carnassials on the upper teeth. Both the grinding area and overall size increase through time in the group, from the Bridgerian

through the Duchesnean. The species of *Miocyon* seem to be the first carnivoramorphs to explore this ecomorphological niche of large omnivores, preceding the amphicyonids and ursids. All three of these groups appear early in North America, suggesting similar evolutionary drivers within the context of the Eocene–Oligocene environmental transitions on the continent that led to this more omnivorous morphology.

Funding Sources NSF- EAR 2011677

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The Miocene genus *Hemiauchenia* (Artiodactyla, Camelidae): a preliminary review suggests discrepancies across North America

Froehlich, Eleanor

University of Colorado, Boulder, Boulder, Colorado, United States

The genus *Hemiauchenia* appeared in North America during the Clarendonian (late Miocene) and survived into the latest Rancholabrean (late Pleistocene) and has been identified across North and South America. The genus is understood to be within the Tribe Lamini and is represented by at least seven species found from the Burge Member, Valentine Formation of Nebraska to the latest Pleistocene of Nevada. These species include the widely recognized *H. macrocephala*, and less common species including *H. guanajuatensis*, and *H. edensis*. However, due to the long history of the genus, described originally by Gervais and Ameghino in 1880, the genus and species contained therein have been synonymized multiple times. *Hemiauchenia* itself has in the past been referred to as *Auchenia*, *Holomeniscus*, some species of *Camelops*, and *Tanupolama*. Phylogenetic terminology

for genus *Hemiauchenia* in specific, and Cameldiae in general, is often not up to date, e.g. *Hemiauchenia vera* was recombined as *Pleiolama vera* in 2004 and is still commonly used. A literature review, aided by the Paleontological Database and the Global Biodiversity Information Facility, demonstrates over 200 published localities with specimens identified to the genus in North America alone that span 13 million years. However, there are discrepancies in the occurrence data that raise questions concerning our understanding of phylogeny and biogeography. These inconsistencies include but are not limited to: species being identified in the same period in Florida and California only, identification from a single premolar, e.g. *H. guanajuatensis*, and the same species being identified across North America for five million years. Patterns in the data suggest that there are biases in our understanding that result from who has studied the material, when it was collected, and where the specimens were collected. Recent work has also suggested that *Hemiauchenia*, along with other contemporary genera, may be polyphyletic. A complete review is necessary to establish what is known and collate all available information into a single source.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**Ontogenetic assessment from dorsal ribs
in a mature titanosaur (Dinosauria,
Sauropoda) from the Upper Cretaceous of
Texas**

Fronimos, John¹, N. Woodward, Holly²

¹Department of Geosciences, Auburn University, Auburn, Alabama, United States, ²Department of Anatomy and Cell Biology, Oklahoma State University – Center for Health Sciences, Tulsa, Oklahoma, United States

Sauropod dinosaurs are of particular interest to studies of growth rates and other life history traits due to their extreme body sizes. Osteohistology, though central to these efforts, is hindered by a poor record of annually formed lines of arrested growth (LAGs) in the sauropod appendicular skeleton due to rapid bone apposition and high rates of bone remodeling. Previous work on the basal macronarian *Camarasaurus* found that its dorsal ribs showed less remodeling than limb bones, preserving a more complete record of LAGs. No such rib data is available for titanosaurs, which include the largest known sauropods and which possess air-filled pneumatic chambers (camellae) in their ribs that may impact the growth record preserved. To assess the value of dorsal rib histology in titanosaurs, we sampled a partial specimen from the Upper Cretaceous of Texas, among the largest known from North America, which includes an almost complete set of dorsal ribs.

Sections of five middle to posterior dorsal ribs were prepared, all from near the proximal end of the shaft. Diagenetic alteration affected the primary bone more so than the remodeled tissue, but LAGs were still recognizable locally. Although sampled in similar locations, the titanosaur ribs differed from *Camarasaurus* in having extensive remodeling by secondary osteons and in the presence of camellae. Compact cortical bone showed multiple secondary osteon generations with primary tissue visible interstitially in places. The camellate bone trabeculae were lined by a lamellar endosteal layer that showed cyclical bone resorption and deposition, demonstrating that trabecular remodeling continued throughout ontogeny. This suggests that camellae could be reshaped throughout life, possibly in response to biomechanical loading. There was no indication of the fibrous pneumosteam noted in some other sauropods, but this may be a result of poor tissue preservation.

The rate and extent of bone remodeling and the conversion of compact bone into camellae make recovering growth records from titanosaur ribs challenging. The least remodeled element was a middle dorsal rib preserving 12 years of growth. Despite the individual's extreme size, an external fundamental system, which signifies cessation of growth, was observed only in one posterior dorsal rib. To explore the implications of this, studies are needed to determine whether skeletal maturity is achieved simultaneously throughout the sauropod axial and appendicular skeleton.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Life histories of latest Cretaceous mammals complicate placental exceptionalism

Funston, Gregory F.¹, Evans, David^{1,2}

¹Natural History, Royal Ontario Museum, Toronto, Ontario, Canada, ²Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada

Drastic differences in reproductive traits and maternal investment of extant mammals have spurred debate about whether life history played a role in the disparate survival and proliferation of mammals after the Cretaceous–Paleogene (K–Pg) extinction. Specifically, eutherian mammals (placental ancestors) reached greater abundance, diversity, and body sizes immediately after the K–Pg extinction, which has been argued to result from their longer gestation periods than other mammals like metatherians (marsupial ancestors) and multituberculates (now extinct). However, it is not clear whether latest Cretaceous representatives of extant clades exhibited similar life histories to those of today. Furthermore, recent work has challenged the idea that eutherians had

exceptional life histories, showing that multituberculates may also have reproduced like living placentals. Recent work has now shown that palaeohistological data from teeth might be able elucidate precise chronologies of early life in some ancient mammals, but the applicability of these techniques to Mesozoic mammals has not been demonstrated—to date, there has never been a study on daily dental growth lines in a Mesozoic mammal. Here we present preliminary results from the first investigation into the daily incremental growth of Mesozoic mammal teeth, including eutherians, metatherians, and multituberculates. Exquisite preservation of growth marks shows that the distinctive reproductive strategies of metatherians and eutherians had already diverged by the Late Cretaceous, and were similar to living representatives of these groups. Suspected neonatal lines in the eutherians and in the large multituberculate *Meniscoessus*, pending geochemical confirmation, indicate extended gestation periods and dental development schedules comparable to precocial placental mammals. Overall, comparative growth metrics reveal substantial variation in dental growth rates between metatherians, multituberculates, and eutherians, but also within these groups. Thus, some of the major differences in life history between these groups were likely to have existed prior to the K–Pg extinction, but members of these clades did not necessarily adhere to singular, stereotypical life histories. These findings complicate the role of life history in the post-Cretaceous rise of mammals, and they show that if any clade of Late Cretaceous mammals were exceptional in terms of reproduction, it was metatherians, not eutherians.

Funding Sources GFF is funded by NSERC and the Vanier–Banting Commission.

DCE is funded by NSERC [RGPIN 2018-06788]

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Paleoenvironmental reconstruction of the Late Miocene primate-bearing site of Can Llobateres (NE Iberian Peninsula) based on carbon and oxygen stable isotopes from herbivorous mammal teeth

G. Arranz, Sara¹, Misas-Alcántara, Marc¹, Comes, Pau², Kimura, Yuri⁴, Villanueva, Juan², Flynn, Lawrence J.³, Alba, David M.¹, Casanovas-Vilar, Isaac¹

¹Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Barcelona, Spain, ²Institute of Environmental Science and Technology, Autonomous University of Barcelona (ICTA-UAB), Barcelona, Spain, ³Geology and Paleontology, National Museum of Nature and Science, Tsukuba, Ibaraki, Japan, ⁴Human Evolutionary Biology, Harvard University, 11 Divinity Avenue, Cambridge, Massachusetts, United States

The Late Miocene (9.8 Ma) site of Can Llobateres 1 (CLL1; Vallès-Penedès Basin, NE Iberian Peninsula) represents one of the latest occurrences of fossil apes in Western mainland Europe, where they are last recorded at ~9.5 Ma. Therefore, the reconstruction of the paleoenvironment is highly significant for understanding the local extinction of European hominoids and other mammalian taxa during the Late Miocene. Here we analyze carbon and oxygen stable isotopes from tooth enamel of large and small herbivorous mammals from CLL1 to refine previous paleoenvironmental inferences about this site. We use carbon isotopes to infer paleodiets, and both carbon and oxygen isotopes to indirectly estimate paleoprecipitation and paleotemperature, respectively. Subsequently, we classify CLL1 using different biome schemes according to climate estimates and $\delta^{13}\text{C}_{\text{diet,meq}}$ (average modern equivalent of diet composition) values. Our results indicate that the diet of

CLL1 herbivores consisted exclusively of C3 plants, with $\delta^{13}\text{C}_{\text{diet,meq}}$ values ranging from –28.92 to –26.06, which respectively correspond to animals that feed in relatively closed canopy forests (more negative values) and mesic woodlands (less negative values). Within this mosaic environment, cricetid rodents appear to have inhabited the more closed environments, while macromammals would have ranged from closed canopy forests to more open mesic woodlands, with the small suid *Parachleuastchoerus crusafonti* showing the less negative $\delta^{13}\text{C}_{\text{diet,meq}}$ values. Mean annual precipitation estimates from $\delta^{13}\text{C}$ values (1406–1831 mm) indicate an even more humid environment than previous inferences based on dental ecometrics of large mammals. $\delta^{18}\text{O}$ values were used to estimate mean annual temperature but yielded too cold estimates. Therefore, we considered previous paleotemperature estimates to classify CLL1 according to Whittaker's biome scheme, which suggests a tropical seasonal forest. A biome attribution was also attempted considering $\delta^{13}\text{C}$ values only, which classified CLL1 as an evergreen warm mixed forest, in further agreement with previous inferences derived from fossil plants and mammals. Comparisons with the roughly coeval (10–9.8 Ma) primate-bearing site of Rudabánya II (Hungary) indicate very similar paleoenvironmental conditions. However, comparisons with extant great ape habitats evidence significant differences with Miocene ape environments from Europe, which appear to have been less forested and more seasonal.

Funding Sources R+D+I project PID2020-117289GB-I00 (AE), Generalitat de Catalunya/CERCA Programme, AGAUR (2022 SGR 00620), INVESTIGO 2022 (100027TC1, Next Generation EU) to S.G.A.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Whodunit? Partitioning of bone nutrients by Arctic rodents

Gaetano, Madison¹, Miller, Joshua H.¹, Wald, Eric², Druckenmiller, Patrick S.³

¹Geosciences, University of Cincinnati, Cincinnati, Ohio, United States, ²U.S Fish and Wildlife Service, Fairbanks, Alaska, United States, ³University of Alaska Museum of the North, Fairbanks, Alaska, United States

Skeletal bones and antlers laying on landscapes are frequently consumed by other animals, with preserved traces of these interactions providing important paleoecological data. Rodents are understood to rely on this resource to meet a variety of needs, including supplementing key minerals (calcium, phosphorus) and nutrients (fat), and as a surface to grind down ever-growing incisors. However, further nuance regarding species-specific reliance on bone nutrients is poorly understood. Using gnawing modifications on shed antlers of caribou (*Rangifer tarandus*) in tundra Coastal Plain and boreal forest settings of the Arctic National Wildlife Refuge, Alaska, we test how cooccurring species of wild rodents exploit bone nutrients in different environments. The Arctic Refuge is ideal for evaluating patterns of rodent bone modification because the boreal forest and Coastal Plain are home to compositionally distinct rodent communities but are geographically adjacent and climatically similar. Porcupines (*Erethizon dorsatum*), red squirrels (*Tamiasciurus hudsonicus*), marmots (*Marmota broweri*), beavers (*Castor canadensis*), and muskrats (*Ondatra zibethicus*), are restricted to the boreal forest while voles (*Microtus* spp.) lemmings (*Lemmus trimucronatus*, *Dicrostonyx groenlandicus*), and ground squirrels (*Urocitellus parryi*) may be found on both landscapes. To compare contributions of candidate rodent taxa to bone recycling, we evaluated gnawing on over 1,300 shed caribou antlers collected from standardized surveys, documenting occurrences of rodent

gnawing, relative intensity of gnawing, and furrow widths. To establish a reference dataset, we measured incisor widths of candidate species (~30 specimens each) from the National Museum of Natural History and partitioned those species into five classes of incisor size, which typically correspond to body mass (0.04 - 20 kg) of the 13 species. We then classified each set of antler rodent furrows into these size classes. Shed antlers were significantly more likely to be gnawed in the boreal forest (50%) versus the Coastal Plain (<3%). Despite lower abundances of larger-bodied species (porcupines and marmots), furrow sizes indicate that they are responsible for the bulk of bone consumption, particularly within boreal forests. Rodent bone consumption is often treated as a monolith, but the species composition of rodent communities plays an important role in bone mineral recycling and the loss of bones prior to long-term preservation.

Funding Sources Geological Society of America, Lewis and Clark Fund, American Society of Mammologists, UC Office of Research, UC Graduate Student Government, UC Sigma Xi

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Ecomorphologic trends in North American mammals across the Oligocene-Miocene boundary

Gallucci, John

Geology and Geological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, United States

The Oligocene to Miocene transition was a time period of climatic, floral, and faunal change. Based on stable isotope and paleosol analysis, the North American climate became cooler and drier throughout

the Oligocene, especially in the interior of the continent. This shift in climate coincided with an increase in the abundance of grass and a gradual reduction in forested environments in central North America, as evidenced by phytolith assemblages. By the end of the Oligocene, multiple groups of large North American carnivores had gone extinct, including several species of the Nimravidae and Hyaenodontidae. These taxa were replaced by members of the Amphicyonidae (e.g., *Daphoenodon*, *Cynelos*). New herbivorous mammals also appeared in North America during this time, such as the Antilocapridae, while other families (e.g., Equidae and Camelidae) diversified during the early Miocene. Here, I analyzed the mesowear (molar cusp sharpness and relief) and hypsodonty (crown height) of herbivores to assess dietary changes across the Oligocene/Miocene boundary. I also compared calcaneal gear ratios of fossil artiodactyls for to those of extant taxa with known habitat preference. In order to determine locomotor mode, I examined calcaneal gear ratios and limb proportions (humeroradial and femorotibial ratios) in extinct carnivores. The data used in this study was collected from fossil specimens of the Oligocene-aged Brule, Sharps, Gering, and Monroe Creek formations, and Miocene-aged Harrison, Marsland, Runningwater, and Sheep Creek formations. Mesowear and hypsodonty analysis indicated a shift towards taller molar crowns and a higher degree of mesowear later in geologic time. Calcaneal gear ratios showed a slight decrease from the Oligocene to early Miocene in herbivores, while carnivore gear ratios remained stable, with a few notable outlier taxa (e.g., *Hyaenodon* for Oligocene carnivores, *Amphicyon* for Miocene carnivores). Carnivore limb ratios, on the other hand, showed no clear trend through time, with most taxa exhibiting limb proportions more similar to those of modern ambush predators than to those of cursorial pursuit predators.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Exploring patterns of modularity and integration in the mandible of terrestrial artiodactyls

Garcia-Lara, Sergio L., Tseng, Z. Jack

Integrative Biology, University of California, Berkeley, California, United States

The mammalian mandible is sometimes considered an anatomically homogeneous and relatively simple structure compared to the mandibles of other vertebrates and other complex skeletal regions such as the cranium. Accompanying this anatomical simplicity is the principal function of the mandible in feeding, whereas the cranium performs multiple functions such as storage and protection of the sensory organs. Nevertheless, mandibular regions originate from different embryological germs that eventually fuse into one structure. Studies in mice, canids, and South American Native ungulates have shown that even in adult individuals it is possible to recognize at least two putative mandibular modules: the ascending ramus and the mandibular corpus. The results in those groups varied from a strong integration between those regions to a modular pattern. Artiodactyla is one of the most taxonomically and ecologically diverse groups of mammals. Hence, we hypothesized that different intensities of integration will be observed between the two aforementioned regions through different artiodactyls clades. To test this hypothesis, we performed an integration analysis using PLS and CR values to measure integration and modularity in a sample that includes most of the artiodactyl clades: Ruminantiamorpha, Camelidomorpha, and Suinamorpha. Preliminary results show that the mandible of artiodactyls, despite its high taxonomic diversity, is more integrated than modular. As this result is widely shared by most of the

artiodactyl clades, it is suggested that this trait evolved from the common ancestor of artiodactyls and that a constraint prevents the modular evolution of mandibles. However, possible nuances in the level of integration are expected as more data is collected and analyzed to confirm this pattern and support this interpretation.

Funding Sources Funding for this work was received from CONAHCYT grant of the first author to pursue a PhD

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

The costs of bipedal locomotion through time in hominins

Gardner, Jacob¹, Humphries, Stuart², Ruxton, Graeme³, Venditti, Chris¹

¹University of Reading, Reading, United Kingdom, ²University of Lincoln, Lincoln, United Kingdom, ³University of St. Andrews, St. Andrews, United Kingdom

Bipedal locomotion is a cornerstone of hominin evolution and is hypothesised to have contributed to the evolution of large brains and stone-tool use. Elongated hindlimbs and specialisations in the feet and hips of later *Homo* are considered adaptations to minimise further the costs of long-distance endurance running. Many studies have used a variety of approaches for estimating the costs of walking and running in select hominin species; however, it remains untested whether there was a general trend through time to minimise locomotor costs. Such a trend would be consistent with persistent selection pressures to reduce the costs of a new advantageous mode of locomotion. Here, we apply Bayesian phylogenetic comparative methods to biophysical models of bipedal walking and synthesise estimates on locomotor costs with morphological characters commonly

linked to efficient bipedal movement. We leverage data from over 450 hominoid fossils to make phylogenetically informed predictions about hindlimb length, stature, and body mass, from which we estimate variation in the mechanical and metabolic costs of walking for 25 hominoid species. Hindlimb length strongly predicts mass-specific locomotor costs across terrestrial animals. When available, we also collected data on the presence of characters linked to efficient bipedal locomotion, such as larger articular surfaces in the knee, shorter pedal phalanges, and a rigid plantar arch in the foot. We then used a Bayesian phylogenetic generalised linear mixed model to test for a general trend in hindlimb length, stature, body mass, and the mechanical and metabolic costs of walking through time. Our model accounts for the uncertainties in our morphological predictions, fossil age ranges, taxonomic assignments of specimens, and phylogenetic topology. We also test for trends in locomotor costs and associated traits within species, such as in the long-persisting and wide-ranging *Homo erectus*, and examine potential deviations from an overall trend. For example, species like *Homo floresiensis* exhibited increased estimated locomotor costs relative to other late-occurring *Homo* due in large part to its shorter hindlimbs. Future analyses will test for an association between locomotor costs, brain size evolution, and palaeoenvironmental change. Our study sets a benchmark for future studies on biomechanical evolution that applies to many terrestrial vertebrate clades.

Funding Sources This work was funded by a Leverhulme Trust Research Leadership Award (RL-2019-012).

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A myriad of maladies: costal, vertebral, appendicular, and severe cranial pathologies in a large individual of *Gorgosaurus* (Theropoda: Tyrannosauridae) from the Upper Cretaceous Dinosaur Park Formation of Alberta, Canada

Garros, Christiana W.¹, Voris, Jared T.², Sharpe, Henry S.¹, Therrien, François³

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Earth, Energy, and Environment, University of Calgary, Calgary, Alberta, Canada, ³Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

Paleopathologies provide unique insights into both the healing processes and individual life histories of extinct taxa. Pathologies are well-studied in tyrannosaurids due to their popularity and the abundance of well-preserved skeletal material exhibiting evidence of injuries. A large specimen of the well-known tyrannosaurid *Gorgosaurus*, TMP1994.12.602, exhibits numerous pathologies throughout its skeleton. Four ribs bear fracture calluses: two have a smooth appearance characteristic of normal healing, but two ribs from the right side of the animal have coarser calluses that contain drainage sinuses indicative of post-traumatic osteomyelitis. Two caudal vertebrae and the right metatarsus show exostoses, suggestive of repeated stress from tendon or ligament activity (enthesophytes). The right fibula is severely altered by a large, smooth fracture callus, exhibiting abnormal, dendritic medial bone structure. On the skull, the maxillae and right dentary have several healed bite marks but more noteworthy and unusual is the near-total removal of the left half of the nuchal crest, where the presence of jagged reactive bone shows early stages of healing. This injury removed the insertion sites for the left M. splenius capitis and M. transversospinalis capitis groups, possibly precluding proper neutral head posture. Some insertion areas for the left M. adductor mandibulae group

were also removed and a lip of reactive bone present on the left side of the sagittal crest is interpreted as a compensatory byproduct of resulting strain. Though the exact cause of the trauma remains unknown, a groove situated below the break on the posterior nuchal crest resembles a large tooth drag. This suggests the trauma may have been caused by a bite to the back of the skull by another tyrannosaurid. Bite-related traumas in Tyrannosauridae are common on the snout but less frequent in the skull roof/braincase region; this could be attributed to a true rarity of such injuries or to a low survivorship rate for violent trauma in this region of the skull. The appearance of the reactive bone on the braincase indicates this trauma occurred closer to the time of death of this individual than the other pathologies, but whether it contributed to its death is uncertain. Regardless, the myriad of maladies on this *Gorgosaurus* illustrates the dangerous lives led by these large predators, and their physiological capacity to withstand them.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Bringing paleontology citizen science into higher education

Gates, Terry A.¹, Hurlbert, Allen³, Vance-Chalcraft, Heather²

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Biology, University of North Carolina at Chapel Hill, Chapel Hill, North Carolina, United States, ³Biology, East Carolina University, Greenville, North Carolina, United States

Over the past twenty years, scientific fields such as astronomy, climatology, and especially ecology, have invested heavily in citizen science. Researchers have capitalized on the public's inherent interest in science by bringing them into the investigation process

through different levels of participation, such as contributing data at one end of the involvement spectrum to taking part in the analysis and even publication of results at the opposite side of the spectrum. Vertebrate paleontology has lagged in the adoption of citizen science, but several have developed in the last decade including Shark Tooth Forensics, Cretaceous Creatures, and paleo-Bio Blitzes. Due to the increase in popularity of citizen science and its rising incorporation into K12 education, the NSF-funded Undergraduate Experiences in Citizen Science (USE Cit Sci) research collaboration network was created to facilitate the application of citizen science in higher education pedagogy. The USE Cit Sci network provides pedagogical tools (e.g., lesson plans and assessments) and pedagogical training for higher education faculty. USE Cit Sci also brings together project managers and instructors to make datasets easier to access for class projects or labs. Faculty members wishing to bring citizen science into their curriculum can take advantage of the open-access lesson plans, webinars, and experienced network members. As an example, the citizen science project Shark Tooth Forensics, a project designed to research the ecology of ancient sharks from paleoecological examination of fossil tooth assemblages, is being integrated into undergraduate ecology labs. We show that students collect size data on shark teeth to the same statistical accuracy as trained lab staff, meaning that college and university students can discover fossils, collect quantitative data, perform statistical analyses, and even test paleoecological hypotheses in the classroom using actual fossil data that will contribute to paleontology. Citizen science can also expand the reach of paleontology to small institutions that may not have access to fossil specimens.

Funding Sources National Science Foundation RCN-UBE 2120459

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Assessing educational outcomes with single-interaction outreach: towards a natural history outreach evaluation model

Gay, Robert J., Barclay, Daniel, Fogelsong, Anne S.

Idaho state University, Pocatello, Idaho,
United States

Evaluating educational outcomes is commonplace in formal educational settings, and many tools and methodologies exist to do just that. Assessing outcomes in informal educational settings is much more difficult. Instruments, such as pre- and post-assessments, are often ineffective or not suitable for events where participants may only be interacting for less than ten minutes. Evaluation rubrics based on subject material are similarly limited as members of the public will not have consistent background knowledge (unlike a classroom setting). Any assessment designed around specific knowledge will be biased towards members of the public who are already familiar with the topic. If the goal of paleontology outreach is to provide information about the vast history of life on Earth, its scientific importance, and why it should be conserved it is vital that we reach members of the public least predisposed or knowledgeable about our fields.

At the Idaho Museum of Natural History (IMNH), the Education Department has begun implementing program evaluations based on guide and participant behavior, anchored in Bloom's Taxonomy of Learning and best teaching practices. This allows program educational outcomes to be evaluated independent of content matter and independent of participant interaction time. The evaluation instrument is a rubric consisting of two educator behavior

performance criteria and two participant behavior performance criteria. Each of these is assessed on a one-to-five scale. Educators are assessed on both their student-centered educational behavior and how much they foster independent investigation of the topic. Participants are assessed on the rigor of the questions they ask, as measured on Bloom's Taxonomy, and their ability to retain and link multiple pieces of information as presented by the educators.

Since the inception of full-scale evaluation by the IMNH in January of 2024, 36 evaluations have been completed on gallery tours and outreach events. These ranged from 10 minute tabling interactions to multi-day camps. Across all months, the average program quality was 76%. Initial evaluations were likely too high, owing to educators still learning how to use the assessment; this is also reflected in the low (<34%) evaluation completion rate in February. After training, completion of evaluations have climbed to above 70% and program ratings have improved by 5.5% as educators have used evaluations to improve how programs are delivered.

Funding Sources Idaho Museum of Natural History

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

A leatherback marine turtle (*Chelonioida*, *Dermochelyidae*) from the Lower Oligocene of the Gulf Coastal Plain of North America

Gentry, Andrew Douglas¹, Burns, Michael⁴, Ebersole, Jun³, Gregson, Kimberly¹, Parham, James²

¹Biology, Alabama School of Mathematics and Science, Mobile, Alabama, United States, ²Biology, Jacksonville State University, Jacksonville, Alabama, United

States, ³Collections and Research, McWane Science Center, Birmingham, Alabama, United States, ⁴Geological Sciences, California State University, Fullerton, Fullerton, California, United States

Leatherback sea turtles (*Dermochelyidae*) have only a single extant representative (*Dermochelys coriacea*) but a rich fossil record extending back to at least the Paleocene. *Dermochelyid* fossils have been reported from every continent, including Antarctica, though many of these specimens consist of disarticulated or isolated fragments. This scenario often results in equivocal taxonomic assignments based on poorly defined diagnostic characters. Here we report a largely intact *dermochelyid* carapace recovered from the Lower Oligocene (Rupelian) Glendon Limestone Member of the Byram Formation in Monroe County, Alabama. This specimen represents the first Oligocene *dermochelyid* reported from Alabama and by far the most complete fossil *dermochelyid* described from the Gulf Coastal Plain of North America. The carapace is approximately 120 cm in length and consists of the typical mosaic of irregularly shaped ossicles characteristic of *dermochelyids*. The fossil is similar to *Natemys* based on the absence of keels or ridges on the dorsal surface of the carapace and the repeated occurrence of a carapacial floricorn pattern comprised of a large, central ossicle with scalloped edges surrounded by a ring of smaller, elongate ossicles. This specimen provides an opportunity to test the validity of diagnostic characters proposed for previously described fossil leatherback specimens and enables more in-depth investigations into Oligocene *dermochelyid* osteology, histology, and taxonomy than have previously been possible.

Funding Sources Dauphin Island Sea Lab, The Explorers Club, ASMS Parent Council, National Oceanographic and Atmospheric Administration, and McWane Science Center

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

New squamate faunas from the late Paleocene and early Eocene of France reveal fascinating patterns of endemism, dispersals, and extinctions

Georgalis, Georgios¹, Mennecart, Bastien²

¹Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Krakow, Krakow, Poland, ²Naturhistorisches Museum Basel, Basel, Switzerland

During the Paleocene and early Eocene, Europe was inhabited by an array of vertebrate taxa, including many enigmatic forms. As a matter of fact, many studies have focused on mammal, bird, turtle, and crocodile faunas from this time interval of Europe, however, our knowledge of coeval squamates from the continent is relatively scarce, limited to material from a few localities. Notably, this time interval coincides with a drastically different palaeogeography of Europe, which is mostly an archipelago of islands, as well as major climatic events, such as the Paleocene–Eocene Thermal Maximum (PETM) and the Early Eocene Climatic Optimum (EECO), which tremendously shaped the evolution and diversity of vertebrate biotas. Our detailed survey at the collections of the Naturhistorisches Museum Basel has revealed a plethora of undescribed fossil specimens of squamates, originating from different late Paleocene (Cernay [MP 6] and Berru [MP 6]) and early Eocene (Pourcy [MP 7], Avenay [MP 8+9], Sezanne [MP 8+9], Condé-en-Brie [MP 8+9], Mancy [MP 10], and Cuis [MP 10]) localities east of Paris, France. Overall, a high diversity is documented. The two Paleocene localities reveal abundant new material of the bizarre lacertoid *Camptognathosaurus*, as well as lacertids, the scincoid *Berruva*, glyptosaurids, palaeovaranids, other enigmatic lizard forms,

and two snake taxa. The early Eocene localities are more diverse, comprising of amphisbaenians, the agamid *Tinosaurus*, iguanids, glyptosaurids, palaeovaranids, plus several other lizard and snake forms. Snakes are indeed diverse in these early Eocene localities, comprising remains of *Palaeophis*, *Dunnophis*, *Russellophis*, “*Calamagras*” *gallicus*, and at least four constrictors. Among the latter, notable is the presence in Cuis of a new species of the North American *Cheilophis*, documenting the first occurrence of this genus from Europe. The abundant new remains offer unique insights into the evolution, anatomical features, and taxonomic diversity of early Paleogene squamate faunas from Europe, further offering interesting implications about extinction events, endemism, and dispersals among different continents.

Funding Sources GLG acknowledges funding from the research project no. 2023/49/B/ST10/02631 financed by the National Science Center of Poland (Narodowe Centrum Nauki).

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Vertebral injuries of *Eremotherium laurillardi* revealed by the use of CT scans in paleopathological analysis

Germano, Rodrigo¹, Cabral Ribeiro Carvalho, Lyvia², Barbosa Amaral, Camila², Rodrigues, Taissa¹

¹Biology, Federal University of Espírito Santo, Vitória, Espírito Santo, Brazil, ²Universidade Federal Fluminense, Rio de Janeiro, Brazil

Among the Pleistocene megafauna mammals, *Eremotherium laurillardi* is known as the Pan-American giant ground sloth, with several known fossils found in the Americas. It was a quadruped but could assume a

bipedal posture by using the tail as a support for its heavy body, whose estimated mass ranges between 1,718-2,361 kg and that could reach up to 4 m in height. It is expected that an animal of this size would have chronic articular lesions, besides occasional traumatic and infectious injuries. We analyzed macroscopically 990 vertebrae of *E. laurillardii* found in caves from northeastern Brazil to search for pathologies. 34 vertebrae were identified as pathological, and ten of them were CT-scanned: 4 cervicals, 1 thoracic, 1 lumbar, and 4 caudals. In six of them, the articular surface of the vertebral body had several irregular erosion pits with cortical loss and bone proliferation on its margins. These features indicate discospondylitis, which is caused by infection of the articular disk and its adjacent vertebral body articular surfaces. In one of these vertebrae, CT images showed a large, well-defined cyst without cortical lining, deep inside the vertebral body, with a fistula opening to the outside of the articular surface. One atlas had erosion pits only in its right wing, with cortical loss but no density change, without extending much inside the bone. We speculate that a one-sided inflammation of a muscle insertion or tendinitis may have triggered this lesion. In one cervical vertebra, its transverse process presented thickened cortical bone without cortical loss, interpreted here as an unspecific degenerative process. One isolated neural arch of a thoracic vertebra presented what appeared to be a tendon ossification. Lastly, one caudal vertebra had an atypical and elongated bone growth from the base of the left transverse process through the ventral margin of the articular surface of the vertebral body. Inflammatory diseases can be recognized through bone loss and cortical destruction, while bone proliferation indicated worsening or a prolonged chronic lesion. CT scans allowed to differentiate cortical and cancellous bone, to identify their rupture or continuity, and to identify intra-vertebral lesions. It revealed

lesions not visible macroscopically, enhancing diagnostic accuracy and enabling a more in-depth diagnosis of previously misinterpreted conditions, highlighting their importance in paleopathological studies.

Funding Sources CAPES (finance code 001) and FAPES/CNPq (grant 509/2020)

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Probability distribution and palaeoecological preference of cave lions (*Panthera spelaea*) in Europe during MIS5-3

Ghezzi, Elena¹, Cooper, David², Marciszak, Adrian³, Zomer, Robert⁴, Kitchener, Andrew C.², Malavasi, Stefano¹, Trabucco, Antonio⁴, Davis, Edward B.⁵

¹Environmental Science, Informatics, and Statistics, Ca' Foscari University of Venice, Venice, Venice, Italy, ²Department of Natural Sciences, National Museum Scotland, Edinburgh, United Kingdom, ³Department of Paleozoology, University of Wrocław, Wrocław, Poland, ⁴Impacts on Agriculture, Forests and Ecosystem Services, 4Euro-Mediterranean Centre on Climate Change, Sassari, Sassari, Italy, ⁵Department of Earth Science, University of Oregon, Eugene, Oregon, United States

The cave lion, *Panthera spelaea*, is one of the most iconic Eurasian species of the Late Pleistocene. Skeletal remains of this species are well represented in the fossil record and depicted in cave paintings and artefacts. Additionally, genetic analyses revealed the evolutionary relationships of extinct and extant populations of all lions. However, the species' climatic constraints and information regarding the environments inhabited by the species compared to modern lions remain unknown.

In our analysis, we focused on European cave lions from the Late Pleistocene period (MIS 5-

3). We carefully selected sites where lion remains have been directly radiocarbon dated or where localities have a fixed chronology within the specified timeframe, resulting in a final dataset of about 100 European sites. By correlating the species' occurrences and its maximum entropy probability distribution, with the 19 estimated raster maps available from the PaleoClim project, which provides climatic variables estimated for past ages, along with a rectified world digital elevation model in R, we calculated the climatic constraints for the lion population in Europe. Furthermore, we inferred environmental strata and zones (EnZ) matching the lion's distribution.

Cave lions showed a preference for “cold and wet” and “cold temperate and moist” EnZ, with a strong preference for the latter, mainly occupying the central European lowlands.

Funding Sources This project has received funding from the European Union's Horizon 2020, under the Marie Skłodowska-Curie Action, Global Fellowship (E.G. grant n. 785821)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Preliminary identification of fish species within the Late Cretaceous Coleraine Formation of Minnesota's Mesabi Iron Range

Gibson, Sarah Z.¹, Westgaard, John G.², Hanks, H. D.²

¹Atmospheric and Hydrologic Sciences, Saint Cloud State University, Saint Cloud, Minnesota, United States, ²Minnesota Discovery Center, Chisolm, Mississippi, United States

Extremely high sea levels in the Late Cretaceous offered vast new habitats for expansion and diversification among all types of fishes (e.g., those with bony skeletons as

well as cartilaginous fishes like sharks and rays). Fishes of the global seas of the Late Cretaceous display a rich and diverse selection of species, with much of this unique diversity in North America represented in the well-studied open ocean deposits of the Western Interior Seaway (WIS) in places such as Kansas and Nebraska. Fewer fishes have been recovered on the near-shore deposits of the WIS. Herein we describe new discoveries of bony fishes from the Cretaceous Coleraine Formation of northern Minnesota's Mesabi Iron Range. These remains consist mostly of isolated vertebrae and teeth. Occasionally, fish scales can be found within the matrix, though they are typically fragmented. The largest of these have been up to 1.5 inches (4cm) across, with many much smaller. Scale samples from *Lepisosteiformes* remain the only identified scale material. The vertebrae recovered from the Coleraine Formation range in size from 1mm to 6cm in diameter. The length of each vertebra is typically shorter than its circular diameter. They are concave on both the front and back surfaces, and exhibit openings or hollowed supports along the “outside” surface. The largest collected specimen is a caudal vertebra of an *Ichthyodectes* sp., (Teleostei: *Ichthyodectiformes*). The specimen is unique in that its length (7cm) is greater than its diameter (5cm). Fish teeth preserved in the Coleraine Formation are usually slender and exhibit a slight curve or recurve in their length. They are difficult to distinguish from some of the marine reptile specimens recovered from the same localities. An example of a crushing palette tooth, resembling the pharyngeal teeth seen in modern drumfish, has been recovered. This rounded and stubby tooth morphotype is currently undergoing examination. While few individual species, like *Ichthyodectes* or gar, can be selectively described from the Coleraine Formation fossil record, more as yet unknown or unidentified species are likely contained in the collection. The range of vertebrae alone should indicate a wider

variety of species that includes many smaller-sized feeder fishes similar to herring.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Live long and prosper: exploring the life histories of Australia's Early Cretaceous polar mammals using synchrotron X-ray cementochronology

Gill, Pamela G.¹, Newham, Elis², Rowe, Andre J.¹, Morales-Garcia, Nuria M.¹, Pollock, Tahlia¹, Dollman, Kathleen³, Rich, Thomas⁴, Vickers Rich, Pat⁵, Ziegler, Tim⁴, Rayfield, Emily¹

¹Earth Sciences, University of Bristol, Bristol, United Kingdom, ²School of Engineering and Material Science, Queen Mary London, London, United Kingdom, ³Structure of Materials, ESRF, Grenoble, France, ⁴Museums Victoria, Melbourne, Victoria, Australia, ⁵Monash University, Melbourne, Victoria, Australia

Excavations in Victoria, Australia, have produced rare Early Cretaceous mammals, predominantly dentaries of *Teinolophos*, *Bishops* and *Ausktribosphenos*, from the uppermost Barremian Flat Rocks site.

Analysis of the dentition places *Teinolophos* within the Monotremata, and the other two taxa within Tribosphenida. During the Early Cretaceous, south-eastern Australia lay within the Antarctic Circle, at about 70 degrees of latitude, with three months of darkness and relatively low mean annual temperatures, so the life histories of these small Early Cretaceous mammals are of particular interest. Although the dentary specimens are often incomplete and cracked, propagation phase contrast X-ray synchrotron micro-computed tomography (PPC-SRμCT) scans reveal well preserved histological detail of the bone and tooth tissues. These tissues include dental

cementum, a continuously growing dental tissue forming circum-annual annuli around the root, from which an individual's age at death can be assessed. Our previous studies used cementum to estimate maximum longevity, growth rates and growth patterns in mammaliaform taxa across the Jurassic, in-turn allowing us to interpret aspects of their physiology. We are applying these techniques to the Early Cretaceous Victoria mammals and have SRCT scanned 27 dentary specimens for cementum data of all the individual tooth roots. We find a lifespan of six years for *Bishops*, which is exceptionally long-lived compared to extant mammals of similar size, such as the Arctic shrew. Mass-specific cementum growth rates in *Bishops* are also significantly slower than extant small-bodied extant mammals, instead correlating with other Mesozoic crown mammals sampled. Cementum growth patterns in *Bishops* also correlate with other Mesozoic crown mammals, with a delayed point of growth rate reduction when compared to extant small-bodied mammals, which show significant growth rate reduction at the advent of somatic maturity in their first two years of life (following mammalian “determinate growth” patterns). Examples of extended wild lifespans in extant small-bodied terrestrial mammals are often the product of hibernation and/or torpor, allowing relatively flexible metabolic output and a slower life history. Alongside a protracted, slower life history as found for earlier Mesozoic mammaliaforms, we suggest that hibernation may have played a factor in these southern polar taxa, resulting in slower growth through a portion of each year-of-life.

Funding Sources Funding for this work was received from UKRI/NERC funded NE/X001504/1; European Synchrotron Radiation Facility, France, ES-1447; Diamond Light Source, UK, MG31897.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A morphological assessment of Paleocene champsosaurs from North Dakota, USA

Glass, Abigail M., Boyd, Clint A.

North Dakota Geological Survey, Bismarck,
North Dakota, United States

Champsosaurus is part of an extinct lineage of freshwater reptiles known as the Choristodera: a clade of uncertain phylogenetic placement. The *Champsosaurus* lineage ranges from Late Cretaceous through Paleocene, surviving the K-Pg mass extinction. Within the Paleocene Fort Union Group of North Dakota, two species of *Champsosaurus* are currently recognized: *C. gigas* and *C. tenuis*. However, current diagnoses for those species are insufficient for properly evaluating the taxonomic affinities of additional specimens, as they consist largely of qualitative statements that are difficult to interpret and/or assess. To address that issue, we examined the morphology of *Champsosaurus* specimens within the collections of the North Dakota Geological Survey (NDGS) and the Science Museum of Minnesota (SMM), including the holotypes of *C. gigas* and *C. tenuis*. We were able to affirm the validity of both of those species and confirm the prior referral of a nearly complete skeleton to *C. gigas* (SMM P77.33.24), which provides a wealth of morphological data not preserved in the fragmentary holotype. Additionally, we identified a contemporaneous specimen (NDGS 16076): a nearly complete skeleton from the Sentinel Butte Formation of North Dakota. NDGS 16076 is diagnosably distinct from *C. tenuis* by its proportionally shorter rostrum, wider shoulder girdle, and clavicle that is long and flat anteriorly; and *C. gigas* by its non-bifurcated occipital condyle, nearly horizontal basal tubera in occipital view, flat and rounded infraglenoid process on the coracoid, and anteroposteriorly expanded

articulation surfaces on the sacral ribs. To assess the systematic relationships of these three taxa, we added NDGS 16076, SMM P77.33.24, and the holotypes of *C. gigas* and *C. tenuis* to an existing choristoderan dataset. Preliminary analysis of that dataset recovers these four specimens within an unresolved polytomy that is the sister taxon to a clade containing the Cretaceous species of *Champsosaurus*. The lack of resolution between these Paleocene specimens reflects the need for additional characters focused on observed variation within *Champsosaurus* to be added to existing datasets, especially postcranial characters. Thus, the historical trend of referring specimens of *Champsosaurus* from the Paleocene to *C. gigas* based on large body size alone, and not shared apomorphies, may be impeding our understanding of the diversity and distribution of *Champsosaurus* species during the Paleocene.

Funding Sources United States Forest Service

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Associations between mammal and plant communities in the Plio-Pleistocene of the Omo-Turkana Basin and their evolution through time

Glöggl, Jeremias^{2,1}, Muriuki, Rebecca M.^{2,1}, Parker, Abigail K.¹, Burgas Riera, Daniel⁷, Saarinen, Juha², Cabeza Jaimejuan, Mar^{5,6}, Kinyanjui, Rahab^{3,4}, Zliobaite, Indre^{1,2}

¹Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland, ²Department of Computer Science, University of Helsinki, Helsinki, Finland, ³Department of Biological and Environmental Science, University of Jyväskylä, Jyväskylä, Finland, ⁴Organismal and Evolutionary Biology Research Programme, Helsinki, Finland, ⁵Helsinki

Institute of Sustainability Science (HELSUS), University of Helsinki, Helsinki, Finland, ⁶Department of Earth Sciences, National Museums of Kenya, Nairobi, Kenya, ⁷Paleobotany Research Group, Department of Archaeology, Max Planck Institute of Geoanthropology, Jena, Germany

We predict past and future ecological processes based on inferences from current ecosystems, applying certain association rules to link ecological components. For instance, functional morphological traits in animals are assumed to be associated with the climate and vegetation of the host ecosystem. Then, using uniformitarian deduction, we can infer characteristics of past ecosystems from present-day associations identified in ecometric models. Our study investigates functional relationships between mammal communities and their paleoenvironments and their potential change over geological time. The Omo-Turkana Basin in East Africa is a well-studied region of immense paleoanthropological, paleontological, and geological interest. The environments in the basin have varied considerably over its geological history. These environmental changes have been linked to major changes in faunal composition through migration and speciation. Despite the plethora of data available, no uniformly synthesized account of all known mammalian fossils and their localities existed previous to this work. We present a revision and compilation of localities, species occurrences, and morphological traits of the mammal record from the Plio-Pleistocene Omo Group in the northern Omo-Turkana Basin, which is based on the comprehensive NOW Database of Fossil Mammals and supplied by literature reviews. We use these data for ecometric analyses of morphological traits including hypsodonty and body mass in large herbivorous mammals. These ecometrics are considered at high spatial and temporal resolution, yielding estimates of

paleoenvironmental conditions, and allowing for detection of potential changes in associations between mammal and plant communities over time. We explore whether modern ecosystems, which are impacted by anthropogenic activity and ecologically impoverished, are functionally isolated from past ecosystem dynamics and thus unsuited for uniformitarian ecological inferences. The compiled data add new localities and species as well as tooth characteristics, enabling broader synthesis and higher resolution faunal studies than have been previously possible in the Omo-Turkana mammalian record.

Funding Sources Funding for this work was received from the Research Council of Finland, project no. 354228

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

The reproducibility crisis in phylogenetic analysis

Godoy, Pedro L.¹, Meachen, Julie², López-Arbarello, Adriana³, D'Emic, Michael D.⁴

¹Department of Zoology, University of São Paulo, São Paulo, Brazil, ²Department of Anatomy, Des Moines University, West Des Moines, Iowa, United States, ³Department of Earth and Environmental Sciences, Ludwig-Maximilians-Universität München, Munich, Georgia, ⁴Department of Biology, Adelphi University, Garden City, New York, United States

Over the past decade, the issue of reproducibility in research has been the topic of vigorous debate and garnered much attention from both the scientific community and the public. A substantial proportion of studies in a wide range of fields are not reproducible, leading to a loss of confidence in scientific results, wasted effort, and diminished research output. Under-reporting

of methodological choices has been identified as a core issue leading to a lack of reproducibility in a number of fields. In order to improve the reproducibility of phylogenetic analyses at the *Journal of Vertebrate Paleontology* (JVP), the journal recently enlisted a specialized Phylogenetics Editor to reproduce and review all phylogenetic analyses the journal receives. From June 2022–April 2024, 67 manuscripts were assessed, with a total of 124 rounds of reviews when counting resubmissions. About one-third of the phylogenetic analyses of the initially submitted manuscripts were not reproducible, either because all necessary files were not provided, some were wrongly formatted, and/or not enough information about the search procedure was reported. This proportion only drops to 20% counting both initial submissions and resubmissions, once authors had a chance to modify analyses and reporting following detailed review from the Phylogenetics Editor. Focusing only on parsimony analyses, the topology and/or number of most parsimonious trees obtained by the Phylogenetics Editor were different from those reported by the authors for about one-third of manuscripts, regardless of whether the analysis was part of a first-time submission or resubmission. Common issues encountered included not specifying the operational outgroup used and/or not specifying detailed search algorithm parameters. These data suggest that a lack of reproducibility may be a significant issue in the field of morphological phylogenetic analysis. Few journals' guides for authors explicitly require that phylogenetic analyses be re-run by editors or reviewers before publication. Based on the data from JVP, it is possible that about one-third of published phylogenetic analyses in the broader field of vertebrate evolution may not be reproducible or their results are reported incorrectly based on existing data. More stringent methodological reporting requirements and the creation of a Phylogenetics Editor

position at journals that publish phylogenetic analyses are ways to improve the robustness of research in systematics.

Colbert Prize Session

Nanoindentation of *Alligator mississippiensis*: a case study for estimating the material properties of extinct archosaur caudal vertebrae

Goetcheus, Grace A.

Biodiversity, Earth & Environmental Science,
Drexel University, Philadelphia, Pennsylvania,
United States

Nanoindentation is the process of deforming an object with a constant force to determine its material properties, such as elasticity (Young's modulus) and hardness (Poisson's ratio). The process is a relatively new application in paleontology and is often associated with finite element analysis, which requires the input of material properties to the model. However, because the original values of elasticity and hardness of fossilized tissues are lost over time through the mineral replacement process, modern bone is often utilized instead. To date, no nanoindentation data has been published for extant archosaur vertebrae, with past studies focusing on mammalian bone or non-vertebral archosaurian elements. This study provides the first data for the material properties of caudal vertebrae from *Alligator mississippiensis*, the closest bony-tailed relative to the non-avian dinosaurs.

Caudal vertebrae from an adult *Alligator* were cut in half transversely, embedded in epoxy resin, and polished with silicon carbide grit and 1 and 0.5 μm Al_2O_3 paste. Arrays of 400 indentations each were performed within the cortical bone of the vertebral centra, with targeted areas including the deposition around the vascular canal and surrounding interstitial bone. The data indicate that

Alligator caudal vertebrae possess material properties more similar to mammalian long bone and vertebrae than what has been reported previously in *Alligator* femora. Average values range between 20.7 (SD = 3.1) GPa and 22.9 (SD = 2.5) GPa for the Young's modulus and 0.847 (SD = 0.173) and 0.969 (SD = 0.144) for hardness. Interstitial bone is shown to be significantly harder than primary osteons, with the difference even more pronounced compared to mammalian bone. Associated thin sections of vertebrae show that the cortical shell consists of lamellar-zonal bone, with little to no evidence of remodeling or Haversian systems in *Alligator*. These results suggest that material properties of the axial skeleton may be retained across taxa despite differences in microstructure.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Chewing the data: Insights into archaeocete whale tooth histology and feeding biomechanics

Gohar, Abdullah S.^{1,2}, N. Woodward, Holly², Antar, Mohamed S.^{1,3}, El-Sayed, Sanaa^{1,4}, Sallam, Hesham^{1,5}

¹Mansoura University Vertebrate Paleontology Center (MUVP), Mansoura University, Manoura, Egypt, ²Department of Anatomy and Cell Biology, Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma, United States, ³Department of Geology and Paleontology, Nature Conservation Sector, Egyptian Environmental Affairs Agency, Cairo, Egypt, ⁴Museum of Paleontology, Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ⁵Institute of Global Health and Human Ecology (I-GHHE), School of Science and Engineering, The American University in Cairo,, New Cairo, Egypt

The Eocene epoch was crucial for cetacean evolution, witnessing the transition from

terrestrial ancestry to a fully aquatic life, which significantly altered cetacean anatomy, particularly the cranium and feeding apparatus. While growth layer groups (GLGs) in the teeth of archaeocete whales can estimate tooth development duration and offer insights into life history, the dental histology of archaeocetes remains poorly understood. Here, we examine archaeocete whale tooth microstructure, including protocetids (lower incisor and molar of *Phiomocetus anubis*) and basilosaurids (lower molar of *Dorudon atrox*, and lower and upper molars of *Masracetus*) from the middle to late Eocene of the Fayum Depression in Egypt. Our results revealed the presence of GLGs to varying degrees in all studied dental tissues (enamel, dentin, and cementum). Enamel thickness in *P. Anubis* ranges from 730–750 µm in the molar to 820–870 µm at the tip of the incisor, which is among the thickest recorded for cetaceans. Striations and tufts are observed in the enamel of *P. anubis*, with well-developed Hunter-Schreger bands (HSB), which most living cetaceans lack. The neonatal line is visible in the enamel of the incisor and the dentine of the molar of *P. anubis*. The contour lines of Owen are visible in the dentine of the incisor and the molar of *P. Anubis* but largely eradicated, possibly by diagenesis. GLGs in the sectioned cementum, which is an advantage in age determination, are parallel to the dentine-cementum junction. The presence of HSB and enamel tufts suggests significant occlusal loads during feeding, and the relatively thick enamel in *P. anubis* likely enhanced resistance to fractures and prolonged tooth life despite wear. These findings indicate that, unlike modern cetaceans that are edentulous or have homodont simplified teeth due to a loss of prey processing, archaeocetes had heterodont complex teeth with moderately thick enamel and prominent HSB, consistent with the raptorial feeding habits proposed for archaeocetes. With additional sampling of archaeocetes and neocetes in the future, this

study will continue to explore cetacean dental evolution patterns and the roles of phylogenetic and functional constraints in dental histology and feeding biomechanics of cetaceans.

Funding Sources This research is supported by Mansoura University, the American University in Cairo, USAID, and Oklahoma State University Center for Health Sciences.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Using a novel imaging pipeline to assess cause of death in a zoo budgerigar (*Melopsittacus undulatus*), with implications for image analyses in preserved specimens

Gold, M. Eugenia L.^{1,2}, Vasquez, Tatiana¹, Gignac, Paul M.^{3,2}

¹Biology, Suffolk University, Boston, Massachusetts, United States, ²American Museum of Natural History, New York, New York, United States, ³Cellular and Molecular Medicine, University of Arizona College of Medicine, Tucson, Arizona, United States

Preserved specimens are often used as extant comparisons for extinct taxa. Novel imaging techniques, such as diffusible iodine-based contrast-enhanced microcomputed tomography (diceCT), allow researchers to differentially image soft tissues in extant organisms, as lipids, carbohydrates, and proteins will absorb disparate amounts of iodine and therefore become differentially radio-opaque. When these scans result in unexpected pathological findings, it would be advantageous to use additional imaging techniques to connect cellular, tissue, organ, and whole-region of interest anatomy. Though previous studies have successfully destained diceCT specimens for use in pathohistology analyses, these studies were performed on

mammalian models and not avians. Here, we utilize this imaging pipeline to assess the cause of death in a previously healthy zoo specimen of an adult budgerigar (*Melopsittacus undulatus*, obtained with permission from Southwick's Zoo) found deceased in its enclosure. Scans revealed an orbital blowout fracture and an unidentified large mass across a majority of the diencephalon, striatum, and midbrain caudal to the right orbit. The specimen was successfully destained and sent for neural pathohistology analyses, which confirmed the mass as a brain hemorrhage with no evidence of neoplasia or inflammation. We conclude that this specimen died of head trauma, likely from a head-on collision within its enclosure. This multiscale imaging workflow (CT and diceCT, followed by destaining and pathohistology) can be leveraged to fully investigate anatomical and pathohistological findings that span from cell to skull levels of organization. This proof-of-concept in avians also enables opportunities for non-pathological extant models to bridge soft- and hard-tissue phenotypes across levels of anatomical organization that may improve interpretations of bony and fossilized phenotypes.

Funding Sources Biology Department, Suffolk University

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

A novel, scaffolded, station-based approach to learning anatomy and physiology

Gold, M. Eugenia L.^{1,2}, Garner, Brittany A.¹

¹Biology, Suffolk University, Boston, Massachusetts, United States, ²American Museum of Natural History, New York, New York, United States

Anatomy and Physiology (A&P) laboratory is often taught across academic levels as a mostly self-guided tour of the human bodies' anatomical structures and their three-dimensional relationships. Students are commonly given thick packets of information or guided dissectors and they are expected to memorize the information on their own. The efficacy of this method has been decreasing in recent years at Suffolk University, especially in a post-pandemic learning environment, as seen by undergraduate student engagement with the material. We spent the last year revitalizing A&P labs to implement a novel, scaffolded, station-based design to this course, that 1) reduces the cognitive load students face, 2) reduces wait time for course materials, 3) gives students practice with the summative assessment format, 4) provides multimodal learning, 5) maintains their engagement throughout the long lab period, and 6) increases their confidence with the material in a self-paced way.

Each lab topic was divided into 10-15 stations with guided instructions for each. The stations were multimodal, allowing students to interact with the material in multiple ways (e.g., reading, drawing, labeling, handling, or dissecting), and were accompanied by additional resources like textbooks and atlases to facilitate the search for structures. At particularly difficult stations, students were instructed to check in with the instructor upon completion- these checks included a discussion of lab progress, recording of student engagement, and rewarding students with a handmade, pun-filled sticker that gives them a sense of accomplishment in a low-stakes and casual way. This approach reduced the cognitive load the students carried in lab, mimicked the testing format they would experience, and kept them motivated throughout the lab session while minimizing 'wait time' between models and slides. Class averages on summative assessments (*i.e.* practicals)

improved by up to 20% and grade distributions shifted to eliminate scores below 50-70% throughout the semester. This new approach has improved student learning outcomes in assessment performance and grade distribution and was received very positively in qualitative student feedback over two semesters.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024,
1:45 PM)

Histology of a tiny phytosaur femur reveals unexpected growth patterns near the base of Archosauria

Goldsmith, Erika R.¹, Barta, Daniel E.², Kligman, Ben T.^{4,3}, Nesbitt, Sterling J.¹, Marsh, Adam³, Parker, William G.³, Stocker, Michelle R.¹

¹Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, United States, ²Department of Anatomy and Cell Biology, Oklahoma State University College of Osteopathic Medicine at the Cherokee Nation, Tahlequah, Ohio, United States, ³Department of Paleobiology, National Museum of Natural History, Smithsonian Institute, Washington, District of Columbia, United States, ⁴Division of Science and Resource Management, Petrified Forest National Park, Petrified Forest, Arizona, United States

The growth dynamics and body size of hatchling archosaurs can provide a necessary baseline from which to compare studies of growth trajectories, early ontogenetic morphologies, and heterochronic shifts. Yet, fossil hatchling individuals are exceedingly rare among Triassic archosaurs, a crucial time period for investigations of archosaur paleobiology. Efforts to extensively sample Upper Triassic sediments of the Chinle Formation in Petrified Forest National Park (Arizona, U.S.A) have yielded complete and

incomplete diminutive archosauriform femora with midshaft circumferences of ~7 mm (PEFO 45274) and ~11 mm (PEFO 45199) allowing us to assess the presence, growth dynamics, and body size of potential hatchling archosauriforms from equatorial North America. We assign these femora to Phytosauria based on the strongly sigmoidal shape (in lateral view), the presence of posteromedial and anterolateral tubera in combination with the lack of anteromedial tubera, and fourth trochanters that do not merge with the proximal end. Osteohistological analyses of PEFO 45274 reveal sparsely vascularized (~5 canals/mm²) parallel-fibered bone with primary osteons that lacks a hatching line or any lines of arrested growth. The lack of cyclical growth marks may suggest an embryonic stage; however, the presence of endosteally deposited lamellar bone suggests that cortical drift occurred and any embryonic bone, if present, was post-natally eroded. Therefore, we interpret PEFO 45274 as a slow-growing individual less than one year old but beyond hatching. The estimated body sizes of these specimens match those of 1.5-2 year old *Alligator mississippiensis*, suggesting that phytosaurs were already larger than *A. mississippiensis* at earlier ontogenetic stages and may have hatched at larger body sizes. Surprisingly, the histology of larger phytosaur femora suggests more rapid growth rates based on increased vascularity within a woven, fibro-lamellar bone matrix, suggesting that phytosaurs may have had size-dependent growth throughout ontogeny as opposed to the expected ontogenetic shift from rapid-to-slow growth rates observed across most archosauriform taxa. We highlight the importance of histologically sampling multiple ontogenetic stages to investigate archosauriform ancestral growth rates given the phylogenetic position of phytosaurs near the base of Archosauria.

Funding Sources NSF EAR 1943286 to SJN

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Three-dimensional skeletal reconstruction of *Afrovenator abakensis* (Theropoda: Megalosauroidae) from Niger, West Africa

González Pérez, Ariadna¹, Vidal, Daniel^{2,3}, Ciudad Real Ballester, María², Simarro Cano, Álvaro², Sereno, Paul C.³

¹Departamento de Geodinámica, Estratigrafía y Paleontología, Universidad Complutense de Madrid, Madrid, Spain, ²Departamento de Física Matemática y de Fluidos, Universidad Nacional de Educación a Distancia, Madrid, Spain, ³Department of Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States

We use computed tomographic scans and stereophotogrammetry to reveal the internal anatomy and 3D skeletal morphology of the presumed Late Jurassic-age megalosauroid *Afrovenator abakensis*, based on the holotype partial skull and skeleton and new materials from a second locality in the Tiouraren Formation of Niger. Discovered at the locality Tawachi, the new bones also associate *Afrovenator* directly with a vertebrate fauna including the abelisauroid *Spinostropheus*, the basal eusauropod *Jobaria* and two other neosauropods, a basal thyreophoran, and several new crocodylians.

New cranial bones include the premaxilla and dentary, the former bounding a slightly larger external naris than previously shown and the latter with a more robust symphyseal process. The cervical series, now almost completely known, has proportionately long mid-cervical centra that compose a S-shaped curve in neutral pose. Posterior cervical and anterior dorsal centra have prominent ventral keels. The tibia, now completely known, has longer proportions than previously reconstructed and may have been roughly equal to femur length. The pes is nearly

completely preserved, completing a hind limb with more cursorial proportions than in *Allosaurus* and *Sinovenator*. We compare the relatively complete skull, neck, manus, and hind limb of this most completely known Jurassic-age continental African theropod to that in other megalosaurids and allosauroids.

Funding Sources Marie Skłodowska-Curie Global Action fellow (HORIZON-MSCA-2021-PF grant 101068861-EvoSaurAf) to Daniel Vidal

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

A re-evaluation of the *Malawisaurus dixeyi* and *Karongasaurus gittelmani* holotypes with new insights into the referred fossils of these titanosaurian sauropod dinosaurs from the Early Cretaceous Dinosaur Beds of Malawi

Gorscak, Eric¹, Nassif, Jann¹, Gomani Chindebvu, Elizabeth²

¹Midwestern University, Downers Grove, Illinois, United States, ²Ministry of National Unity, Lilongwe, Malawi

The titanosaurian sauropod dinosaur *Malawisaurus dixeyi* from the Early Cretaceous (Aptian) of Malawi has been critical in understanding Cretaceous African faunas for nearly a century. Initially described as “*Gigantosaurus dixeyi*” in 1928, the holotype specimen SAM 7405 of *Malawisaurus dixeyi* includes an anterior caudal vertebra, right scapula, both sternal plates, and a right pubis. During the 1980s–early 1990s, expeditions to the area of the holotype recovered additional fossils that were referred to *Malawisaurus dixeyi*, including several cranial elements, and the second Malawian taxon *Karongasaurus gittelmani*, with the bulk of these fossils coming from the same quarry. Here, we provide an updated assessment on these

holotypes with respect to the referred cranial and postcranial fossils, including several re-identifications and new insights.

After re-evaluation, the holotype of *Malawisaurus dixeyi* appears valid with new diagnostic and character combinations while not reliant on the referred elements as in previous studies. These include a subtle accessory ridge on the pedicle of the anterior caudal vertebra and the presence of both dorsomedial tubercle and ridges on the proximal scapular blade. However, the *Malawisaurus dixeyi* holotype significantly differs from their referred counterparts: the sternal plates are more rectangular compared to the crescentic referred sternal plates and the anterior caudal vertebra differs in various morphologies and proportions from the recovered caudal vertebral morphs. This suggests that at least some of the attributed fossils do not pertain to *Malawisaurus dixeyi* with no other comparable elements to base referrals. The re-examination of cranial material previously referred to *Malawisaurus* has resulted in the reinterpretation of several elements. For example, the jugal and ectopterygoid as a putative nasal and pterygoid, respectively. Assuming the cranial remains pertain to a single individual, the skull shape is more consistent with the low-and-elongated morphology seen in other titanosaurians, like *Tapuiasaurus macedoi* from the Aptian of Brazil, than with the previously-reported high-and-short morphology. Finally, the partial holotypic *Karongasaurus* dentary seems to have been L-shaped including a guillotine crest posterior to the alveoli, similar to several Late Cretaceous titanosaurians from South America. This suggests an earlier appearance and only known African representative for this unique titanosaurian clade.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Estimating the consequences of life history for mammal cranial evolution using a high-resolution morphometric approach

Goswami, Anjali¹, Clavel, Julien¹, Mulqueeney, James¹, Noirault, Eve¹, Barber, Nicole¹, Beck, Robin M.², Engelman, Russell³, Portela Miguez, Roberto¹, Fabre, Anne-Claire⁴

¹Natural History Museum, London, London, United Kingdom, ²University of Salford, Salford, United Kingdom, ³Case Western University, Cleveland, Ohio, United States, ⁴Naturhistorisches Museum der Burgergemeinde Bern, Bern, Switzerland

The shapes of distantly related taxa are difficult to compare meaningfully using geometric morphometric approaches due to the problem of identifying unambiguously homologous landmarks in disparate morphologies. As a result, analyses spanning major groups of vertebrates, such as Mammalia, necessarily reduce landmarks to a handful of points that capture a minority of the variation present in their anatomy. Numerous landmark-free approaches exist, but these are often excessively computationally demanding and, to date, have primarily been applied within closely related taxa, particularly in intraspecific comparisons. Our recent work has applied dense sliding semilandmark analysis extensively to diverse vertebrate clades, but this approach is highly manual and struggles with increasing disparity of morphologies. More recently, we have demonstrated deterministic atlas analysis to be a powerful approach that captures similar variation as high-density semilandmarks. Here we present comprehensive 3D analyses of skull shape spanning living and extinct mammals, comprising 322 placentals, 83 marsupials, and 4 monotremes. Using a combination of surface and micro-CT scans, we applied both sliding semilandmark and landmark-free approaches to demonstrate their strengths and weaknesses and suggest a path forward for homology-informed landmark free

analysis. Extracting the phylogenetic and kernel PCs, respectively, that capture the full variation of the dataset, in combination with recently published phylogenetic frameworks, we fit a range of evolutionary models to this dataset to identify clade-specific patterns, including testing for differences in tempo and mode of evolution based on life history, in particular degree of development at birth, and ecological traits. Our results demonstrate that altriciality is consistently associated with lower rates of cranial evolution across mammals. We further applied a newly described climatic OU model, where evolutionary rate tracks an extrinsic factor, specifically temperature through the Cenozoic. Our results demonstrate that this model is well supported in some groups, but that interaction with climate is strongly dependent on diet and habitat, with, for example open habitat species more closely tracking shifts in global temperature. Our work further demonstrates that landmark free approaches are orders of magnitude faster to apply than manual landmarking and produce comparable results in macroevolutionary analysis.

Funding Sources European Research Council grant STG-2014-637171, Horizon 2020 MCSA Fellowship IF 797373-EVOTOOLS, and Leverhulme Trust grant RPG-2021-424

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

The hepatic piston in extant and extinct crocodylomorphs

Grand Pre, Clinton A.

Anatomy, Stony Brook University, Stony Brook, New York, United States

Extant crocodylians have a novel mechanism unique among archosaurs that relies on the displacement of the liver and other viscera to

ventilate the lung called the hepatic piston apparatus. As this system is comprised of muscle and viscera, a lack of fossilized evidence has left questions related to when and under what conditions the hepatic piston first evolved in crocodylomorphs. This research has five objectives: 1) validating osteological correlates of the axial skeleton using ultrasound data collected from living American alligators (*Alligator mississippiensis*); 2) applying those osteological correlates to the fossil record and identifying fossil evidence from thoracic vertebrae for the hepatic piston in crocodylomorph archosaurs; 3) formalizing characters for the crocodylian mobile pubis; 4) establishing the mobile pubis as a secondary osteological correlate for the hepatic piston; and, 5) applying it to the fossil record. Results of this work reveal a new understanding of the functional morphology of the hepatic piston in extant crocodylians and demonstrate that the hepatic piston and mobile pubis evolved convergently together at least two to three times, often during a terrestrial to aquatic transition, during the crocodylomorphs' ~250-million-year evolutionary history. The earliest evidence for the hepatic piston occurs in marine thalattosuchians and is not identified in basal terrestrial spheosuchians. This offers the first fossil evidence for the hypothesis that the hepatic piston evolved in an aquatic environment to control pitch and roll, and only secondarily as a mechanism for ventilation. Establishing the evolutionary history of the hepatic piston is relevant to the understanding the relationship between environmental transitions and the evolution of the lung across Archosauria.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**Sloth unguals and claw sheaths:
Comparisons between taxa and**

**implications for xenarthran locomotor
habits**

Grass, Andy¹, Smith, Heather F.², Muchlinski, Magda N.³, Melin, Amanda D.⁴, Veilleux, Carrie C.²

¹Anatomy, A.T. Still University School of Osteopathic Medicine in Arizona, Mesa, Arizona, United States, ²Anatomy, Midwestern University, Glendale, Arizona, United States, ³Anatomical Services Center, Oregon Health and Science University, Portland, Oregon, United States, ⁴Anthropology and Archaeology, University of Calgary, Calgary, Alberta, Canada

Despite the restricted morphology of modern sloths, extinct sloths showed a wider range of morphologies and locomotor habits. This includes hypotheses of fossorial behavior, a trait that they share with the other xenarthran clades, anteaters and armadillos, both of which are well known for digging and burrowing. Extinct sloths have been associated with digging for food, as well as possibly being responsible for large paleoburrows with distinct claw marks on the walls. This potential behavior has been studied by assessing forearm anatomy and musculature, as well as curvature of the ungual phalanges, and, when available, the claw sheath. These studies have both supported and refuted the hypotheses of giant ground sloth burrowing ability, depending on the taxon. This anatomy may also have been well suited to being co-opted to the current suspensory lifestyle of modern sloths.

This study uses microCT scans of both extant and extinct sloth and other xenarthran unguals with the claw sheaths still attached to compare the shapes and relative volume of the bony core and the sheaths. In general, modern sloths have a higher claw sheath volume compared to the ground sloths, with the tip of the sheath extending farther out from the bony core. Additionally, in ground

sloths, more of the sheath volume is located along the dorsal surface of the claw, while in modern suspensory sloths more of the sheath volume is located on the ventral surface of the claw. Both of these characteristics fit with what might be expected from a transition from digging and burrowing to hanging from tree branches. During digging, much of the force is concentrated on the ventral surface of the claw, so the bony core being closer to the sheath on this side may help reinforce it against those forces. The longer and higher ventral volume sheath of modern sloths would be more prone to breakage during higher stress activities like burrowing and digging, but better suited to lower energy hanging and climbing. Additionally, while *Choloepus* and *Bradypus*, the two genera of modern sloths, both show the same patterns described, *Bradypus* seems to have a more extensive claw sheath than *Choloepus*. This morphology could potentially reflect their differing ancestries. In most recent phylogenies, *Choloepus* is more closely related to ground sloths that have been associated with digging behavior, and *Bradypus* to those that are interpreted as having been less fossorial.

Funding Sources This work was supported in part by the National Science Foundation (#2218023).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A partial braincase from the Brule Formation (Orellan, Oligocene) of South Dakota reveals the presence of charinaid snakes in North American Paleogene small booid faunas

Greaves, Minnie F., Head, Jason

Zoology, University of Cambridge, London,
United Kingdom

North American Paleogene snake faunas were dominated by small-bodied booids prior to the diversification of colubroids during the Neogene, but the systematic identities of these taxa are poorly understood.

Assignments based primarily on vertebral morphology and a limited number of isolated cranial elements have included Erycinae (sensu lato), Ungaliophiinae, and Loxocemidae, but the lack of well-preserved crania has limited the ability to test these hypotheses. We analyse a well-preserved braincase from the early Oligocene Brule Formation of South Dakota. The specimen is the posterior skull consisting of the basicranium and neurocranium. Digital dissection of the specimen reveals similarities with extant North American rubber and rosy boas (Charinidae), and inclusion of the specimen in a comprehensive phylogenetic analysis of snake places it as the sister taxon of extant *Lichanura*. This is supported by their shared 'tab-like' anterolateral wings, midsagittal crest extending from the parietal midline to the supraoccipital, u-shaped frontoparietal suture as well as other characters. This record minimally constrains divergences within Charinidae to no later than 32 Mya, and further increases the diversity of North American Paleogene booids to include both tropical climate immigrants and temperate climate endemic clades.

Funding Sources Natural Environment Research Council grants NE/W007576/1 and NE/S000739/1 to JJH

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Taxonomy and paleobiogeographic implications of a nodosaurid sacral shield from the Late Maastrichtian Ferris Formation, Wyoming

Green, Brayden^{1,2}, Cavigelli, Jean-Pierre³,
Vietti, Laura A.¹, Wroblewski, Anton¹

¹Geology and Geophysics, University of Wyoming, Laramie, Wyoming, United States, ²Missouri Institute of Natural Science, Springfield, Missouri, United States, ³Tate Geological Museum, Casper, Wyoming, United States

The Ferris Formation (67-63 Ma) is a mixed fluvial and lower coastal plain succession accumulated on the western shoreline of the Western Interior Seaway. The Ferris Formation has a diverse array of vertebrates, including chelonians, chondrichthyans, crocodilians, euselachians, mammals, ornithischians, and saurischians, contributing to the Ferris's paleontological significance.

Ankylosaurids are represented by a single tooth while the nodosaurid material consists of five isolated teeth and over 120 fragmentary to complete osteoderms, representing a minimum of 10 individuals. The scarcity of ankylosaur skeletal remains in Upper Maastrichtian deposits complicates efforts to understand broader taxonomic relationships within these groups. UW-34391, an isolated section of nodosaurid sacral shield has potential significance in advancing understanding of their diversity within the Ferris Formation and across latest Cretaceous Laramidia.

UW-34391 is made up of 41 complete or mostly complete osteoderms and 9 incomplete osteoderms. The specimen measures approximately 34.3 cm by 29.9 cm and is characterized by individually fused hexagonal osteoderms. These osteoderms vary in size, with the largest measuring 7.0 cm by 5.1 cm and the smallest measuring 2.5 cm by 2.5 cm, with an overall average of large and small being 4.4 cm by 3.7 cm.

Notable features consist of a row of keeled osteoderms that form one side on UW-34391. The dorsal surface of each osteoderm exhibits distinct furrows, likely pathways for blood vessels, indicating the presence of a

vascularized chitinous covering in life. On the ventral side, the osteoderms display a unique "woven basket" texture, which is otherwise convex.

Morphometric analyses were conducted which focused on the key characteristics of the specimen including the distinct keels, the shape and size of the osteoderms, and the patterns observed on the ventral surface. The data was then compared with known nodosaurid taxa from surrounding sites of similar age. We interpret UW-34391 to represent either the northernmost representative of *Glyptodontopelta*, a previously unrepresented section of armor from *Denversaurus*, or an unrecognized taxon.

Funding Sources N/A

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Assessing the ontogenetic maturity of the '*Nanotyrannus lancensis*' holotype with hyoid osteohistology

Griffin, Christopher¹, Poust, Ashley W.², Bugos, Jeb E.³, Morris, Zachary S.⁴, Petermann, Holger⁵, Fabbri, Matteo⁶, Colleary, Caitlin³

¹Geosciences, Princeton University, Princeton, New Jersey, United States, ²Nebraska State Museum, Lincoln, Nebraska, United States, ³Cleveland Museum of Natural History, Cleveland, Ohio, United States, ⁴Natural History Museum of Los Angeles, Los Angeles, California, United States, ⁵Denver Museum of Nature and Science, Denver, Colorado, United States, ⁶Johns Hopkins University, Baltimore, Maryland, United States

Assessing maturity in non-avian dinosaurs is notoriously difficult, which impacts our ability to determine whether individuals differ because they are distinct species or differing

ontogenetic stages of the same species. The putative '*Nanotyrannus lancensis*' is a prime example: originally erected as a dwarf tyrannosaurid coeval with *Tyrannosaurus rex* based on an isolated skull (CMNH 7541), the limb histology and cranial morphology of similarly sized tyrannosaurid skeletons indicate immaturity, suggesting that CMNH 7541 is an immature *Tyrannosaurus rex*. Unfortunately, the lack of limb or rib elements to histologically sample in the holotype has made testing this claim difficult. However, CMNH 7541 does preserve hyoids—elongated, endochondral elements that may contain a record of growth, which could be useful for testing the maturity status of the '*Nanotyrannus*' type. We first demonstrated the utility of hyoid histology in extant archosaurs (ostrich, American alligator, dwarf caiman) and lepidosaurs (*Varanus*). These data show that hyoid histology is most similar to that of ribs, containing lines of arrested growth (LAGs), annuli, secondary osteons, and (in the case of ostrich) an external fundamental system (EFS) indicating cessation of growth. Notably, the greater maturity of the dwarf caiman compared to similarly sized alligator is apparent in the hyoid histology. Sampled individuals of *Edmontosaurus annectens*, *Coelophysis bauri*, and *Allosaurus* sp. confirm that this utility holds across non-avian dinosaurs as well. Ongoing analysis of a *T. rex* growth series will establish the extent to which tyrannosaurids follow or deviate from the general reptilian pattern of hyoid histology. Surprisingly, the hyoid of CMNH 7541 contains strong indications that this individual is fully grown: the cortex is extensively remodeled with at least eight generations of secondary osteons and preserves at minimum 14 LAGs. Further, the medullary cavity is surrounded by well-developed endosteal lamellae, and the outermost cortex preserves an EFS. Although it is possible that CMNH 7541 is a small *Tyrannosaurus rex* (e.g., extremely high intraspecific variation, high sexual

dimorphism with diminutive males, 'sneaker' male with immature morphology, congenital dwarfism), we consider the most likely interpretation to be that CMNH 7541 represents a distinct taxon of diminutive, morphologically paedomorphic tyrannosaurid.

Funding Sources NSF PRFB

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Early burst radiations are more commonly observed in comparative studies that sample fossils, are phylogenetically broad, and use ecomorphological traits

Grossnickle, David², Ely, Ricardo³, Santana, Sharlene¹, Slater, Graham⁴

¹Oregon Institute of Technology, Klamath Falls, Oregon, United States, ²Indiana University, Bloomington, Indiana, United States, ³University of Washington, Seattle, Washington, United States, ⁴The University of Chicago, Chicago, Illinois, United States

Adaptive radiations are often hypothesized to involve initial bursts in morphological evolution as lineages rapidly adapt to new ecological niches. However, this hypothesis has been challenged by studies claiming that early bursts are rare, suggesting that rates of evolution through time might be more uniform or stochastic than previously realized. Here, we argue that expectations for observing early bursts are reliant on the underlying data and sample used in comparative studies, and that early bursts will be more commonly observed under specific conditions. We focus on three methodological choices and how they influence the results of comparative analyses, using mammals as our study organisms. First, we demonstrate that the inclusion of fossils in analyses increases the chance of identifying early bursts. For

instance, using jaw measurements and a large phylogeny of fossil and extant mammals, we show that the inclusion of fossils in analyses increases the fits of early burst evolutionary models to morphological data. Second, we use two case studies – one on phyllostomid bat molars and one on carnivoran dentitions – to show that ecomorphological data (rather than non-ecologically informed data) is more likely to evolve via an early burst pattern, which is expected because ecological opportunities drive adaptive morphological changes at the onset of radiations. Thus, researchers are more likely to observe evidence for early bursts if they use ecomorphological data in comparative analyses. Third, we provide evidence that early bursts are more common at relatively higher phylogenetic levels because large clades (e.g., taxonomic orders) are more likely to include lineages that have shifted into new adaptive zones. Therefore, researchers should expect a greater chance of observing early bursts when sampling taxa at relatively broad phylogenetic levels. Our findings highlight that early burst radiations are likely more common than some studies have suggested, but expectations for observing the early bursts are dependent on the inputted data in comparative analyses. This conclusion emphasizes the importance of methodological choices in macroevolutionary studies, and we encourage the inclusion of fossils, large sample sizes, and ecomorphological traits whenever possible.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Unbreakable: Armor biomechanics in *Borealopelta markmitchelli* (Dinosauria: Nodosauridae) with implications for intraspecific combat and predation defense

Habib, Michael B.^{1,2}, Brown, Caleb M.³

¹Cardiology, UCLA, Los Angeles, California, United States, ²Dinosaur Institute, NHMLA, Los Angeles, California, United States, ³Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

The holotype of the armored dinosaur, *Borealopelta markmitchelli*, exquisitely preserves the integumentary soft tissue across much of the body. This soft tissue preservation includes thick keratinous sheaths covering most of the in situ osteoderms. Given the extensive contribution of the keratinous covering to the underlying osteoderms, and the contrasting material properties of keratin and bone, this specimen presents an opportunity for modeling this composite structure for the first time. Here, we analyze the energy absorption and dynamic load specializations of the armor in *Borealopelta*, considering the influence of the keratin components on the shape, size, and material properties of the osteoderms.

Layered keratin has immense impact energy absorption capacity (toughness), owing to the properties of the keratin material itself and the large amounts of energy required to separate the layers as they fail piecemeal under impact. We used reported keratin material properties for living mammals, specifically those with keratin armor (porcupines) and keratin-bone composite horns (bovids) as baselines. We added terms to our model to account for ablative effects, again based on keratin separation energy values known for living taxa. We then applied this model to the measured osteoderms of *Borealopelta*, accounting for changes in relative keratin thickness across the armor.

We conservatively estimate that the armor of *Borealopelta* was capable of absorbing over 125,000 Joules of energy per square meter – energy values similar to high-speed automobile collisions. This energy absorption capacity would have been excessive for

resisting the bite of a large theropod predators. In short, the armor is “overbuilt” compared to expectations from a predation-only model of selection. Instead, we suspect that the armor of *Borealopelta* was primarily adapted to loads incurred in intraspecific (i.e., sociosexual) combat, with predation-resistance being a secondary modality. With the full keratin extent reconstructed, the osteoderms across the dorsum of *Borealopelta* become nearly interlocking, and we predict that they would lock together and load in compression along the long axis of the animal in shoulder-to-shoulder intraspecific combat. Finally, we propose that keratinization of the armor in *Borealopelta markmitchelli* may be indicative of a broader pattern, and that energy-absorption capacity may have predominated over stiffness in thyreophoran armor.

Funding Sources Funding: Suncor Energy, Royal Tyrrell Museum of Palaeontology, Royal Tyrrell Museum Cooperating Society, National Geographic Society, and NASA Astrobiology Institute.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Immersive connections in geosciences:
Paleontological field experiences and
bridges to robust career training
opportunities**

Haiar, Brooke

University of Lynchburg, Lynchburg, Virginia,
United States

Despite geoscience’s relevance to economies and livelihoods, this particular field remains one of the least racially and ethnically diverse disciplines in the United States. Diversity, specifically in the geoscience fields, is staggeringly low. Recruitment of a diverse body of students is essential to maintaining our workforce and to

creating a more inclusive field. Student participation in a field-based activity has been shown to positively affect student learning and engagement, and is a critical component for recruitment of geoscience majors. This high-impact learning experience provides vital career preparation, regardless of the students’ ultimate career goals. However, there are systemic barriers to these activities including the additional cost, time taken away from summer employment, and the perception of geoscience careers as being low-earning and low-prestige compared to other STEM fields.

This study combines participation in an immersive three-week summer vertebrate paleontology field experience, a STEM-specific mentored project with the Virginia Museum of Natural History, and, novel to this project, broadly applicable career preparation provided by the university’s Career and Professionalism Center. We are in year two of a three-year research program centered around the question of whether these efforts, combined with the removal of a financial barrier, will increase enrollment in geoscience majors, specifically among the target audience of underrepresented students.

Our program used an outside evaluator to quantitatively and qualitatively evaluate the goals of the project. Evaluation methods include surveys administered before and after the field experience, as well as student interviews. To date, we have seen a marked increase in the diversity of students participating in the summer field program compared to historical institutional rates. We’ve also seen increases in the quality of STEM participation activities students have had post-summer field experience, including an increase in the number of participants adding an environmental science major, and achievement of academic successes within their own majors. Students who participated in the first cohort highlighted their strengthened skills in teamwork and

collaboration, as well as self-sufficiency as important parts of their learning experience. They described their gains in networking and collaboration with professionals, as well as improvements in their professional communication skills.

Funding Sources NSF RISE (2227897)

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Was *Smilodon fatalis* a gang member?
Solitary ambush or social pursuit predator**

Haji-Sheikh, Misty H., Naples, Virginia L.

Biology, Northern Illinois University, DeKalb,
Illinois, United States

The predatory habits of *Smilodon fatalis* have intrigued paleontologists and the public since Leidy described it 1869. Many researchers have championed alternate killing hypotheses for *S. fatalis*; a social group with pursuit habits versus solitary ambush habits. Pursuit arguments are: first, predators show social behavior like modern lions, which form prides and have adaptations that allow them to capture prey cooperatively after chases in open savannahs. These predators have relatively long limbs and tails that are used as rudders while running, and other endurance adaptations. Second, a social group would care for injured members. Severely injured individuals would never have survived without provisioning by conspecifics. Third, some of these cats show evidence of healing from serious injury. Fourth, as a social group chasing prey, *Smilodon* may have become trapped *en masse* in tar seeps at La Brea Tar Pits, e.g., Rancho La Brea. The contrasting hypothesis is: first, ambush predators are solitary, attacking individually from cover in closed environments such as forests. Anatomical adaptations are for strength at the sacrifice of running speed or endurance, including robust musculature, short limbs,

and tails. Second, coordinating attacks among social hunting groups in closed habitats would be visually difficult and vocal communications would be as easily detectable by potential prey as conspecific predators. Prey alert to threats would be able to avoid capture, making cooperation during such hunts problematic. Third, evidence from oxygen isotope analysis reveals plant species consumed by *Smilodon*'s suggested preferred prey correlated with closed habitats. These studies conclude that the prey were medium to large herbivores inhabiting forests, based on a preponderance of C3 plants constituting their diet. Fourth, survival of injured cats depends more on the ability to obtain water than food. Water cannot be supplied by cats even in a social group. These opposing hypotheses cannot both be correct; therefore, we reevaluated the details of each theory, including new evidence from *Smilodon*'s anatomical adaptations to enhance stealthy movements compared to other felid predators, floral and faunal composition analyses and felid physiological limits predicting the survival of injured individuals. Our hypothesis is that when studied collectively the body of evidence will assert that *S. fatalis* was a solitary ambush predator.

Funding Sources N/A

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

**Catarrhine distribution throughout the
Early Miocene Kisingiri Sequence on
Rusinga Island, Kenya**

Hall, Abigail S.¹, Jenkins, Kirsten², Lehmann,
Thomas³, Michel, Lauren⁴, Muteti, Samuel^{1,5},
Peppe, Daniel J.⁶, McNulty, Kieran P.¹

¹Anthropology, University of Minnesota,
Minneapolis, Minnesota, United
States, ²Social Sciences, Tacoma Community
College, Tacoma, Washington, United

States, ³Messel Research and Mammalogy, Senckenberg Research Institute, Frankfurt, Germany, ⁴Earth Sciences, Tennessee Tech University, Cookeville, Tennessee, United States, ⁵Palaeontology, National Museums of Kenya, Nairobi, Kenya, ⁶Geosciences, Baylor University, Waco, Texas, United States

Early Miocene deposits on Rusinga Island, Kenya, have produced almost 16,000 mammalian fossils, including more than 1800 specimens of at least six species of catarrhine primate. The catarrhines represented within these deposits include *Ekembo heseloni* and *Ekembo nyanzae*, two early apes critical for understanding the Early Miocene hominoid radiation. *Dendropithecus macinnesi* and *Nyanzapithecus vancouveriorum* are also found there, as are two other small-bodied catarrhines, one typically referred to *Limnopithecus legetet* and the other unnamed. To better understand patterns of catarrhine distribution within the context of their faunal communities, we analysed mammalian community structure at the main collecting localities on Rusinga. Our results show that most of the catarrhines are known only from the highly fossiliferous Hiwegi Fm, but that *Ekembo* and *Dendropithecus* are represented at nearly all large collecting areas, spanning all three mammal-preserving geological formations (from oldest to youngest): the Kiahera Fm, Hiwegi Fm, and Kulu Fm. The relative abundances of *Ekembo* and *Dendropithecus* relative to all mammals differ at fossil localities on Rusinga in interesting and likely ecologically informative ways. Within the Hiwegi Formation localities, the relative abundance of *Ekembo* is highest at R105-R106-R107 whereas the highest relative abundance of *Dendropithecus* is found at the younger R3 locality. This variation reflects our results for some other mammalian taxa. For example, the relative abundance of the chalicothere *Winamia* and the anthracothere *Rusingameryx* are much higher at R105-R106-R107 than at R3, whereas the relative

abundance of the rodents *Diamantomys* and *Paraphiomys* are much higher in the R3 assemblage than in the R105-R106-R107 assemblage. Proboscideans and rhinocerotids make up approximately the same proportion of each assemblage. These results are interesting considering paleoenvironmental work at these localities that reconstructed R105-R106-R107 sites as a riparian forest contrasting with the R3 paleoenvironments interpreted as a sub-humid to humid, closed-canopy forests. Thus, this study suggests that catarrhine primates, like other mammals, may be useful paleoenvironmental indicators, not as much in their presence/absence, but in their relative proportions regarding the broader mammal community.

Funding Sources Funding was provided through grants from the Leakey Foundation, National Science Foundation (BCS 2142037) and Anthropology department at the University of Minnesota.

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Effects on FEA-simulated stresses in feeding rodents when teeth are modeled and implanted as separate structures

Hall, Lauren¹, Weil, Anne¹, Snively, Eric²

¹Oklahoma State University Center For Health Sciences, Tulsa, Oklahoma, United States, ²Oklahoma State University College of Osteopathic Medicine-Cherokee Nation, Tahlequah, Oklahoma, United States

In Finite Element Analysis (FEA) the skull is often modeled as two structures, the cranium and mandible, with teeth attached although separate material properties can be applied. We tested the effect of modeling teeth as separate structures from Morphosource CT scans of *Rattus norvegicus* (ID: 55306) and *Cavia porcellus* (ID: 55304).

We produced a continuous model of the cranium and mandible with the teeth included and models with teeth as separate objects from the skull. Models were imported into Strand7 to apply muscle forces and tissue material properties. Forces from similar-sized specimens were applied for the masseter, temporalis, zygomaticomandibularis, and pterygoids. We used elastic moduli of 17 GPa for bone, 16.9 GPa for dentine, and 93 GPa for enamel. We added constraints to simulate a bilateral incisor bite, and the start of a unilateral left sided chewing motion. Direct attachments were used to connect the teeth to the cranium and mandible. von Mises stress was sampled from six locations on both the sides of the mandible; the top and bottom of the mandibular ramus, the angular process, the lateral side below the first mandibular tooth, the condyle, and the coronoid process. Additional data points were collected at either the molar or incisors. To evaluate subtleties of von Mises stress distribution, we visualized results with a maximum stress of 15 MPa.

All separated models differ from the continuous ones in stress distribution. Detaching the teeth from the jaw reveals where stress is transferred from the teeth to the cranium and mandible. While continuous models result in stress extending from the bite location on the tip of the incisors to the extent of the top of the mandibular ramus in both taxa, separated models show the highest stress at the incisors, the bottom of the mandible, and the upper part of the angular process. In the molar chew, continuous models yield highest stresses in front of the tooth row and at the mandibular condyle, but in separated models the highest stress occurs along the molars. Enamel and dentine separated models produce similar results, but enamel models have less stress in the mandible than dentine models. Overall, we find that modelling the teeth separately from the jaw results in a more realistic stress

model for both incisor biting and for chewing. Future refinements applied to fossil and extant taxa will test the effects of periodontal ligaments and of separating dental tissues within the tooth.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Early insights into new additions to the Marine Reptile fauna of Late Cretaceous deposits within the Coleraine and Windrow Formations of Minnesota

Hanks, H. D.¹, Westgaard, John G.¹, Hastings, Alex K.², Korf, Jason²

¹Paleontology, Minnesota Discovery Center, Chisholm, Minnesota, United States, ²Paleontology, Science Museum of Minnesota, St. Paul, Minnesota, United States

The Cretaceous Period in Minnesota is in large part represented by two formations and is largely under-investigated and poorly reported in literature in the past 130 years. The primary areas of Cretaceous exposures lie in the open mine pits in the Coleraine Formation of north-central Minnesota and the Windrow Formation along the Minnesota River Valley and its tributaries. The Coleraine Formation is described as largely marine in origin due to the transgression of the seaway from the west and contains numerous invertebrate marine fossils that are indicative of near shore deposition. The Windrow Formation has been interpreted to be of deltaic flows and lacustrine deposits as the seaway transitioned from marine sources in the west to non-marine deposits to the east. Both the Coleraine and the Windrow Formations are labeled as likely Cenomanian in age due to biostratigraphic comparisons. The fossils recovered from the Coleraine Formation include an isolated elasmosaurid vertebra and proximal section of a propodial, a partial snout of *Terminonaris robusta* along with a second sacral vertebra, as well as a

partial humerus of a juvenile *Protostega* and isolated turtle carapace fragments. Additionally, numerous reptilian teeth have been recovered, the majority of which appear crocodilian with a few elasmosaurid specimens. The Windrow specimens include 5 elasmosaurid vertebrae collected from farm fields and riverbanks in scattered locations across southern and western Minnesota. Also present are crocodilian teeth, several turtle carapace fragments and an indeterminate partial turtle femur.

Ongoing research into the Cretaceous deposits of Minnesota will help interpret the environments along the eastern margin of the Western Interior Seaway and this region of the prehistoric Appalachian western coastline. This should illuminate a clearer understanding of the vertebrate contributions from these formations to the fossil record.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

The three species problem: a revised look at the systematics and phylogenetic relationships of neornithischian dinosaurs in the Upper Cretaceous Two Medicine Formation of northcentral Montana

Hannebaum, Zakaria¹, Varricchio, David J.¹, Scheetz, Rod³, Brown, Caleb M.², Avrahami, Haviv M.⁴

¹Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Museum of Paleontology, Brigham Young University, Provo, Utah, United States, ³Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada, ⁴Paleontology, NCMNS, Raleigh, North Carolina, United States

The Campanian (ca. 83.6 Ma to 72.1 Ma) marks the peak of non-avian dinosaur diversity in North America, now corroborated by recent chronostratigraphic work in

contemporaneous formations across the former subcontinent of Laramidia. The Two Medicine Formation is exceptionally fossiliferous, and its depositional history temporally encompasses much of the Campanian (ca. 82.4 Ma to 74.4 Ma). New geochronologic data constrains Two Medicine Formation faunal occurrences, thus revealing distinct dinosaur community trends through time.

Historically, small-bodied neornithischians in the Two Medicine Formation were all assigned to *Orodromeus makelai*. Two orodromine specimens collected from the Landslide Butte Field Area (ca. 75.25 Ma) nearly 30 years ago consist of a skeletally mature individual and an immature one, both largely complete skeletons. The adult specimen (MOR 473) exhibits many distinct morphological characters inconsistent with its previous diagnosis and unique from other Laramidian orodromines. These place it outside of the genus *Orodromeus*. One apomorphic character unites it with two isolated femora collected from temporally equal strata in the Dinosaur Park Formation of Alberta, Canada, confirming a northern range in Laramidia for this new orodromine. Bob's Vacation Site (BV) (ca. 76.24 Ma) has produced the third highest density of orodromine fossils in the Two Medicine Formation. The morphology of specimens here are more consistent with *Orodromeus makelai*, but three key autapomorphic characters likely warrant a separate species designation and group the BV orodromine material with a postcranial skeleton from temporally similar strata in the Oldman Formation of Alberta. With these new divisions, *O. makelai* becomes restricted temporally and geographically to fossil localities, like Egg Mountain, within the Willow Creek Anticline in a time interval from ca. 76.64 Ma to 77.41 Ma. This previously unrecognized Orodromine diversity shows the Campanian was a dynamic time for non-avian dinosaurs, large and small, with

northern Laramidia proving to be a nexus of diversity.

Funding Sources Jurassic Foundation

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

An ontogenetic study of the skeleton in Hawai'i's large extinct Quaternary waterfowl: Investigating the roles of paedomorphosis and selection for hindgut fermentation in the evolution of large, secondarily flightless island birds

Hanson, Michael, James, Helen F.

Vertebrate Zoology, Smithsonian Institution, National Museum of Natural History, Washington, District of Columbia, United States

Prior to human arrival, Hawai'i was home to two lineages of large-bodied waterfowl, adapted to a flightless, fully terrestrial lifestyle, that were the largest herbivores on their respective islands: The moa-nalo species of Kaua'i, O'ahu, and islands of Maui-Nui, likely descended from dabbling ducks (Anatini), and a flightless goose of the genus *Branta* on the Island of Hawai'i. Compared with their continental relatives, adults of these species exhibited an enlarged abdomen and graviportal body structure, with modifications to the hindlimb, pelvis, and vertebrae to support their mass, whereas their wings and thoracic girdles were greatly reduced. Their highly divergent bills were large, robust, and in some cases bore bony denticles to process tough plant matter. Fecal analyses indicate that, at least for the moa-nalo, this diet was processed via hindgut fermentation; a digestive process uncommon in birds. A dietary shift toward consumption of fibrous terrestrial vegetation plus specialization for hindgut fermentation may provide an explanation for these morphological changes. Moreover, large

flightless island endemic birds have been characterized as paedomorphic with respect to their flighted relatives; "frozen" in earlier growth stages resembling juveniles. We conducted a study to determine if this was the case for the moa-nalo (†*Ptaiochen pau*) as it adapted to a new ecological niche, comparing CT scans of juvenile and adult moa-nalo skeletons found in Maui lava tubes with an ontogenetic series of skeletons of the related extant mallard (*Anas platyrhynchos*) from embryos with the earliest ossifications to osteologically mature individuals. This 3D visualization of duck skeletal development reveals differences between the derived moa-nalo and a typical dabbling duck in the timing of development of different skeletal regions, with the juvenile moa-nalo skull already similar to the adult's, while hindlimb to forelimb proportions in hatchling mallards resemble the juvenile moa-nalo. The hindlimb to forelimb size difference in adult moa-nalo exceeds anything seen in mallard ontogeny. Fossil egg size indicates moa-nalo chicks hatched at a much larger body size than is typical for ducks, potentially facilitating acquisition of hindgut fermentation. We intend to similarly evaluate a growth series of Canada geese (*Branta canadensis*) to compare with the flightless Hawai'ian goose (†*B. rhuax*), which was morphologically and ecologically convergent upon the moa-nalo.

Funding Sources Smithsonian Institution, National Museum of Natural History

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

A new early-diverging oviraptorosaur from the Lower Cretaceous Miaogou Formation of western Inner Mongolia, China

Hao, Mingze¹, Li, Zhiyu², Wang, Zhili², Wang, Shuqiong², Ma, Feimin³, Qinggele, Qinggele², King, Logan¹, Pei, Rui¹, Zhao, Qi¹, Xu, Xing¹

¹Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China, ²Inner Mongolia Museum of Natural History, Hohhot, China, ³Inner Mongolia Institute of Geological Survey, Hohhot, China

Oviraptorosauria is a group of diverse pennaraptoran theropods known primarily from an abundant Asian and North American Cretaceous fossil record. However, there has long been a gap in the evolutionary history of oviraptorosaurs between Jehol early-diverging taxa such as *Caudipterygidae* and late-diverging taxa included in *Avimimididae* and *Caenagnathoidae*. We report a new early-diverging oviraptorosaur species based on two specimens recovered from the Lower Cretaceous Miaogou Formation (Aptian-Albian) of the Maortu Locality in Inner Mongolia, China. The specimens preserved most of the postcranial skeleton in articulation, which show a unique combination of features distinguishing it from all other oviraptorosaurs: the ilium has a preacetabular process that is nearly 50% longer than the postacetabular process; the anterior process of the pubic boot is reduced and shorter than the hooked posterior process; the elongated tibiotarsus and tarsometatarsus are fused without distinct sutures; and an arctometatarsalian pes. This new species presents a mosaic of transitional body plans between the earliest-diverging members of the Jehol Biota and other late-diverging clades, and our phylogenetic analysis recovered it as a sister taxon to the clade formed by *Avimimididae* and *Caenagnathoidea*. This new discovery not only provided new evidence on oviraptorosaur early evolution, but also enriched our knowledge to oviraptorosaur morphological diversity. Notably, this new oviraptorosaur has an ilium with an extremely short postacetabular process and a hindlimb with proportionally elongate and fused lower segments - an enigmatic character combination unknown among other oviraptorosaurs but common in wading birds

- suggesting a possible wading ecology. The specimens preserved gastroliths similar to *Caudipteryx*, suggesting a gastric mill was present in this new species. Furthermore, the presence of gastric mill highlights potential discrepancies in the digestion mode of early- and late-diverging oviraptorosaurs. The oral specialization in late-diverging taxa could help process food items with higher efficiency to compensate the loss of mechanical function of the gastric mill whereas early-diverging taxa would have relied more on gastric mills for mechanical food processing.

Funding Sources National Natural Science Foundation of China (42288201 to X. X.; 42372031, 41972025 to R. P.) and Yunnan Revitalization Talent Support Program (202305AB350006 to X. X.)

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Ecometric analysis of artiodactyls from the Miocene Dove Spring Formation reveals stability in functional traits over geologic time

Hardy, Fabian C.^{1,2}, Kort, Anne E.³

¹Ecology and Evolutionary Biology, University of Michigan, Ann Arbor, Michigan, United States, ²Vertebrate Paleontology, Natural History Museum of Los Angeles County, Los Angeles, California, United States, ³Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States

During the Miocene (~23-5 Ma), the Mojave region of North America had exceptionally high species richness of large mammals. A decline in species richness beginning ca. 15 Ma coincided with a regional shift from closed forest or woodland habitats towards more open grasslands. We assessed how functional traits may have changed during this decline using ecometric analyses of artiodactyl fossils (*Antilocapridae*, n=62;

Camelidae, n=120) from the Dove Spring Formation (12.5-8.5 Ma) of southern California. Stable isotope and stratigraphic facies analysis of this formation suggest a paleoenvironment composed of a patchwork of grassland and wooded habitats that became more open as the basin developed. The functional traits of mammals are strongly linked to their environment and we expect changes in predominant body size and locomotor function to correlate with an increase in open habitat. Mammalian body size correlates with ecological characteristics such as diet, population density, and home range size, all of which may vary as vegetation and water resources change. The ratio of functional length to distal radius (gear ratio) of the astragalus correlates with the relative power or speed of movement in the hindlimb, and relatively short astragali indicate cursorial adaptation. We measured tarsal gear ratio in astragali, with molar width and astragalus width as indicators of body size. We used the high-resolution geochronology of the Dove Spring Formation as a framework for our time series analysis of functional traits, placing each fossil into temporal and stratigraphic context. We found that antilocaprid body sizes increased while gear ratios decreased. This trend indicates larger and more cursorial morphology, reflecting the early stages of morphological changes within Antilocapridae that continued into the Pleistocene. Camelids exhibited no trends in size or gear ratio, although a statistically significant, moderately positive trend exists between their size and gear ratio. The largest camelid species (>1000 kg) disappeared from the fossil record after the onset of basin rotation and translation at 9.5 Ma. This shearing tectonic episode altered the drainage patterns and moisture available to plants and animals, which may have discouraged large camelids from returning to the basin. Species that adapted to the increasingly open and arid habitats of the Mojave persisted, while those that did not became locally extinct.

Funding Sources University of Michigan Rackham Graduate School; Michigan Society of Fellows

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A Pleistocene jaguar skeleton from Acadia Parish, Louisiana

Hargrave, Jennifer E., Martin, James E.

School of Geosciences, University of Louisiana, Lafayette, Louisiana, United States

The first occurrence of jaguar in Louisiana is represented by a partial skeleton of a young adult discovered at the Carrier Mastodon Site, located less than 30 km northwest of Lafayette near Church Point, Louisiana, in Acadia Parish. The preserved elements are relatively large, and suggest assignment to *Panthera onca augusta*. Although the bones were eroded and disassociated, the lack of duplicated elements and elements of similar ontogenetic age indicate a single individual, and the unfused postcranial epiphyses coupled with an adult dentition suggests an ontogenetic stage of a young adult. Even at this stage, the individual appears larger than the extant jaguar. The occurrence of *P. onca augusta* in Louisiana is to be expected as the subspecies appears across southern North America and is particularly common in the Gulf States. This felid skeleton was found associated with a partial skeleton of *Mammuth americanum* and teeth of both *Equus* sp. And *Bison* sp. These associations are indicative of accumulation during the late Pleistocene (Rancholabrean North American Land Mammal Age).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A caudal vertebra from *Thecachampsa* sp. (Crocodylia: Tomistominae) with comments on systematics

Hart, William J.¹, Hill, Robert V.², Bennington, J. B.¹

¹Geology, Environment, and Sustainability, Hofstra University, Brooklyn, NY, New York, United States, ²Science Education, Donald and Barbara Zucker School of Medicine, Hempstead, NY, New York, United States

In 1998, on a Geological Society America Penrose Conference field trip, a vertebra was recovered from the Earliest Late Miocene-aged Conoy Member of the Choptank Formation (~ 11.6 Ma), and has been unexamined until now. Despite being fragmented, it is still well-preserved, demonstrating some interesting anatomical features (i.e. uneven corresponding fossa at the ventral base of the neural spine, sheet-like spurs in the interior lateral walls of the neural canal that correspond to the uneven fossa, and a visible neurocentral suture on the dorsal surface of the centrum). Based on scaling with *Alligator mississippiensis*, this individual is estimated to have been 5.76 meters (18.9 feet) and was potentially still growing. Based on comparison to previously described and figured Calvert Cliffs region specimens, this is an anterior caudal (c.f. Caudal 2-4) of an indeterminable species of *Thecachampsa*. The position of the *Thecachampsa* genus within the Tomistominae likely needs revision, to answer hypotheses on inter-taxa relationships and also to account for the biogeographic radiation of these crocodylians during the Cenozoic. In recent analyses, *Thecachampsa* is unresolved relative to other taxa in Tomistominae reinforcing this notion of it being phylogenetically unstable, and so here we suggest potential steps to better establish the relationships within *Thecachampsa* species as well as other members of Tomistominae.

Funding Sources We would like to thank Hofstra University for funding this work.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Best practices for fossil vertebrate skeletal diagrams

Hartman, Scott¹, McDavid, Skye N.²

¹Integrative Biology, UW-Madison, Madison, Wisconsin, United States, ²Independent Illustrator, Rye City, New York, United States

Skeletal diagrams communicate overall skeletal morphology and basic life appearance of extant and fossil vertebrates, are commonly used in academic publications, popular science books, museum displays, and as a reference for artists. Published skeletal diagrams vary widely in style and content, causing confusion when interpreting these diagrams. We propose a set of best practices and terminology with the aim of minimizing future interpretive errors.

Today's skeletal diagrams descend from comparative anatomy diagrams made in 19th Century Europe, themselves inspired by Renaissance illustrations of human skeletons. Though illustrated in various styles over time, the most common style nowadays is of white bones on a black soft tissue silhouette.

We recommend known bones be represented in white. To differentiate between bones known from fossils and bones reconstructed based on relatives, we recommend that the reconstructed bones be gray. Other colors or patterns can be used to differentiate bones of different specimens in a composite skeletal diagram, confidently or tentatively assigned bones, etc, but we recommend avoiding white for such purposes. Since black outlines used to illustrate the individual bones blend into the black silhouette background, simply

adding a silhouette around them will make the resulting bones appear too slender. Instead, the edge of the white (or colored) portion should represent the edge of the actual (or reconstructed) bone. The most basic silhouette that can be added to a skeleton consists of only muscles, major organs, and conservative estimates of solid keratin (claws, horns, etc); the resulting diagram is a ‘flayed’ skeletal diagram. Optionally, soft-tissue features such as fur, patagia, feathers, and wattles or soft-tissue crests can be added to the silhouette. They may optionally be differentiated from the muscles and organs using dark gray, though we recommend that illustrators specify whether a skeletal diagram is flayed or includes soft tissue.

We recommend humanoid silhouettes used for scale have realistic human proportions (i.e. avoid fictional characters with unrealistic proportions) and indicate the height of the human referenced. To maintain accurate proportions, when referencing 3D scan data to produce the illustration, parallax should be disabled, and likewise, when photographing specimens for the purposes of illustrating a skeletal diagram, distortion in the image caused by parallax should be minimized.

Funding Sources Nothing to declare.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Paleontology in Cuvier’s Paris: an international research experience for historically minoritized undergraduates aimed at broadening participation

Hartstone-Rose, Adam¹, Cerda-Smith, Jacqueline², Deutsch, Ashley R¹

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Psychology, North Carolina State

University, Raleigh, North Carolina, United States

A lack of research opportunities for minoritized students contributes to limited diversity in science, technology, engineering and mathematics (STEM). Most research programs recruit students with high grades, volunteer lab experience, and strong recommendations from research supervisors. Although these track-records of success may increase the likelihood that the recruited students will be successful in these programs, these requirements are barriers to marginalized students who may have poor grades and have forgone research opportunities because of other societal pressures (e.g., the need to work for a salary).

Thus, we recruited minoritized students – selecting students, regardless of academic success and without previous research opportunities – to participate in an intensive funded international research program. Students participated in a week-long training in comparative anatomy research methods and traveled for a month to Paris to collect data in the historic museum collections. Before and after the program, participants responded to questions about their STEM career interest, research self-efficacy and science identity.

Twelve participants (2 cohorts, 83% female, male = 21.25) identified as Black (25%), Latina (25%), White (25%) and Multiracial (25%). Two identified as neurodivergent. Paired-samples t-tests were conducted to explore pre/post-program changes in science identity, research self-efficacy, and STEM career interest. Even with a small sample size, the program had a statistically significant impact on both cohorts: Participants demonstrated enhanced science identity and increased research self-efficacy. Furthermore, the program influenced career interests: although some leaned away from research trajectories, others, who did not previously envision themselves as being

capable of pursuing further STEM degrees, developed substantial research interests – including pursuing PhD programs. This study affirms that a program designed to give research experience to historically marginalized students can have considerable effects on science identity and career trajectories – potentially broadening participation in our academic fields.

Funding Sources The National Science Foundation (USA)

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

First record of non-avian Maniraptora (Theropoda) from Minnesota (USA)

Hastings, Alex K.¹, Westgaard, John G.², Hanks, H. D.¹, Korf, Jason¹, Makovicky, Peter³

¹Paleontology, Science Museum of Minnesota, St. Paul, Minnesota, United States, ²Minnesota Discovery Center, Chisholm, Minnesota, United States, ³Earth & Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States

Fossil remains of non-avian maniraptorans are rare in eastern North America. Known occurrences are limited to southern and eastern regions, with no record for the upper Midwest. Discovery of a fossil distal ungual (claw) of a non-avian maniraptoran from northern Minnesota represents a key expansion of their record. To date, this is the only confirmed presence of any non-avian theropod from Minnesota. The fossil was recovered in 2015 as part of the Hill Annex Paleontology Project, collecting Cretaceous fossils from a former mine in the Mesabi Iron Range. While displaced from the original rock wall, massive piles of the Cenomanian-aged Coleraine Formation remain adjacent to the pit and have yielded countless vertebrate fossils.

Anteroposteriorly, the ungual is 34.4mm long, with just a small portion of the narrow tip missing. At the articular facet, it is 19.2mm tall and 7.0mm wide. It possesses a fairly robust flexor tubercle with notable dorsal curvature along the ventral margin and is also quite mediolaterally compressed. The claw sheath groove is more prominent on one side than the other, and is dorsoventrally offset between left and right sides. Placement in the pes or manus has been difficult. The strong mediolateral compression and lack of ventral thickening precludes identification as pedal unguals I, III or IV. Manual unguals reportedly curve upwards from the articular surface when the latter is vertical, and also bear flexor tubercles that are half or more the depth of the articulation. Neither of these traits is observed in the Minnesota specimen. Based on these factors, the specimen appears to be a paravian pedal ungual II, the ‘sickle’ claw. These combined features along with the overall profile align best with Troodontidae.

Troodontids in North America have largely been limited to the western portion, but there are known occurrences in north-central South Dakota and northeastern Texas (the only other Cenomanian record for North America). Troodontid presence on the continent is rare at this time, and this specimen helps fill a temporal gap between their oldest occurrence in the Early Cretaceous (Valengian) and their much more common occurrences in the Campanian. Further taxonomic assignment is limited, but additional maniraptoran material from Minnesota could provide a more definitive identification.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Assembling a dinosaur assembly: Development of dinosaur-themed STEM content for grades 3–5

Hastings, Alex K.¹, Holm, Jessica², Stallnick, Emilie², Groenert, Janet², Rohde, Brendan², Dzenowski, Nicole¹, DeVault, Grace¹

¹Paleontology, Science Museum of Minnesota, St. Paul, Minnesota, United States, ²STEM Education, Science Museum of Minnesota, St. Paul, Minnesota, United States

The Science Museum of Minnesota (SMM) provides educational experiences to students across the state, including large-group assemblies. A popular SMM assembly is a Dinosaurs program for K–2nd grade that uses fossils to demonstrate making observations. To complement this learning goal, the team developed a Dinosaurs program for 3–5th grade that focuses on how and why scientists change their minds.

The thesis of the assembly is how scientists use new evidence to revise their ideas, using dinosaur behavior and appearance as examples. It opens with early paintings of dinosaurs in a “kangaroo pose” and a photo of a real theropod fossil trackway. Students re-create the trackway with a tail that either drags on the floor or stands out behind them, showing that fossil evidence does not support a tail-dragging posture. Continuing the theme of reconsidering paleoart, students next see depictions of modern animals drawn in a “shrink-wrapped” style, encouraging them to think about how dinosaurs might have looked different from how they are often depicted. Next, it moves from speculation to evidence-based comparison, sharing research on melanosomes in fossil feathers, and letting students compare fossil and modern bird feather appearance. This highlights another way that scientists reassess evidence to change their ideas, using new tools like microscopes. Next up is how *Microraptor* may have used its four feathery wings. Students launch *Microraptor* models down from a tree and up from a rock to represent the concepts of “tree down” and “ground up,” resulting in no right answer (yet)! Students see how using a model based on modern animal behavior to

replicate the behavior of an extinct animal is a way to collect data, just like observing fossils. The assembly ends with the end of the Cretaceous Period. A demo about how paleontologists and geologists came together to solve the question of the K–Pg extinction emphasizes collaboration as an important tool in science.

After piloting and updating, the assembly is now a part of the SMM outreach catalog. Initial feedback from educators has been very positive. This assembly, using dinosaurs as a fun hook to talk about how scientists change their minds, was conceived of during the anti-science backlash of the pandemic. Because of this, it became a passion project, and helps to communicate to young people that change in science is healthy, and ideas changing due to observation and modeling means stronger ideas.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Examination of the predentary bone and lower jaw kinematics in *Euoplocephalus tutus* using multibody dynamic modeling

Haye, Justin¹, Siegler, Sorin², Nabavizadeh, Ali³, Booth, Skylor L.⁴, Voegele, Kristyn¹

¹Geology, Rowan University, Glassboro, New Jersey, United States, ²Mechanic Engineering and Mechanics, Drexel University, Philadelphia, Pennsylvania, United States, ³Biomedical Sciences School of Veterinary Medicine, University of Pennsylvania, Philadelphia, Pennsylvania, United States, ⁴Herald Hamm School of Geology and Geological Engineering, University of North Dakota, Grand Forks, North Dakota, United States

Ornithischia is well known for numerous cranial specializations allowing for intra/interspecific identification, defense, and efficient mastication of plant matter. One

such specialization is the presence of the prementary bone, which evolved three main morphotypes thought to provide different advantages in cropping and processing of plant matter. It has been previously proposed that the prementary would provide a fixed point, in occlusion with the premaxilla, to facilitate palinal (posteriorly-oriented) and medial rotations of the dentaries predicted by previous dental microwear studies. To test this hypothesis, we modeled the skull of *Euoplocephalus tutus* within the multi-body simulation software, Adams, with six degrees of freedom at each joint. Following a recently hypothesized reconstruction of adductor musculature, we simulated all adductor musculature as 14 muscle strands per dentary that originate in the adductor cavity and insert more anteriorly on the dentaries than in other reconstructions. Our model allows for independent motion of the dentaries, and we demonstrate it can produce the palinal and medial rotations seen in microwear studies. Such kinematic solutions are produced by varying the individual muscle strand forces and recruitment timing of each strand. Independent motion also allows for unilateral bite force to be tested by occluding the jaw on a solid cylinder, which produces the same predicted palinal and medial rotations, without the variations mentioned above. The bite force generated from this simulation can also be compared with a recent study that utilized a reconstruction of less anteriorly-extending adductor musculature and finite element analysis (FEA) to estimate the bite force of this taxon. For example, we found using the minimum force required to achieve occlusion (56 N) produced a posterior bite force of 228.39 N. Others have found using FEA that a muscle force based on estimated cross-sectional area (1883.2 N) could produce a bite force of 443.75 N in this taxon, indicating that the choice of modeling parameters and methods influence estimated bite force. Thus, our model demonstrates an alternative method for

estimating bite force and supports the hypothesis that anterior attachment of the adductor musculature on the dentary can produce the jaw motions observed in dental microwear studies through both simulations of passive (unilateral chewing) and active movements (varied muscle recruitment timing and force magnitudes).

Funding Sources Rowan University

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Younger giants: Reconstructing the evolutionary and ecological histories of *Python* (Serpentes: Pythonidae) in Africa

Head, Jason¹, Lawing, Michelle², Manthi, Fredrick³, Parker, Abigail K.⁴, Boisserie, Jean-Renaud⁵, Roberts, Lucy E.¹, McNulty, Kieran P.⁶, Cote, Susanne⁷, Müller, Johannes⁸

¹University of Cambridge, Cambridge, United Kingdom, ²Texas A&M University, College Station, Texas, United States, ³National Museums of Kenya, Nairobi, Kenya, ⁴University of Helsinki, Helsinki, Finland, ⁵Université de Poitiers, Poitiers, France, ⁶University of Minnesota, Minneapolis, Minnesota, United States, ⁷University of Calgary, Calgary, Alberta, Canada, ⁸Museum fuer Naturkunde, Berlin, Germany

Pythonids are among the largest extant snakes, with multiple independent evolutionary histories of gigantism including occasional total body lengths (TBL) exceeding six meters in tropical Asia, Africa, and Australia. The histories of gigantism in pythonids, including their timing and environmental drivers, remain poorly understood, however, due an apparent paucity of fossil evidence. Multinational field research in the Neogene through Holocene of Kenya and Ethiopia combined with surveys of museum collections from Kenya, Ethiopia,

Tchad, and Uganda have generated a long, nearly continuous record of pythonid precloacal vertebrae and cranial remains spanning the last 20 million years, allowing for inferences of immigration, divergence timings, and body size evolution through equatorial climatic transitions.

There are no definitive records of pythonids from African Paleogene localities, and precloacal vertebrae from the Early Miocene (approx. 21 Mya) localities of Napak, Uganda represent the first occurrence of the lineage on the continent. Exceptionally preserved cranial remains from the Kiahera Formation, Rusinga Island, Kenya are morphologically consistent with extant *Python sebae*/*P. natalensis* and indicate divergences within Afro-Asian *Python* by no younger than approximately 18 Mya. Employing established linear regression models of vertebral measurements against TBL for extant snakes produces a history of body size change in *Python* consisting of smaller maximum lengths between two and four meters during the Early to Middle Miocene, following by maximum increases to between five and six meters from the Late Miocene to Pleistocene. A single precloacal vertebra from the lower Pleistocene of the Shungura Formation of Ethiopia models an estimated body length of seven meters, approximating the largest reported modern lengths. In total this record indicates a young history of body size increase within the lineage, a pattern that is inconsistent with climatic histories of temperature decrease and increased seasonality, given a poikilothermic metabolism. Instead, size increase is consistent with environmental transitions toward open habitats and concomitant increases in body size and diversity of bovid ungulates, an important prey item of extant *Python*.

Funding Sources Funded by NERC grant NE/W007576/1 to JJH, NSF award 2124836 to JJH and AML, and a Cambridge Africa Grant to JJH and FKM.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Tanystropheid (Diapsida, Archosauromorpha) occurrences from the Lower Triassic Burgersdorp Formation (Cynognathus Assemblage Zone: Early Triassic) of South Africa: A rare early Gondwanan record of the clade

Heckert, Andrew B.¹, Hancox, John P.², Choiniere, Jonah²

¹Geological & Environmental Sciences, Appalachian State University, Boone, North Carolina, United States, ²Evolutionary Sciences Institute, University of the Witwatersrand, Johannesburg, South Africa

In the wake of the end-Permian mass extinction diapsids would come to dominate most tetrapod-based ecosystems. While the roots of diapsid diversification extend deep into the Permian, great disparity, especially among archosauromorphs, is so far only apparent in the Triassic. One early example of this diversification are the highly autapomorphic tanystropheids, which possess the proportionately longest necks of any Triassic tetrapod, with cervical centra four to 14 times longer than tall. Although their distinctive vertebrae render even isolated fossils identifiable, currently the overwhelming majority of the tanystropheid record is Laurasian, with essentially all complete specimens from Middle and Upper Triassic strata of western Eurasia and North America.

Here we describe six cervical vertebrae that represent multiple individuals of modestly sized (estimated ≤ 2 m total skeletal length) archosauromorphs that we interpret as early occurrences of tanystropheids. These fossils derive from multiple horizons at Driefontein, an exceptionally fossiliferous outcrop in the lower Burgersdorp Formation in the Free State of South Africa. The Driefontein

assemblage is the type assemblage of the *Garjainia-Langbergia* subzone at the base of the *Cynognathus* Assemblage Zone (CAZ) and is of latest Early Triassic age. While not exceptionally elongate, all of the centra we describe here are considerably longer than either articular facet is tall (~3:1). Other key features include the relatively low position of the diapophysis (at the mid-height of the articular facet), the minimal separation between it and the parapophysis, and extremely low neural spines. Longitudinal ridges extend posteriorly along the lateral surfaces of the centra from both the diapophyses and the prezygapophyses. The preserved individuals are of different sizes, but their neurocentral fusion provides evidence that they are adults, suggesting that either two taxa are present or, alternatively, a single taxon with substantial ontogenetic variation. The Driefontein tanystropheids join *Augustaburiana vatagini* Sennikov from the Lipovskaya Fm of Russia and probable tanystropheids from the Sanga do Cabral Fm in Brazil as the earliest records of Tanystropheidae. Tanystropheids comprise fewer than 10 of the tens of thousands of specimens from Driefontein, highlighting the importance of collecting and identifying large quantities of specimens whenever possible.

Funding Sources ABH was funded by a Fulbright Global Scholar award. JNC is funded by a grant from the NRF AOP program (GUN 136516).

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Hierarchical variation in eggshell ornamentation elucidates unique oviraptorosaur nesting biology

Hedge, Joshua^{1,2}

¹Biology, NC State University, Raleigh, North Carolina, United States, ²Biology, Lake Forest College, Chicago, Illinois, United States

Oviraptorosaurs are one the most enigmatic and unique clades of dinosaurs, laying pairs of the largest eggs in the fossil record (*Macroelongatoolithus*, > 50 cm), in nests that have complex and unique architecture. The eggshell exterior is sculpted with lavish nodes and ridges that are most variable in these dinosaurs. Gross observation of a *Macroelongatoolithus* nest from the mid-Cretaceous of Utah (NCSM 33576), the first of its kind in North America, insinuates variation even between eggs within this same nest, necessitating investigation at greater resolution than current categorization permits. Oviraptorosaur eggs have such variable ornamentation that interpretation beyond high level taxonomy is difficult to study with current methodologies.

Here I address 1) at what hierarchical level(s) does ornamentation vary, 2) can quantification of ornamentation independently corroborate hypothesized oviraptorosaur nesting habits, and 3) how does their unique nesting biology fit into the macroevolution of dinosaurs and birds?

I describe a new quantitative method (SCORE) for external eggshell ornamentation analysis through surface-scanning and analysis using three functions in the R package 'molaR', proxies for ornamentation complexity, relief, and direction. This method statistically corroborates gross observations of ornamentation. I expanded the study to other oviraptorosaur nests of various sizes and geographic regions. My results here show variation across a range of hierarchies: all nests (n = 13) were significantly different from each other, and inter-pair eggs of the same nest were significantly different but intra-pair eggs were not. I conclude that 1) eggshell ornamentation patterns within nests supports oviraptorosaur polygamy and non-functional drivers of ornamentation variation, and 2) more complex and higher relief ornamentation is selected for in response to increased chemical thinning in more mesic paleoenvironments. Both conclusions are

supported by independent lines of evidence, represent a departure from the macroevolutionary lineage of avian and non-avian theropods, and reiterate the unique nature of oviraptorosaur reproductive biology.

Funding Sources Jurassic Foundation; Paleontological Society Yochelson Student Research Awards; Western Interior Paleontology Society, Karl Hirsch Memorial Grant (JH), NSF #1925973 (LZ)

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

New tetrapod material from the Lower Pennsylvanian Scottish Coal Measures

Herring, Theodore^{1,2}, Brusatte, Stephen¹, Elliott, Francis³, Smithson, Timothy⁴, Challands, Tom¹

¹University of Edinburgh, San Francisco, California, United States, ²University of Minnesota, Minneapolis, Minnesota, United States, ³Scottish Universities Environmental Research Centre, University of Glasgow, Glasgow, Scotland, United Kingdom, ⁴University Museum of Zoology, University of Cambridge, Cambridge, United Kingdom

The water-to-land transition was a major shifting point in the diversification of tetrapods that took place during the Devonian and Carboniferous Periods. However, vertebrate fossils from these periods are rare, leaving much of this transition a mystery. Fifty vertebrate fossils were recently discovered from a locality in Scotland of Langsettian age (Lower Pennsylvanian), including tetrapod and fish fossils of new or rare genera. These fossils are described using micro-CT scans, photography, illustration, and comparative anatomy. A phylogenetic analysis was conducted to determine the new genera's relationships to other tetrapod taxa. Many of the identified genera belong to broader

tetrapod groups not yet discovered in Lower Pennsylvanian and/or Scotland localities, reframing our knowledge of tetrapod geographical and temporal distribution.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Evaluating the use of casting sand as a medium for large block stabilization

Herzog, Lisa¹, Anné, Jennifer¹, Lund, Eric¹, Knowles, Aubrey¹, Zanno, Lindsay E.^{1,2}

¹NC Museum of Natural Sciences, Raleigh, North Carolina, United States, ²Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

In 2023, the NCMNS prepared to open a new exhibit and paleontology lab space to house the iconic Dueling Dinosaurs specimen. This project included moving a total of eight large field jackets into the space from various storage rooms around the building. Together the combined weight of these fossil jackets totaled nearly thirty-two thousand pounds. Fossil jackets were previously opened, partially prepared, and fossils were exposed for over a decade without additional stabilization. As a result, most of the blocks contained visible cracks in the matrix that extend deep into the matrix. After careful consideration, the team chose to use a novel method for paleontology but familiar to metal foundries known as casting sand or greensand. This method was selected for several reasons but primary importance was the low impact of chemical contamination to the specimen in consideration of future molecular analysis and reversibility. Details of the casting sand method were presented at this Society's Annual Meeting in 2023. Our custom greensand mixture ended up at 50% play sand, sieved to 1.18mm grain size and 50% sodium bentonite clay purchased online and pulverized in a blender for consistency. Tap water was added slowly until the mixture

would hold its shape when compressed (~30% volume of dry mixture). The mixture was successfully applied to fill all cracks in the blocks prior to their relocation into the new lab space. After moving, and now being in place for a little over a year the success and satisfaction with this method has been assessed. We have found that the casting sand method served the purpose intended for stabilizing cracks in the blocks. Specimen blocks were moved into the new lab space with no visible damage or additional cracking either around or through the greensand filled spaces. Once the greensand has dried out, it maintains a cohesive structure, but is not difficult to remove.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Sticking up for Cuvier: osteological correlates of performance and ecology from big morphological data

Hieronymus, Tobin^{1,2}

¹Anatomy & Neurobiology, Northeast Ohio Medical University, Rootstown, Ohio, United States, ²Biomedical Sciences, Kent State University, Kent, Ohio, United States

Highly-dimensional, densely-landmarked morphology datasets seem to offer an unparalleled chance to test for relationships between morphology and function, but many recent analyses of morphological covariance in big morphology data have only recovered allometric and phylogenetic signal. This has been surprising, as many of the systems assessed (e.g., bird beaks) have long been viewed as textbook examples of adaptive morphology. Many current forms of analysis, inherited from linear and low-dimensional geometric morphometrics, do not allow full exploration of densely-sampled morphology—or if they do, they couple

morphological complexity with ambiguous, low-fidelity ecological data. This results in bias that inflates evolutionary allometric signal and filters out ecological relationships. While the prevalence of evolutionary allometry is a noteworthy result, it does not need to be mutually exclusive of ecological signal. This study uses simulations alongside Partial Least Squares (PLS) analyses of hand-wing morphology and qualitative ecological information in extant coraciimorph birds to assess two analytical strategies for recovering ecological relationships. The first strategy addresses the shape of ‘unpreserved attribute’ data, and is assessed by comparing guild-like ecological categories (e.g., aquatic, semi-aquatic, and terrestrial), principal coordinate analyses on binary performance-related characters, and direct inclusion of binary or proportional performance-related characters by a modified Hellinger transform. Preliminary results of this assessment show that both data reduction approaches restrict inferences to patterns of covariance seen in the ‘training’ taxon set, preventing an inference of novel performance combinations with novel morphology. The second strategy addresses the treatment of landmark data, and is assessed by comparing morphological data reduction by Principal Components Analysis, landmark decimation based on morphological covariance, and a novel decimation approach informed by estimated morphology-performance relationships across the tree. Preliminary results from this assessment show that strict morphology-based data reduction may not be desirable for PLS analyses of ecology. Taken together, these strategies offer a means to look past expected allometric signal and test for subtle, evolutionarily stable relationships that can serve as quantitative osteological correlates.

Funding Sources Northeast Ohio Medical University

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

A leg to stand on: a new sauropod dinosaur hindlimb from the Wessex Formation, Isle of Wight, UK

Higgins, Robert¹, Mannion, Philip D.¹, Barrett, Paul², Upchurch, Paul¹

¹Earth Sciences, University College London, London, United Kingdom, ²Earth Sciences, Natural History Museum, London, United Kingdom

The Barremian Wessex Formation of the Isle of Wight, United Kingdom, offers a globally significant glimpse into the sauropod dinosaur faunas of the Early Cretaceous. These deposits have yielded specimens of several eusauropod lineages, including rebbachisaurids, early-branching titanosauriforms, and titanosaurs. Here, we report an undescribed sauropod partial hindlimb (NHMUK PV R 16500) from the Wessex Formation, composed of an associated left tibia, astragalus, and nearly complete pes. Phylogenetic analyses support an early-branching somphospondylan position in most cases, but a minority of results place NHMUK PV R 16500 as an unexpected early-branching flagellicaudatan. If the latter is correct, this would bolster otherwise tenuous evidence for the persistence of flagellicaudatans in Laurasia after the Jurassic/Cretaceous transition. However, we present evidence that the somphospondylan interpretation is more plausible and should be preferred for the time being. NHMUK PV R 16500 can be diagnosed on the basis of two autapomorphies (an unusually high distal end to midshaft transverse width ratio in metatarsals III and IV, and the presence of small bump-like projections located in the centre of the proximal articular surfaces of the unguals of pedal digits I and II), and displays numerous features that distinguish it from other contemporaneous early-branching

somphospondylans known from Europe. Although NHMUK PV R 16500 might represent a new taxon, we do not erect a new name at this stage because of its relatively incomplete preservation and a lack of anatomical overlap with other named putative somphospondylans from the Isle of Wight fauna (e.g. *Eucamerotus*).

Funding Sources PDM's research was supported by a Royal Society University Research Fellowship (UF160216, URF\R\221010).

Colbert Prize Session

New fossil balaenopterid (Cetacea: Mysticeti) from the Middle Miocene of the western North Pacific

Higuchi, Sena¹, Kohno, Naoki^{1,2}

¹Graduate school of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan, ²Department of Geology and Paleontology, National Museum of Nature and Science, Tsukuba, Ibaraki, Japan

The evolution and adaptation, diversification of the baleen whales of the Balaenopteridae in the Mysticeti have long been a subject of studies for the marine mammal biology. Morphological and molecular evidence have been analyzed to understand their phylogenetic relationships, however hypotheses explaining their evolutionary history are still controversial. The Balaenopteridae includes the charismatic blue whale, the largest mammal on the Earth, but their early evolution is uncertain due to the lack of sufficient fossil evidence for the early diverging taxa among them. A new Middle Miocene specimen of balaenopterid from Japan will help elucidate this evolutionary history.

The specimen (MSFM-00013) was collected from the Middle Miocene Bessho Formation in Matsumoto City, Nagano Prefecture, by the

staff of the Matsumoto Shiga Fossil Museum (MSFM) in 1988. We included morphological data from MSFM-00013 into previous phylogenetic analyses for the Mysticeti including the Balaenopteridae including, a cranium containing the posterior part of the rostrum and the braincase with the ear bones. We also conducted our phylogenetic analysis with backbone constraint of topology based on the molecular evidence of the extant taxa.

On the basis of our phylogenetic analysis, MSFM-00013 is recognized as a balaenopterid because it exhibits a derived character of the Balaenopteridae; a supraorbital process of the frontal that is abruptly depressed to a level noticeably below the vertex with the lateral skull wall above the supraorbital formed by both the parietal and the frontal. This new specimen is recognized as a basal taxon within the family because lacks characters of later diverging balaenopterids such having an anterior border of the supraoccipital shield that is squared (it is rounded in MSFM-00013). MSFM-00013 is known from the Middle Miocene (14-13 Ma), and our results are consistent with the fact that it is the oldest known balaenopterid.

Additionally, palaeobiogeographic analyses based on our phylogenetic tree suggests that the emergence of the Balaenopteridae might have occurred in the North Pacific before the Middle Miocene. It is possible that the high productivity due to upwelling at that time might have encouraged baleen whales to adapt to engulfment filtration, as seen in the modern balaenopterids.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Qualitative XROMM analysis of hip joint kinematics and soft tissue interactions in

***Alligator mississippiensis* during low-walk locomotor behaviors**

Hill, Danielle¹, Tsai, Henry P.^{1,2}

¹Biology, Southern Connecticut State University, New Haven, Connecticut, United States, ²Biomedical Sciences, Missouri State University, Springfield, Missouri, United States

The hip joint anatomy of extant archosaurs differs significantly between the avian and crocodilian lineage. In particular, the crocodilian hip joint uses a large amount of soft tissues, including hyaline cartilage, fibrocartilage, and elastic tissues to maintain congruence between the femur and acetabulum. Previous work has documented the structures, kinematics, and soft tissue interactions in the hip joint of *Alligator mississippiensis* during the high-walk locomotor behavior. However, the kinematics and functional roles of hip joint soft tissues during low-walk (“sprawling”) behaviors remain poorly understood. This study used marker-based XROMM (x-ray reconstruction of moving morphology) to qualitatively analyze the kinematics and soft tissue interactions within the alligator hip joint during the low-walk. Metallic markers were surgically implanted onto the hindlimb and pelvic bones of three juvenile alligators. After recovery, the animals’ locomotor behaviors were recorded using biplanar x-ray cameras. Three dimensional positions of the markers were digitally tracked and used to animate 3D models of the pelvic girdle and soft tissues of the same individuals derived from contrast-enhanced CT scans. Compared to the high-walk, the low-walk is characterized by elevated levels of abduction in both swing and stance phases, with medial and lateral rotation of the femur playing key roles in orienting both the femoral head and distal condyles, and therefore the knee, throughout the step cycle. However, our results reveal broadly similar soft tissue interactions during the low-walk as the high-walk. The

anatomical neck of the femur maintains articulation with the antitrochanter menisci throughout the entirety of the step-cycle, whereas the anatomical head of the femur frequently moves outside the center of the acetabulum during hip extension. Consistent interpenetration of the antitrochanter and acetabular labrum with the fibro- and hyaline cartilage of the proximal femur suggests possible deformation of these acetabular soft tissues in life. These results contribute to a growing foundation of knowledge that will lead to a better understanding of the mechanical and functional properties of soft tissues within archosaurian joints. Continuation of these studies may aid in reconstructing the functional consequences of articular soft tissue in extinct archosaur joints, as well as the role of each tissue in the vertebrate skeleton.

Funding Sources This research is supported by the Brown University Bushnell Postdoctoral Research Grant and the Southern Connecticut State University Faculty Startup Fund.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A partial skeleton of a Middle Mississippian (Viséan) ctenacanthiform shark (Chondrichthyes, Elasmobranchii, Ctenacanthiformes) from the Horse Cave Member of the St. Louis Formation at Mammoth Cave National Park, Kentucky, U.S.A.

Hodnet, John-Paul M.^{1,4}, Bolden, Richard², Toomey, Rickard², Olson, Rickard², Tolleson, Kelli², Tweet, Justin³, Santucci, Vincent⁴

¹Archaeology, Maryland-National Capital Parks and Planning Commission, Upper Marlboro, Maryland, United States, ²Paleontology Program, National Park Service, Washington, District of Columbia, United States, ³Mammoth Cave National

Park, National Park Service, Mammoth Cave National Park, Kentucky, United States, ⁴Paleontology Program, National Park Service, Cottage Grove, Minnesota, United States

Mammoth Cave National Park (MACA) in central Kentucky holds the longest cave system in the world, with cave passages cutting through Middle to Upper Mississippian limestones. These limestones hold records of fish assemblages, mostly dominated by chondrichthyans, that are primarily identified from isolated teeth, spines, and occasional skeletal cartilages. The Middle Mississippian Ste. Genevieve Formation has examples of two ctenacanthiform specimens that preserve both teeth and jaws belonging to *Saivodus striatus* and *Glikmanius careforum*.

A new partial skeleton of a shark has been found in the ceiling of an underground river passage, which is only accessible by kayak, in the older Horse Cave Member of the underlying St. Louis Formation. The partial skeleton consists of associated, though scattered, cartilages pertaining to the jaws, hyoid arches, branchial arches, and scapulocoracoid. This skeleton is identified as a ctenacanthiform shark based on the presence of a square-shaped anterodorsal process on the otic process of the palatoquadrate and a well-developed dorsal ridge originating from the anterodorsal otic process to the quadratic process, as well as the Meckel's cartilage bearing a ventrolateral ridge originating from the articular cotylus, and a retroarticular process that extends two thirds the length of the jaw.

The jaws of this new ctenacanth skeleton are less anteroposteriorly elongated than those seen in *Ctenacanthus* and *Cladodus*, but are more elongated than those seen in *Heslerodus*, *Glikmanius*, and *Dracopristis*. However, this individual does share with the latter three taxa the palatoquadrate having a less anteroposteriorly expanded though more

dorsoventrally deep otic process. These jaws are nearly identical in the morphology seen in a partial skeleton of a small juvenile ctenacanthiform shark from the Late Mississippian Bear Gulch Limestone in Montana that bears *Saivodus*-like teeth. Potentially, this new skeleton from MACA may represent a more mature *Saivodus striatus* and could provide important information on the ontogenetic development of this taxon.

Funding Sources N/A

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Ears of an enigma: Reconstructing the hearing characteristics of the extinct American Cheetah, †*Miracinonyx trumani*, using dynamic finite element methods

Hoeflich, Jennifer^{1,2}, Liu, Juan^{1,2}

¹Integrative Biology, UC Berkeley, Berkeley, California, United States, ²University of California Museum of Paleontology, Berkeley, California, United States

Despite the ecological importance of hearing in mammals, the functioning of the middle ear has been largely underexplored in paleontological research. The goal of this study is to reconstruct the hearing capability of †*Miracinonyx trumani* and evaluate its ecological implications. †*M. trumani* ranged across the western and southern United States during the Rancholabrean (0.25-0.012MY), and whether it preferred dense understories like the puma, open savanna like the African cheetah, or most recently the mountainous terrain like the snow leopard is under debate. Using previously developed and validated dynamic finite element methods for modeling the hearing function of *Felis catus* and *Vulpes vulpes*, we are able to estimate hearing characteristics by simulating the middle ear function of extinct carnivorans. We CT-scanned one specimen of

†*M. trumani* (UCMP 29524) using GE Phoenix Nanotom M (voxel size 40.7µm, power 120 µA, current 120 kV). Both the malleus and incus were intact and digitally recovered through segmentation in Avizo. The stapes was not recovered from the specimen, instead reconstructed and rescaled using the stapes geometry of the extant *Felis catus* which was viable because of the extremely conserved stapes morphology in Felidae. We processed the ossicles in Geomagic Wrap (Version 2021.0.0.3008), then constructed the model and ran modal and harmonic analyses in ANSYS Workbench (Version 2021 R1). Our harmonic analysis produced a resonant frequency at the stapes footplate of 3 KHz, tested in frequency range of 0.01-150 KHz – inclusive of the full known carnivoran hearing range. The resonant frequency is the frequency at which the middle ear ossicles most efficiently transfer sound pressure into the inner ear and therefore corresponds to highest hearing sensitivity. The estimated best hearing frequency at 3KHz is close to that of the African lion, 2.7 KHz., as estimated from middle ear impedance measurements. These preliminary results suggest that †*M. trumani* may have also favored open habitats. This work is the first time that dynamic finite element analysis (dFEA) has been used to reconstruct an extinct animal's hearing abilities, and it demonstrates the utility of dFEA modeling for paleo-sensory reconstructions. To more accurately reconstruct the paleoecology of ancient cats, future work should incorporate more extant felines to establish the framework of forms and function of hearing and its characteristics associated with habitat.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Geometric morphometric analysis of the most complete dinosaur in Mississippi: a saurolophine hadrosaurid from an early-

Campanian locality in the Coffee Formation, Prentiss County, MS

Hoffman, Derek A.¹, Brink, Alyson A.^{1,2}, Phillips, George³, Starnes, James⁴, Baghai-Riding, Nina⁵, Hotton, Carol⁶, Pharr, Olivia⁵, Hanes, Dave⁷

¹School of Biological, Environmental, and Earth Sciences, University of Southern Mississippi, Hattiesburg, Mississippi, United States, ²Department of Vertebrate Paleontology, Sam Noble Museum, Norman, Oklahoma, United States, ³Mississippi Museum of Natural Science, Jackson, Mississippi, United States, ⁴Office of Geology, Mississippi Department of Environmental Quality, Jackson, Mississippi, United States, ⁵Division of Mathematics and Sciences, Delta State University, Cleveland, Mississippi, United States, ⁶Department of Paleobiology, National Museum of Natural History, Washington, District of Columbia, United States, ⁷Columbia Gem & Mineral Society, American Federation of Mineralogical Societies, Columbia, South Carolina, United States

The dinosaur fossil record of Mississippi includes nearly 90 dinosaurs, most consisting of individual elements with poor preservation. Hadrosauroids are by far the most well-represented dinosaurs in the state's fossil record, but none found so far contain enough diagnostic information permitting classification to species, genus, or even family. Here we describe the most complete dinosaur ever discovered in Mississippi, a saurolophine hadrosaurid (MMNS VP-12239) from the early to mid-Campanian Coffee Formation of northeastern Mississippi. This specimen was discovered in 2010 near Booneville, Prentiss County, MS. This site, informally named the Tolar-Stevens Dinosaur Site, has been interpreted as a tidally-influenced estuarine to deltaic environment in the Gulf Coastal Plain along the eastern flank of the Mississippi Embayment. At least two individuals have been recorded from the

site: a juvenile, represented by a toothless dentary, and an adult, represented by various postcranial elements. Additional fauna recovered from the site include bivalves, gastropods, ammonites, turtle shell fragments, shark teeth, and bony fish elements. Due to extensive modification of their cranial morphology, taxonomic identification of hadrosauroids has been achieved primarily using cranial characteristics. This is problematic for identifying the adult specimen because only postcranial elements have been recovered. Coupling this missing data with a paucity of southeastern hadrosauroids with which to compare makes identification more challenging. Geometric morphometric analyses of hadrosaurid cranial material has proven an effective tool to illustrate taxonomically significant differences in homologous characters between hadrosauroids. Some geometric morphometric studies focusing on the postcranial elements have also yielded promising results, particularly for identifying hadrosauroids to the subfamily level. Preliminary investigation suggests that MMNS VP-12239 exhibits a pubic morphology more similar to saurolophine hadrosaurids than to lambeosaurine hadrosaurids. The results of this study indicate that saurolophine hadrosaurids may have been present on the Mississippi embayment during the Late Cretaceous and adds to our understanding of southeastern Appalachian dinosaur diversity.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Osteohistology of the Eocene alligatoroid *Diplocynodon hantoniensis* informs growth in alligators and caimans

Hoffman, Devin¹, Felice, Ryan², Goldsmith, Erika R.³, Houssaye, Alexandra⁴, Maidment, Susannah⁵, Mannion, Philip D.¹

¹Earth Sciences, University College London, London, United Kingdom, ²Cell & Developmental Biology, University College London, London, United Kingdom, ³Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ⁴Mécanismes Adaptatifs : des Organismes aux Communautés, Muséum National d'Histoire Naturelle, Paris, France, ⁵Earth Sciences Division, Natural History Museum, London, United Kingdom

Among living crocodylians, alligatoroids exhibit a wide range of body sizes and a biogeographic distribution that spans tropical to temperate climates. The fossil record of alligatoroids shows even greater variation with multiple examples of gigantism. Osteohistological studies on extant alligatoroids shows living alligators and caimans both exhibit seasonal growth, with comparable growth rates. However, the dearth of studies on extinct alligatoroids makes it unclear if this shared condition indicates convergent responses to changing climate or represents the ancestral condition in alligatoroids. To address this discrepancy, we conducted the largest monospecific osteohistological studies of fossil crocodylians to date, providing unique insight into the intraspecific variation in growth of a fossil taxon. We describe the bone microstructure and histology of the early-diverging alligatoroid *Diplocynodon hantoniensis* from the late Eocene of the UK, based on a sample of nine femora. In addition to qualitative descriptions, we quantitatively reconstruct growth rates and allometry. The microanatomy of *D. hantoniensis* shows moderate bone compactness, with a well-defined medullary cavity, and histologic features that are consistent with those of extant alligatoroids. In all samples, the endosteal tissue is lamellar and periosteal tissue is dominated by parallel-fibered bone.

However, samples vary greatly in the degree of remodeling and vascularity, as well as preserving features such as Sharpey's fibers, highlighting the importance of studies on intraspecific variation. Our ontogenetic assessment indicates our sample captures a range of skeletally immature to mature individuals roughly related to femur size. We find that body size estimates for *D. hantoniensis* fall within the typical range of living American alligators. Femoral circumference scales positively with femoral length in *D. hantoniensis* ($p = 0.02$), demonstrating similar allometry to *Alligator mississippiensis*. This differs from other extant Crocodylians (e.g., *Crocodylus*, *Caiman*), which suggests that *D. hantoniensis* and *A. mississippiensis* experienced similar terrestrial loading and, therefore, locomotor habits. This in-depth look into a fossil alligatoroid indicates seasonality and growth rates were established near the base of Alligatoroidea and predicts that other extinct species of the clade likely exhibited similar growth and matches what limited data is already available for extinct alligatoroids.

Funding Sources This work was funded by NERC grant NE/X014010/1

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

MOR than puppets: Best practices in creating dynamic dinosaur ambassadors

Hogan, Chelsea¹, Hall, Ashley E.¹, Hall, Lee¹, Scannella, John¹, Kuhn, Keegan²

¹Montana State University Museum of the Rockies, Bozeman, Montana, United States, ²TRX Dinosaurs, Sedona, Arizona, United States

Dinosaur paleontology education can consist of using dinosaur toys, images, fossil casts, and other tangible static items to engage museum visitors. But in more recent years, 3-

dimensional, life-size puppets have been created by several different companies as a means to bring dinosaurs to life. While the majority of these companies have aesthetically pleasing puppets used for entertainment purposes, they are not always scientifically accurate, or used in an educational context. Museum of the Rockies, in partnership with TRX Dinosaurs, has come together to create eye-catching and accurate dinosaur puppets based on MOR's vertebrate paleontology collection. Utilizing the most up to date research, measurements, and a deep understanding of the specimen's anatomy, MOR and TRX produced several scientifically accurate and innovative reconstructions as tools for the museum's science communication, outreach, educational classes, and to inspire curiosity and wonder about Montana's dinosaurs. Through interacting with our dinosaur puppets, visitors of all ages and abilities have not only experienced the "WOW" factor, but have been intrinsically drawn in to learn more. Children's curiosity with dinosaurs is often their first introduction to scientific concepts, making the creations of scientifically accurate paleontological reconstructions of even greater importance.

Funding Sources Museum of the Rockies and MOR donor Anne Teppo.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Late Pleistocene fauna of Lake Elsinore (Riverside County, California) and observations on the timing of Pleistocene faunal extirpations

Hohman, Charlotte J.⁴, Dooley, Alton C.¹, Scott, Eric², Beatty, Brian L.³

¹Department of Biological Sciences, Sam Houston State University, Huntsville, Texas, United States, ²Western Science Center, Hemet, California, United States, ³Cogstone

Resource Management, Orange, California, United States, ⁴New York Institute of Technology, Old Westbury, New York, United States

The late Pleistocene megafaunal extinction in North America has been long debated, particularly regarding the respective influence of human activity and climatic factors. Recent assertions propose that a rapid drying of the environment and an uptick in fires possibly driven by humans ~13,200 years ago was largely responsible for the disappearance of the Pleistocene megafauna in southern California. However, occurrence dates for the megafauna were derived from dated Rancho La Brea (RLB) specimens, whereas the ash and pollen data indicating increased fire activity come from Lake Elsinore, a naturally occurring lake ~100 km from RLB that has been inundated at various times extending back to the late Pleistocene.

To test this hypothesis, we employed a late Pleistocene assemblage from Lake Elsinore, where 2017-2019 excavations for the Summerly Homes Development Project exposed Pleistocene lacustrine deposits, yielding mammalian megafauna (N=62), microvertebrates, and invertebrates. Wood specimens from the base of the fossil-bearing deposits yielded calibrated radiometric ages of 14,610 +/- 50 and 14,830 +/- 50 years before present, predating the proposed uptick in fires and loss of tree cover.

Bison comprised 50% of Lake Elsinore's megafaunal assemblage, with *Camelops* at 48.4%, and the remainder being *Mammut*. Absent from the fossil assemblage was *Equus*. This absence is likely not due to habitat preference, as *Equus* fossils are found in abundance across many other late Pleistocene sites; nor is it likely due to a sampling bias given the number of well-preserved fossils recovered from the site. The lack of *Equus* might be attributed to its extirpation in the region prior to the loss of the other megafauna. This contrasts with RLB,

where precise dating indicates that *Camelops* disappeared before *Equus*.

The Lake Elsinore fossils suggest a nuanced regional variation in megafaunal extirpation dynamics in southern California. This variation is not unexpected, as California contains a diversity of distinct communities in proximity to one another. This diversity is largely due to the heterogeneity of California's topography, which has remained relatively stable since the late Pleistocene.

Attempts to construct a narrative of extinction based upon data from disparate locations must be approached with caution. Because ash layers at Lake Elsinore are much younger than the fossiliferous layers lacking *Equus*, extirpations of some taxa may have commenced before the uptick in fires.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

The use of hydrogels in fossil preparation, a novel material and method in cleaning and removing matrix from bone

Holbach, Brady P.

Royal Tyrrell Museum, Drumheller, Alberta,
Canada

Water and scrubbing tools were vital prior to modern advancements in fossil preparation (e.g., air scribes, air abrasion, sonic cleaning). One method of fossil preparation that uses water is to slowly expose the bone to small amounts of water and use hand tools to remove sediment layers. Another, riskier method is to soak the entire fossil for a prolonged period of time; this softens the matrix for faster, easier removal, but can destabilize the interior of the bone. Delicate fossils cannot be soaked, and so preparators must either scrub or leave the matrix on if other methods are unavailable. In this work, I propose a novel method to address this problem using a hydrogel, which can

rehydrate and solubilize matrix with minimal water exposure (and risk of damage) to the fossil. Hydrogels are a network of polymers that absorb and hold liquids. The goal of using hydrogels for fossil preparation was to identify a solution for removing stubborn matrices that are: difficult to remove in a timely manner; containing delicate fossils that are vulnerable to damage during soaking; difficult to air abrade. I chose sodium polyacrylate as the polymer to make the gel for its ease of use and chemical similarity to Paraloid B72. The hydrogel was applied in 11 tests to six *Triceratops* fossils from the Hell Creek Formation that contained either phosphatized or compacted sediment. A thin layer of the hydrogel was applied to each fossil and left for 24 hours. Results were taken by visual inspection of the matrix removed after the fossils were cleaned with water and acetone to remove the hydrogel and hydrated matrix. The control was cleaning a spot of equal size and time on the fossil where hydrogel was not applied. The experiment ran over 72 hours, with cleaning and results taken every 24 hours. Results are categorized as such: major effect (majority of matrix was removed); minor effect (small amount of matrix was removed); minimal to no effect (no noticeable change occurred to the matrix from the control); or failure (the hydrogel desiccated in <24 hours). The 11 experiments resulted in two major, three minor, four minimal, and two failures. Phosphatized matrices were resistant to this method of cleaning, but proved effective with compacted matrices by either removing the matrix from the bone or decreasing the amount of work time needed to prepare the specimen. Therefore, I conclude that hydrogels should be considered an effective method for preparing fossils.

Regular Poster Session 2 (Thursday, October
31, 2024, 4:30 - 6:30 PM)

Reanalysis of the relationships among perissodactyls and certain South American native ungulates using an expanded matrix

Holbrook, Luke T.¹, Beatty, Brian L.², Croft, Darin A.³, Wright, April⁴

¹Department of Biological and Biomedical Sciences, Rowan University, Glassboro, New Jersey, United States, ²Department of Anatomy, NYIT College of Osteopathic Medicine, Old Westbury, New York, United States, ³Department of Anatomy, Case Western Reserve University, Cleveland, Ohio, United States, ⁴Department of Biology, Southeastern Louisiana University, Hammond, Louisiana, United States

South American native ungulates (SANUs) are a collection of extinct Cenozoic placental lineages known almost exclusively from South America. Many SANUs superficially resemble hoofed placental lineages from other continents, such as perissodactyls and artiodactyls, at least in certain respects. The relationships of SANUs to other placentals are not well understood, despite their extensive fossil record. Molecular data (DNA and collagen) obtained from two Late Pleistocene SANUs, one litoptern and one notoungulate, indicate that the closest living relatives of these lineages are perissodactyls. Subsequent studies have attempted to evaluate support for this claim via parsimony analyses of morphological data by adding representatives of several SANU lineages (specifically litopterns, didolodontids, and kollpaniines) to a published matrix originally created to analyze relationships among cambaytheres (an extinct group from the Eocene of India), perissodactyls, and paenungulates. One major limitation of these analyses is that they have included relatively few other extant and extinct placental lineages. Here, we analyze an expanded version of this “cambaythere matrix” that includes five additional afrotheres, two additional laurasiatheres, and three representatives of Euarchontoglires, a

supraordinal group not previously included in these analyses. The matrix includes the same SANUs as the previous studies and expands the number of characters from 214 to 332. An unconstrained parsimony analysis of this matrix recovers a monophyletic grouping of the SANU lineages with artiodactyls as their sister-taxon, and with Perissodactylamorphia as sister to this clade. Constraining the analysis to conform to the results of molecular studies of placental relationships results in a strict consensus that is far less resolved, though the majority rule consensus supports SANU lineages as having closer relationships to Perissodactylamorphia than to Artiodactyla. In future analyses, we will integrate additional SANU lineages, including notoungulates and astrapotheres.

Funding Sources Funding for this work was provided to LTH by US NSF (DEB 1456826)

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

From tots to titans: Implications of different modes of parental care on community structure in dinosaurs vs. mammals

Holtz, Thomas R.

Geology, University of Maryland, College Park, Maryland, United States

Mesozoic dinosaurs and Cenozoic mammals are often regarded as broadly ecologically equivalent, as they included the majority of medium-to-large-bodied terrestrial vertebrates of their respective eras. One of the most significant differences between them is their mode of reproduction: oviparity and large clutch size regardless of adult body size in the former; viviparity and litter size decreasing with adult body size in the latter. Furthermore, the disparity between hatchling and adult body size is much greater in dinosaurs than neonate and adult body size

in mammals on average. The effects of these differences are examined with regards to the size distribution and species counts in fossil communities.

Species lists and estimated adult body sizes were assembled for Jurassic and Cretaceous dinosaur and Cenozoic mammal communities based on the instantaneous diversity within well-sampled formations: only communities in which at least one taxon equal or exceeded 1000 kg mass were chosen. The distribution of adult sizes within communities were compared to replotting the same communities with earlier growth stages included in the "species size" counts: dinosaur hatchling size was estimated from known egg sizes of related taxa, while mammalian neonate size was estimated from those of extant relatives. The size distribution including the entire ontogenetic series results in a greater shift of average body size in dinosaurian communities than in mammals due to the much smaller dinosaur baby size. However, these two sets of plots may not reflect the ecological realities of their respective communities. In many mammals the young are directly fed via lactation and later by provisioning by mothers until they are a substantial fraction of adult body size: thus, the adult-only plots for mammals may be accurate reflections in terms of the realized feeding community structure. In contrast, evidence for long-term parental care in non-avian dinosaurs is scanty for most clades. While gregariousness is supported in the body and trace fossil record of dinosaurs in multiple clades, for most taxa this is found at present as intra- rather than multigenerational groups, with many juvenile dinosaurs living (individually or in small groups) independently for most of their lives. Thus, due to these ontogenetic niche shifts, those plots in which different growth stages are counted as their own "taxa" might more accurately represent the trophic ecology within dinosaurian communities.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Evaluating morphological characters used to distinguish dire wolves from other canids

Hoole, Brad, Schubert, Blaine W.

Center of Excellence in Paleontology and
Dept. of Geosciences, East Tennessee State
University, Johnson City, Tennessee, United
States

The evolutionary origin of the dire wolf (*Aenocyon dirus*), a large wolf-like canid that occurred across North America and into South America during the late Pleistocene, is not fully understood. While originally described as *Canis dirus*, the classification within the *Canis* genus has not always been supported, with the alternative *Aenocyon dirus* proposed and subsequently synonymized with *Canis dirus*. Morphological phylogenies supported this interpretation, but it was recently resurrected by a genetic study that indicated the dire wolf is a divergent lineage and offered an alternative phylogenetic hypothesis. Previous phylogenetic descriptions based on morphology suggested dire wolves being of the same stock as the extinct *Canis armbrusteri* and represented as a sister group to the extant gray wolf (*Canis lupus*). Distinguishing dire wolf characters include broad palate and frontal regions and a high sagittal crest with a backwards extension that exceeds other wolves. There are also distinguishing dental features associated with hypercarnivory, including a weakening, or loss, of the anterolabial cingulum in the M¹ and M₂, respectively, large upper and lower carnassials, reduced P⁴ deutocone and M¹ hypocone, and both the P² and P₂ often lack posterior cusps. *Aenocyon dirus* is generally considered to be more robust, with a larger skull, broader shoulders, and more massive pelvis than other wolves, but shares

dental synapomorphies with *C. armbrusteri*, as well as sharing dental and cranial synapomorphies with *C. lupus*. Dental autapomorphies appear to differentiate dire wolves from other canids. However, if the alternative genetic based phylogeny is correct in identifying *A. dirus* as a divergent line from *Canis*, it is possible that similar morphological features are influenced by convergence, thereby also influencing morphology-based phylogenies. With this in mind, this project reviews past criteria for separating dire wolves from gray wolves and other canids and explores the use of micro-CT technology on canid crania, particularly of the auditory region and inner ear, as a novel source of characters to further investigate the phylogenetic relationships of these canids based on morphology.

Funding Sources Funding for this work was provided by ETSU Center of Excellence in Paleontology and Department of Geosciences

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Exploring the macroevolutionary ratchet in burrowing mammals using phylogenetic and paleontological approaches

Hopkins, Samantha^{1,2}

¹Earth Sciences, University of Oregon, Eugene, Oregon, United States, ²Museum of Natural and Cultural History, University of Oregon, Eugene, Oregon, United States

Burrowing habits have evolved more than a dozen times across the mammalian tree, with convergent evolution of a variety of anatomical and physiological features associated with fossorial adaptation. Highly specialized burrowers, which have evolved a fully subterranean lifestyle, evolve a complex of adaptations that make evolutionary reversal very unlikely. Reduced eyes and ears

make predator detection more difficult, and shortened limbs with long claws make aboveground locomotion slow and awkward. All of these changes create an evolutionary landscape that favors the evolution of greater burrowing adaptation over time. Phylogenetic comparative analysis of evolutionary rates of burrowing evolution using a complete phylogeny of extant mammals demonstrates a clear macroevolutionary ratchet in burrowing, where these derived forms remain in this specialized ecology rather than re-evolving generalists. The best-supported models all show clearly that the rates of evolution of semi-fossorial or terrestrial ecology from a fully fossorial one are essentially zero. While consideration of many clades of burrowing mammals shows that this ratchet appears to hold even for the evolution of semi-fossorial habits, this is not supported by comparative analysis of extant mammal phylogenies. However, it appears that some of the reason for this lack of support is the difficulty of reconstructing the direction of character evolution in lineages that repeatedly evolve burrowing habits. Examination of the history of ecomorphological evolution with the addition of diversity from the fossil record shows a consistent pattern of increasing fossorial adaptation through time in burrowing lineages. Unfortunately, the paucity of phylogenies including fossil and modern burrowing taxa renders it difficult to reconstruct these histories for many of the lineages involved in spite of the excellent preservation of many extinct burrowing mammals. Continued efforts to elucidate the phylogeny of small mammal lineages will hopefully clarify the pervasiveness of the macroevolutionary ratchet in driving convergence of burrowing ecomorphologies.

Funding Sources This work was funded in part by NSF grants DEB-1256897 and EAR #2322803 to Samantha Hopkins.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Evidence of feeding by the macropredatory shark *Otodus megalodon* on a cetacean rib bone from the Middle Miocene Calvert Formation, Virginia, USA

Hoppe, David A.^{1,2}

¹AOES, George Mason University, Fairfax, Virginia, United States, ²Paleontology, Calvert Marine Museum, Solomons, Maryland, United States

Fossil cetacean bones exhibiting bite marks are relatively common in Neogene marine deposits and serve as evidence of trophic interactions (e.g. predation, scavenging) in the fossil record. Bite marks made by sharks typically occur as linear gashes on the outer surface of the bone. In rare cases, additional features such as parallel grooves made by serrations may permit the identification of the shark species responsible for the bite marks. Such identifications are relatively straightforward when fossil shark teeth are found associated with or, in exceptional cases, embedded in the cetacean bone. In the case of bite marks on isolated remains, one must rely on qualitative comparison of the marks with the morphology of teeth from shark species known from the same locality and horizon as the bone. A recently discovered partial cetacean rib bone recovered *in situ* from the Middle Miocene Calvert Formation (Virginia, USA) exhibits several conspicuous bite marks with fine parallel grooves presumably made by the serrated cutting edge of a large shark tooth. As preserved, the specimen is approximately 25.5 cm long and its overall size and morphology suggest it may have belonged to a small mysticete such as a cetotheriid. To identify the species that inflicted the bite marks, the rib specimen was consolidated and a silicone putty mixture was pressed into a gash with well-defined serration marks, producing a positive mold to serve as a model

of the original morphology of the shark tooth. This model was compared to the cutting edge of teeth from various shark species with large serrated teeth known from the Calvert Formation. The size and spacing of the serrations in the silicone model most closely resemble the cutting edge of teeth from the extinct macropredatory shark *Otodus megalodon*. The rib specimen represents evidence of *O. megalodon* feeding on large marine mammals, but whether this is an example of active predation or scavenging is uncertain. Smaller, unserrated bite marks occur along a sheared surface with serration marks, which may suggest subsequent scavenging by a smaller shark species after the larger mark was made. Despite not being associated with additional skeletal remains or shark teeth, this isolated cetacean rib fossil provides additional insight into the trophic interactions between sharks and cetaceans and the role of the latter as a food source for *O. megalodon* during the Middle Miocene.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Preliminary assessment of South American hadrosauroid dinosaur paleobiogeographical hypotheses using tip-dating Bayesian methods

Hornicak, Nicholas A.¹, Lamanna, Matthew², Gorscak, Eric³

¹College of Natural Science and Math, Indiana University of Pennsylvania, North Huntingdon, Pennsylvania, United States, ²Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ³Midwestern University, Downers Grove, Illinois, United States

Hadrosauroid ornithomimids were common during the Cretaceous in the Laurasian continents, with numerous taxa distributed throughout North America, Europe, and Asia.

However, hadrosauroid fossils are rare in Gondwana, having only been recovered from a limited number of localities in South America, Antarctica, and Africa. The recent discovery of several new hadrosauroid specimens from the latest Cretaceous (Campanian–Maastrichtian) of Patagonia has prompted questions regarding the paleobiogeographic origins of South American representatives of this clade. At present, there are two dominant hypotheses regarding the origin of South American hadrosauroids: the longstanding ‘North American immigrant (NAI) hypothesis’ proposes that these dinosaurs dispersed from North America into South America, probably via a single event, by the late Campanian (76–72 Ma). The competing ‘South American endemism (SAE) hypothesis’ argues that hadrosauroids had a substantially longer evolutionary history in South America and/or a more complex arrival pattern into the continent, potentially involving multiple dispersals.

To test these hypotheses, we modified a recent phylogenetic data matrix that includes most Patagonian hadrosauroid taxa and analyzed this dataset using tip-dating Bayesian methods in order to estimate divergence dates and assess paleobiogeographic patterns for these taxa. The modified matrix includes 360 characters and 51 non-lambeosaurine hadrosauriforms, but excluded definitive lambeosaurines because, based on prior analyses, they do not appear closely related to South American hadrosauroids. Autapomorphies of each taxon taken from the literature were added to the data matrix, and both paleogeographic and chronostratigraphic ranges were added from the Paleobiology Database to inform the tip-dating analysis performed in MrBayes [Ver.3.2.7a]. Resultant analyses recovered a monophyletic clade of South American hadrosauroids nested within the otherwise North American saurolophine hadrosaurid clade Kritosaurini. These results suggest a

single Late Cretaceous kritosaurin dispersal from North America, as opposed to multiple emigration events, supporting some aspects of the NAI hypothesis. Nevertheless, the South American kritosaurin clade is hypothesized to have diverged from its North American relatives at approximately 90 Ma, suggesting that hadrosaurids may have arrived in South America substantially before the late Campanian.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Bears will be bears: the scapholunar reflects phylogeny and function in the Ursidae

Hotchner, Anthony, Meachen, Julie, Dunn, Rachel H.

Anatomy, Des Moines University, West Des Moines, Iowa, United States

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. In a previous study, we examined the scapholunar (wrist) bone in several carnivoran groups, including canids, felids, and hyaenids. These analyses revealed separation in morphospace between carnivoran groups as well as variation within groups that reflect differences in locomotor and manipulative behavior. Here, we add bears (family Ursidae) to our analysis to better understand how bears use their wrists compared to other carnivorans and investigate potential “bear-like” carpal morphology of *Smilodon* as has been suggested by some prior studies. For this study, we include extinct and extant specimens from the families Felidae (4 spp), including *Smilodon fatalis*, Canidae (2 spp), Hyaenidae (2 spp) and Ursidae (9 spp). Since the scapholunar bone has a complex

morphology not easily captured by linear measurements, we follow previous studies in using surface areas of articular facets and angles between these facets obtained from 3D surface scans generated by a NextEngine laser scanner, measured in GeoMagic and Rhino, and analyzed in R. We find that bears fall in their own morphospace, far from any other carnivoran family. This suggests the presence of a phylogenetic signal but may also suggest that bears are using their wrists in different ways compared to other carnivoran taxa. However, within bears, taxa that climb regularly, such as *Helarctos malayanus* and *Tremarctos ornatus* are in a separate morphospace from primarily terrestrial bears, such as *Ursus arctos*, suggesting that locomotor mode plays a role in scapholunar morphology in ursids, as in other carnivoran groups. *Smilodon fatalis* falls well within felid morphospace indicating that *Smilodon* does not have bear-like scapholunar morphology, at least when considering angular and surface area data alone. The results of this study corroborate our previous work in suggesting that the scapholunar bone of carnivores reflects both phylogeny and ecology and expands these observations to bears.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**Reframing the question: are reversible
adhesives also removable?**

Householder, Mindy L., Boyd, Clint A.

North Dakota Geological Survey, Mandan,
North Dakota, United States

The field of fossil preparation continues to work towards implementing and improving a set of best practices that seek to preserve the original aspects of fossils throughout the processes of collection, preparation, stabilization, and curation. One aspect of that work is the wider adoption of adhesives that

are relatively stable while also being easily reversible. Those criteria have led to the broader adoption of a set of solvent-based polymer adhesives; however, the concept of reversability is often conflated with the idea that these adhesives are fully removable as well. This concept of removability remains little explored but could have unintended impacts on research that requires the chemical composition of the fossils to be unaltered. To test the removability of adhesives from fossilized bone we used a pXRF to compare the chemical composition of bones before adhesives were applied and after they were removed. For this study, each bone specimen was scanned five times in the same spot to record their initial chemical composition. A different adhesive was applied to each specimen (Vinac B15, Paraloid B72, Butvar B76, Butvar B98, and one historic adhesive, shellac, dissolved in acetone or ethanol). We used relatively thin mixtures (5% weight/weight) to ensure penetration into the bone rather than just applying a thick surface coat that is easily removed. Once the adhesive was dried the samples were each scanned five times again, and then the adhesives were removed using a cotton ball soaked in the original solvent until no visible trace of the adhesive remained. Once the specimens had dried, a final set of five scans were conducted on each specimen. Two control specimens were also examined where only solvent was applied at each step to test their impact on the specimens. T-tests were used to compare the mean values of 31 elements detected in each specimen at the start and the end of the study. All samples, including the controls, displayed significant differences in the values of some elements at the end of the test, with the biggest impact on Al, Cl, Fe, K, and Si values. It appears the alterations are largely the result of the solvent and not incomplete removal of the adhesive, given the similar effects observed on the control samples and the adhesive samples. These data suggest that reversible adhesives are largely

removable, though the application of acetone, and to a lesser degree ethanol, does impact the data collected via pXRF analysis.

Funding Sources The State of North Dakota

The David B. Jones Foundation

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

The evolution of climate tolerances and the shifting community composition of sympatric congeners of *Sceloporus* spiny lizards

Howard, Alexandra¹, Hurtado Materon, Maria A.¹, Rivera, Julio A.², Zúñiga-Vega, Jaime³, Martins, Emília², Lawing, Michelle¹

¹Ecology and Conservation Biology, Texas A&M University, College Station, Texas, United States, ²School of Life Sciences, Arizona State University, Tempe, Arizona, United States, ³Departamento de Ecología y Recursos Naturales, Universidad Nacional Autónoma de México, Mexico City, Mexico

The relationship between climate, species climatic tolerances, and spatial distributions are important factors for understanding global biodiversity patterns. Ectothermic taxa such as reptiles provide a useful example as they are sensitive to changing climatic conditions such as maximum temperature. We examine trends in the evolution of climatic tolerances and map them onto shifts in the availability of suitable climate spaces through time with spatially explicit models of change in alpha, beta, and gamma diversity, using data on *Sceloporus* lizards. *Sceloporus* lizards are a clade of phrynosomatid lizards endemic to North America. While the current extant species diversity is concentrated in central Mexico, the fossil record shows that *Sceloporus* initially diverged in northern USA and subsequently moved south during the cooling events of the middle and late Miocene. We implement

PaleoPhyloGeographic models using the *ppgm* R package to examine the evolution of climatic tolerances in *Sceloporus* in the context of global cooling since the Middle Miocene climatic optimum. We integrate paleontological, neontological, and spatial data into a phylogenetic comparative framework, accounting for uncertainty across phylogeny, fossil record, and evolutionary modelling techniques. Importantly, we show that the population process of climate tracking is not enough to account for observed evolutionary shifts in climate tolerances. As lineages shifted southward and encountered increased topographic and habitat heterogeneity, the evolution of maximum climate tolerances across lineages strongly trended towards increasingly hotter optima. Analysis will be discussed examining these trends of climatic tolerances throughout the Miocene, and how they relate to the number of sympatric congeners able to tolerate climatic conditions in a spatial context.

Funding Sources Supported by National Science Foundation under Grant Numbers 2154897 and 2154898.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Using the osteological postnatal development of *Sphaerodactylus townsendi* (Sphaerodactylidae: Gekkota) to evaluate variation in the Dominican Amber gecko *S. dommeli*

Howerton, Elyse D., Leard, Raynie, Sherratt, Emma, Bauer, Aaron, Daza, Juan

Biology Department, Sam Houston State University, Huntsville, Texas, United States

Today, 35 species have been described from the Hispaniola Bank and Navassa Islands. There are also 14 Early Miocene or early Middle Miocene, 15 to 20 Ma fossil remains in

amber, and only two have been formally described: *Sphaerodactylus dommeli* and *S. ciguapa*. The former was described based on two specimens, and their identity has been confirmed (there have been some claims that they are anoles and not geckos). The amber gecko *Sphaerodactylus dommeli* from Hispaniola was described in 1984 based on two specimens; the holotype is 2.4 times larger than the paratype, suggesting they correspond to adult and hatchling stages, respectively. However, when comparing these fossils with a postnatal series of the extant gecko *S. townsendi*, some characteristics support the recognition of the paratype of *S. dommeli* as a separate species. The SVL/skull length ratio in *S. townsendi* is 3.5 (hatchling) and 4 (adult); the differences in *S. dommeli* are larger; the paratype is 2.7 and the holotype is 3.8. The snout/skull ratio in *S. townsendi* is 0.53 (hatchling) and 0.59 (adult), indicating that the snout maintains the same proportions. In *S. dommeli*, the same ratio is 0.4 (paratype) and 0.57 (holotype), indicating that the snout is proportionally shorter when compared with the proportions in *S. dommeli*. We will continue exploring differences in patterns of ossification, but based on preliminary new evidence, we conclude that the paratype of *S. dommeli* needs to be described as a separate species, adding to the large number of Dominican amber species that remain to be formally characterized.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A new Mississippian fish from the Diamond Peak Formation of east-central Nevada, USA

Hruska, Aimee L.¹, Gibson, Sarah Z.¹, Hilton, Richard², Bonde, Joshua³, Druschke, Peter⁴

¹St. Cloud State University, St. Cloud, Minnesota, United States, ²Sierra College, Rocklin, California, United States, ³Nevada

State Museum, Carson City, Nevada, United States, ⁴Bureau of Land Management, Elko, Nevada, United States

In 2009 and 2010, twenty-three bones were collected in the Mississippian Diamond Peak Formation of east central Nevada. We conducted an anatomical and morphological study of this fossil material, primarily comprised of skull and scale elements. One specimen contains scales that were identified as a possible actinopterygian (ray-finned fish). The rest of the material has been putatively assigned to Rhizodontida, a group of large, predaceous, sarcopterygian fishes. A large operculum has been identified. Another specimen depicts a partial sequence of rostral bones. A larger specimen contains parts of a pectoral fin and articulated flank scales, with some internal anatomy exposed. Morphologically, the scale ornamentation is distinct from other known species and likely is representative of a new species. Likewise, the varying size and ornamentation on isolated scales likely represent more than one individual. Rhizodont fishes of this age have been found in North America in the Appalachian region, but this occurrence is a first for the Mississippian of the Great Basin and this project is a first step towards building a larger portrait of fishes and fish evolution during this dynamic time in Earth's history.

Funding Sources SCSU Student Mentor Collaboration Grant.

SCSU Faculty Improvement Grant.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Identification of the first fossil vertebrates described from Trinidad & Tobago: giant Ice Age armadillos (Chlamyphoridae: Glyptodontinae)

Huang, Ferrania S.², Lindsey, Emily³,
Mohammed, Ryan⁴, Rincon, Ascanio⁵,
Peacock, Brandon R.¹

¹Idaho State University, Pocatello, Idaho, United States, ²La Brea Tar Pits, Los Angeles, California, United States, ³Regis University, Denver, Colorado, United States, ⁴Venezuelan Institute for Scientific Research, Miranda, Venezuela, Bolivarian Republic of, ⁵Biological Sciences, Idaho State University, Pocatello, Idaho, United States

Caribbean islands have served as natural laboratories of evolutionary biology in living organisms, and provided incredible test cases of mammalian extinction in the late Pleistocene and Holocene. Patterns of megafaunal occurrence are better known from the American mainlands, and large islands like Cuba; though vertebrate remains have been reported from asphalt seeps on the island of Trinidad. Alongside reported mylodontid ground sloths and a gomphothere, the most abundant Pleistocene megafaunal fossils from Forest Reserves Oil Well 1060 are isolated osteoderms of giant armadillos (glyptodonts), although a mandible and an articulated partial carapace and pelvic girdle have also been recovered. Starting with the abundant osteoderms, we have begun the process of identifying these isolated specimens to better understand the biodiversity and biogeographic history of Trinidad.

Firstly, we scored each of the isolated osteoderms in a recent phylogenetic character matrix of Glyptodontinae: each has a single circular central figure and several peripheral figures arranged in a row, all defined by sulci. These scorings are consistent with two likely late Pleistocene glyptodonts known from mainland South America: *Glyptodon* and *Glyptotherium*. These two genera have a complex biogeographic relationship as currently understood, with little reported sympatry. *Glyptotherium* is known from North America

(from Florida and Texas to western Panama), Venezuela, and eastern Brazil, while *Glyptodon* interrupts this distribution with occurrences in eastern Panama and Colombia. Recently, a non-overlapping set of transverse sulci measurements have been proposed to differentiate the osteoderms and carapaces: narrower 1-2.4 mm widths for *Glyptotherium* and 4-6 mm widths for *Glyptodon*. Our linear morphometrics finds several osteoderms (n=6) in the hypothesized range for *Glyptotherium*, with a single osteoderm in the range of *Glyptodon* from Trinidad, but many specimens (n=8) exist “in between” the hypothesized ranges. Variations on these millimeter-scale features likely existed across the glyptodont carapace, and it is unknown how the breadth of sulci changed through ontogeny. Quantifying the relative size relationships between osteoderms (= area), figures, and sulci is ongoing work, as well as studying the non-armor remains.

We report the strong likelihood that *Glyptotherium* occurred in Trinidad, which agrees well with the many *Glyptotherium* fossils that have been found in Venezuela.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Wear and tear: Complexity of tooth renewal in manatees

Huff, Kayla, Peredo, Carlos M.

Biology, Miami University, Harrison , Ohio,
United States

Sirenians are a lineage of herbivorous marine mammals which evolved from terrestrial afrotherians. Transitioning from terrestrial to a fully aquatic lifestyle selects for extreme modifications in sirenians relative to their terrestrial ancestors. Because sirenians are obligate herbivores their feeding morphology is constrained by the marine environment.

Sirenians exhibit a reduction or complete loss of teeth as well as keratinized pads in the mouth to facilitate underwater feeding. Unlike dugongs, which retain the dental patterns of their terrestrial ancestors, manatees are unique in having evolved a system of horizontal tooth replacement. This involves new teeth which are constantly developing and erupting from the back of the oral cavity and move anteriorly in a conveyor belt-like fashion as they wear. This study aims to uncover the patterns of dental wear in manatee teeth along the dental arcade? We measure the dental wear on manatee teeth using various metrics for dental complexity (i.e., OPCR, RFI, etc.). Then, we compare these results across tooth position and tooth row. Finally, we compare values of dental wear across modern and fossil manatee taxa. We quantify the extent of dental wear in manatees and measure the degradation of the dental surface. Our results encompass the full tooth cycle, from newly erupted to worn beyond utility. This highlights the extreme morphological cost of herbivory and suggests that conveyor-belt tooth replacement is a key innovation in manatees that drives their evolutionary success.

Funding Sources This work was funded by Miami University Department of Biology research funds and the Miami University Graduate School Summer Fellowships.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Paleoecology and taphonomy of megaherbivores (Mammalia: Proboscidea and Rhinocerotidae) from Stratum 3 of the late Hemphillian Montbrook Local Fauna, Florida

Hulbert, Richard C.¹, Pirlo, Jeanette², Narducci, Rachel E.¹, Woodruff, Aaron¹, Bourque, Jason R.¹, Lockner, Cindy¹, Riegler, Mitchell¹, Jukar, Advait M.¹, Bloch, Jonathan I.¹

¹Florida Museum of Natural History, Gainesville, Florida, United States, ²Department of Biological Sciences, California State University, Stanislaus, Turlock, California, United States

Nine years of excavations at Montbrook (ca. 5.5 Ma, Levy Co., Florida) have recovered ca. 200,000 vertebrate fossils from an area of 525 m². Over 90% are fish, alligator, turtle, and other aquatic taxa; this in addition to sedimentological evidence supports a fluvial depositional environment. Three fossil-bearing units are recognized, Strata 2, 2A, and 3. The lowest unit Stratum 3 consists of alternating beds of unconsolidated to semi-consolidated quartz sand 2–50 cm thick and dark, compacted clay 0.3–1.5 cm thick. Unlike the other Montbrook strata, it preserves multiple associated and/or partially articulated skeletons of three mammalian megaherbivores, the gomphothere *Rhynchotherium* sp., the mastodon *Mammuthus* sp., and the rhinocerotid *Teleoceras* sp. Isolated fossils of these three taxa are present in Strata 2 and 2A, but are relatively uncommon, in contrast to those of smaller ungulates such as equids and cervids. No associated skeletons of smaller ungulates have been found at the site. The bones making up each associated megaherbivore skeleton have no evidence of weathering or water wear, but damage by postmortem compaction is often extensive. Right and left dentaries remain attached at the symphysis, except in very young juveniles. Articulations are most often found between foot bones or vertebrae/ribs. At least 38 skeletons of *Rhynchotherium* sp. were recovered ranging in age from young juveniles to full adults. Almost 60% of the dentaries belong to the youth age class (dp4-m1 in wear, m2 unerupted or erupting). Only four skeletons of *Mammuthus* sp. have been found, all juveniles or subadults. Seven, potentially eight, skeletons of *Teleoceras* sp. are known; of these, one is a juvenile, one a subadult, and the remainder adults. In addition to the difference in age

structure, the rhino skeletons are more scattered, less complete, and more rarely articulated than those of the two proboscideans. We hypothesize that the primary large scavengers in this aquatic ecosystem were alligators, which were capable of completely dismembering and consuming the entire carcasses of relatively small ungulates, but for the most part could only remove the soft tissues of very large carcasses, such as adult *Teleoceras* sp. and both juvenile and adult proboscideans. Spatial and stratigraphic relationships of the Stratum 3 skeletons suggest that they were not the result of a single mass mortality event, but rather record deaths over an interval that lasted decades to centuries.

Funding Sources Montbrook excavations funded by NSF award 1645530 and the Felburn Foundation; NSF grant 1756306 provided funding for specimen curation and preparation.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Fresh ink and fresh perspectives: tattooing as a novel method of labeling silicone molds

Hummel, Rudolph R.¹, Swenson, Sierra K.¹, Bird, Lora², McGee, Nicole A.³

¹Earth Science, Denver Museum of Nature and Science, Denver, Colorado, United States, ²Nest Art Collective, Wheat Ridge, Colorado, United States, ³Museum and Field Studies, Colorado University Boulder, Boulder, Colorado, United States

Molding and casting has been one of the primary methods of three-dimensionally replicating museum objects for 50+ years. These replicas play a significant role in museum display, education, and research. The Madagascar Paleontology Project has used casts throughout its 30 year history to

collaboratively study the fauna of the Late Cretaceous of Madagascar across multiple institutions. In 2023, the Denver Museum of Nature & Science (DMNS), where the majority of the original specimens are housed, began curating this cast and mold collection in advance of over half of the original specimens returning to the University of Antananarivo (UA) in Madagascar.

While casts can be curated similarly to their original counterparts, molds are challenging to label because they are typically made of room-temperature vulcanizing (RTV) silicone, which is hydrophobic and repels marker pigments. Stamping a label into the silicone before it cures has traditionally been the most legible and longest lasting option, but this method doesn't allow the label to be modified after the silicone cures. Here we present methods for labeling silicone molds post-cure with inexpensive commercial tattoo equipment and archival ink.

We tested three different silicone products (Dow HS III, Silicones Inc. GI-1000, and Silicones Inc. GI-1100 with GI-2020A catalyst) and worked with a professional tattoo artist to test four different round liner (RL) needle cartridge configurations. The resulting labels were legible, easily applied, and very difficult to remove from all three types of silicone. While seven- and five-pointed (7RL and 5RL) needle cartridges were easiest for new tattooers to use, three-pointed (3RL) cartridges were capable of the smallest, most precise labels.

The development of this innovative methodology highlights the benefits of diversity in academic institutions as well as STEAM thinking and collaboration between artists and scientists. Since the implementation of this method, over 600 Madagascar Paleontology Project molds have been labeled by DMNS staff and licensed tattoo artists working in concert. We recommend tattoo labels to any institution maintaining a large collection of silicone

molds due to their legibility, durability, and low cost. We also recommend forging reciprocal relationships with local tattoo artists, as they can provide equipment and expertise that may be integral to project success.

Funding Sources We acknowledge the National Science Foundation grant DBI-2242716 to David W. Krause for funding the purchase of supplies for this project.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Eco-sensory significance of crocodylian cranial morphology revealed through *in vivo* perimetry analysis with implications for visual field reconstruction in fossil taxa

Hunt, Tyler C.

Department of Biological Science, Florida State University, Tallahassee, Florida, United States

Visual fields delimit the area over which an organism can extract near instantaneous optical information from its environment. Avian visual analyses demonstrate that shifts in visual field configuration align with regions of ecologically relevant visual cues, often subserving specific perceptually demanding tasks, such as prey capture. Visual field tuning is primarily achieved through alteration of orbit position, changes in ocular optics, and shifts in infringing optical adnexa. Comparable analyses outside of Aves have yet to be conducted and correlations with cranial morphology remain unexplored. Similar to birds, crocodylians exhibit a diversity of cranial types thought to reflect niche specialization. Here, I measure the *in vivo* visual fields of 16 species spanning the extant diversity of crocodylian cranial types using the ophthalmoscopic reflex technique. Using traditional morphometrics, I comparatively investigate visual field and

cranial morphology covariance, enabling the development of osteological correlates for estimation of visual field parameters. Further, I highlight shared visual field regions among cranial types that possess ecological utility and align with feeding habits. The results show that generalist and blunt-snouted taxa possess wide, short binocular fields with extensive ventral, dorsal, and posterior blind spots. The highly terrestrialized, dorso-ventrally vaulted *Paleosuchus*, exhibits narrow, short binocular fields with expansive dorsal blind spots, and enhanced visual coverage of the infra-snout region mediated by a reduction in rostral and infraorbital infringement. Conversely, longirostrine crocodylians maximize coverage of the celestial hemisphere exhibiting increased binocular field lengths and near panoramic vision. This trend is maximally derived in the piscivorous *Gavialis gangeticus*, which shows complete panoramic vision, and surprisingly, 17° of posterior binocular overlap. The convergence of longirostrine forms towards dorsally directed visual fields suggests important visual cues emanate from above and may be an adaptation for ambush style feeding in a 3D aquatic environment. These findings underscore the significant relationships between extant crocodylian cranial morphologies, visual field configurations, and their dietary ecology. Furthermore, they provide a novel framework for inferring visual field parameters and feeding behaviors in fossil Crocodylia, and perhaps, closely related neosuchians.

Funding Sources This work was supported by the Crocodile Specialist Group: Student Research Assistance Scheme.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Geochemical fingerprinting using portable X-Ray Fluorescence and Rare Earth

Elements of Late Jurassic dinosaur fossils from the Colorado Plateau, USA

Hunt-Foster, ReBecca K.¹, Titus, Alan L.⁵, Suarez, Celina A.³, Polly, Paul D.², Knauss, Georgia⁴

¹Dinosaur National Monument, Jensen, Utah, United States, ²Bureau of Land Management, Kanab, Utah, United States, ³University of Arkansas, Fayetteville, Arkansas, United States, ⁴Indiana University, Bloomington, Indiana, United States, ⁵Bureau of Land Management, Salt Lake City, Utah, United States

Large scale illegal poaching of publicly owned vertebrate fossils from the Colorado Plateau region of the United States has been taking place for several decades. In particular, the Upper Jurassic Morrison Formation, containing abundant, large dinosaur remains, which are exposed across the Colorado Plateau, are commonly targeted for poaching and commercial selling. To address this issue, we are studying the geochemistry of the Morrison Formation on the Colorado Plateau, including both fossils and associated sediments, using portable X-ray fluorescence (pXRF) and Rare Earth Elements (REE) towards the end of being able to provenance fossils from unknown localities.

An objective of this project has been to identify, evaluate, and document known areas of unauthorized collection in the field, as well as fossils from unknown localities within museum collections. The resulting data is then compared to results from fossils from known stratigraphic occurrences throughout the Morrison Formation, both on and off the Colorado Plateau. Vertebrate fossil specimens data were collected from sites with various land ownership status (Federal, State, Private), across a wide area and in as many stratigraphic and facies associations as practical. These were then analyzed for bulk elemental composition using pXRF, and the REE compositions were

measured using inductively coupled mass spectrometry. We then used statistical methods to see if any of the unknown material could be statistically tied to known sources.

Results of the pXRF study are indicating that the chemical compositions of the original deposition within fluvial and overbank deposits of the Morrison Formation can assist in determining provenance. Results of REE analysis indicate that this method is most powerful when a quarry site is well characterized for its REE concentrations ($n \geq 5$ vertebrate fossils from across a quarry stratigraphically and laterally) and it is then compared to suspected vertebrate fossils from the site. Alternatively, vertebrate fossils that are claimed to be from a specific quarry on private land can be compared to bones properly documented from the quarry if the quarry is well characterized.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

New material of '*Crocodylus*' *affinis* (Crocodyloidea) from the Eocene Bridger Formation of Wyoming

Hurrell, Sarah C., Vietti, Laura A.

Geology and Geophysics, University of Wyoming, Laramie, Wyoming, United States

The Eocene Bridger Formation of south-central/west Wyoming is composed of fluvial, paleosol, and lacustrine sediments abundant with eusuchian fossils including '*Crocodylus*' *affinis*. Phylogenetic placement of '*Crocodylus*' *affinis* is tenuous and recent analyses have shown '*Crocodylus*' *affinis* to be a basal crocodyloid more closely related to stem Longirostres than to true *Crocodylus*. More fossil examples will help resolve the affinity of '*Crocodylus*' *affinis*; however, this is made difficult due to the limited number of

well-preserved specimens in addition to natural variation in species.

To help resolve the ambiguity of '*Crocodylus*' *affinis*, we present UW-58275, composed of previously undescribed material assigned to '*Crocodylus*' *affinis*. UW-58275, housed in the Vertebrate Fossil Collection at the University of Wyoming, is comprised of a nearly complete, although repaired, mandible including both dentaries with most teeth in place, intact splenials, intact angulars, mostly intact external mandibular fenestrae, and slightly worn but intact articular and retroarticular processes. Preliminary observations of UW-58275 indicate the specimen belongs to a younger animal.

To address the issues related to natural variation in '*Crocodylus*' *affinis*, we performed morphologic comparisons of dental and bone elements of UW-58275 with other known '*Crocodylus*' *affinis* specimens. We also tested the hypothesis that skeletal bone ornamentation displayed on the angular bone is correlated with the relative size, and potentially the age, of an individual of '*Crocodylus*' *affinis*. Our research introduces an important new specimen to complement the growing number of '*Crocodylus*' *affinis* specimens and increase the sample size of this species. We also provide new insights into the natural variation of '*Crocodylus*' *affinis* mandibles that will better inform future analyses on the taxa.

Funding Sources Funding for this project was received from the Wyoming Research Scholars Program.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The trace assemblage of the Pilcomayo megafan and insights into the terrestrial trace fossil record

Hutchinson, Ian S.¹, Redman, Cory M.³, Souberlich, Ricardo⁵, Sarubbi Jacks, Yennifer⁵, Colman, Christian⁵, Apgar, Alexandra D.⁴, Bosch, Keely⁴, Moore, Jason R.²

¹Biology, University of New Mexico College of Arts and Sciences, Albuquerque, New Mexico, United States, ²Grand Rapids Public Museum, Grand Rapids, Michigan, United States, ³FACEN, Universidad de Asunción, Asunción, Paraguay, ⁴Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, United States, ⁵Honors College, University of New Mexico, Albuquerque, New Mexico, United States

Understanding fossil preservation, distribution, abundance, and assemblage composition allows us to judge the accuracy of our reconstructions of ancient ecology and organisms' response to changes in the past. The trace fossil record provides a window into the ecology of the past that is mostly unavailable from studying body fossils alone. Current modern analogs for fossil preservation on land are relatively poor representations of the rock record. We hypothesize that megafan systems provide a significantly better model of past preservation. The Pilcomayo River is one such fan system located on the border of Paraguay and Argentina whose environments have not been as seriously affected by human influence. For the last two years, our research group has been studying the preservation of death assemblages of modern organisms at two localities on the Pilcomayo to provide ground-truthing data for studies of the fossil record. Broadly, taphonomic and ecological analyses of the Pilcomayo Fan match well with expectations from the fossil record, and analyses of taxonomic representation by subenvironment suggest that the ecology of the living community is being reflected in fan systems surficial death assemblages. Here we are extending these studies to assess the compositional and spatial fidelity of the trace assemblage record of the Pilcomayo.

Due to the abundance of traces in our study areas, individual localities were surveyed and described at random for trace fossil presence, rather than undertaking an exhaustive search. In addition, particularly noteworthy traces/localities were also recorded using photogrammetry and LiDAR to capture detailed 3D scans of trace evidence. Domestic species data is more prominent but this pattern is less seen counting by locality rather than by individual trace. Based on preliminary data there is a good correlation between living occurrence and presence in the trace fossil record, although abundances correlate less well. Trace occurrences have been described in all surveyed Pilcomayo subenvironments. Notably, these trace fossils are more abundant in medial environments than in proximal environments, likely due to the dryness of the Pozo Hondo region (proximal) in contrast to the wetter, actively depositing General Diaz (medial) region. This supports the hypothesis that the preservational patterns observed in the Pilcomayo Fan System provide a robust analog for understanding past environments and deep time taphonomy.

Funding Sources We acknowledge the UNM Honors College HRI, the UNM RAC, a UISFL Field Research Award, the UNM Global Education Office, Michael Sasoni and William Verrillo.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

Diadectomorphs (Pan-Amniota) from the Carboniferous-Permian Cutler Group of Utah and their stratigraphic significance

Huttenlocker, Adam³, Feinberg, Joshua M.², Henrici, Amy C.⁴, Irmis, Randall⁵, Marsh, Adam⁶, Stine, Jonathan M.⁷, Sumida, Stuart S.⁸, Tse, Yuen Ting¹

¹Department of Integrative Anatomical Sciences, University of Southern California,

Los Angeles, California, United States, ²University of Minnesota, Minneapolis, Minnesota, United States, ³Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ⁴University of Utah, Salt Lake City, Utah, United States, ⁵Petrified Forest National Park, Holbrook, Arizona, United States, ⁶University of Minnesota, Minneapolis, Minnesota, United States, ⁷California State University San Bernardino, San Bernardino, California, United States, ⁸Integrative Anatomical Sciences, University of Southern California, Los Angeles, California, United States

The Carboniferous-Permian (C-P) Cutler Group records changes in nonmarine tetrapod diversity during the peak Late Paleozoic Ice Age (LPIA). Historically, these fossils have contributed to C-P vertebrate diversity and biogeography with little regard for their precise stratigraphic or environmental context. Among these, the clade Diadectomorpha comprises stem-amniotes including small faunivores like *Tseajaia*, large carnivores like *Limnoscelis*, and the first large-bodied herbivores (Diadectidae). These lineages occur in the Cutler Group of Utah and New Mexico, with *Limnoscelis* and *Diadectes* also in Colorado. In New Mexico they have been sorted into biostratigraphically-significant assemblages: limnoscelids in the lower 'Cobean' assemblage and anatomically derived diadectids (*Diadectes*) in the upper assemblages.

Recent southeastern Utah fieldwork investigates the timing and responses of tetrapod community evolution relative to the LPIA by adding new fossils, refining geochronology, and developing environmental proxy datasets. In the lower Cutler beds of the Valley of the Gods area, limnoscelids and plesiomorphic diadectomorphs are restricted to the lower Halgaito Formation and *Diadectes* to the upper Halgaito. Further north, two articulated *Tseajaia*-like skeletons occur in different

localities near the top of the lower Cutler beds. The first specimen, lacking most of the skull, shares a combination of features with *Tseajaia*: supratemporal-tabular horns, swollen neural arches; low neural spines that alternate in height; stout, reduced 'lumbar' ribs; strongly posteriorly angled caudal ribs; and short, box-shaped phalanges. The second specimen has a well-preserved palate and postcranial skeleton. The Utah record demonstrates important differences from New Mexico: (1) during the mid-Ghzelian, 'Coblean' taxa (e.g., *Limnoscelis*) overlap with diagnostic 'Coyotean' taxa such as *Sphenacodon*; and (2) small tseajaiid-like diadectomorphs were present close to the C-P boundary (Asselian) at horizons older than the previously known 'Coyotean' and 'Seymourian' occurrences of *Tseajaia* in New Mexico and Utah, respectively. These records emphasize the difficulty of interbasinal biostratigraphic correlation using vertebrates alone. Thus, improved geochronology and stratigraphic control, along with new fossil occurrences and environmental proxy data, will help revise our understanding of how western Pangean tetrapod communities evolved in relation to the LPIA.

Funding Sources NSF-EAR-2219947 to A.K.H.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Global Fossil Crime: An initial investigation on the illicit world of fossil trafficking

Huynh, Andy^{1,2}

¹U.S. Department of Homeland Security, Washington, District of Columbia, United States, ²United Nations Office on Drug and Crime, Vienna, Austria

Fossil crime involves the illegal trade, poaching, import, and export of fossils. Transnational Criminal Organizations (TCOs), Drug Trafficking Organizations (DTOs) and

Foreign Terrorist Organizations (FTOs) traffic fossils that supply the commercial trade. There are paleontologists involved in the acquisition, study, and publication of illicit fossils. This study aimed to document the global extent of fossil crime based on the primary literature, media articles, government reports, and anecdote. Three case studies of global fossil crime are outlined here to show its global extent and points of contact with the science.

DTOs in Mexico + S. Am. + Europe: Under Mexican law it is illegal to commercially trade fossils. Fossil crime there is connected to Germany and South America through DTOs in Nuevo León that distribute fossils from the source quarries to the international market. Scientists based in Germany have collected, purchased, and published fossils in peer-reviewed journals from these quarries.

TCOs in Eurasia, S. Am. + AU: In Eurasia, European and Asian TCOs control one of the world's most extensive black market trafficking routes from Russia to southeast Asia. TCOs have trafficked Pleistocene mammals and Asiatic dinosaurs, taking advantage of loopholes in global laws and weak enforcement. Argentine fossils were seized in Australia while Mongolian fossils were found in a South Korean raid. In 2003, Shenyang Customs conducted a raid that led to the seizure of 2,364 pieces of paleontological fossils and arrested criminals tied to Chinese and Korean TCOs.

FTOs in N. Africa: In the Sahel, FTOs loot fossils and archeological artifacts and sell them to private collectors in order to fund terrorism. In May 2015, a US raid found that FTOs generated revenue from the extraction and sale of antiquities, including fossils. It is not clear if any of these fossils have made their way into museums or the scientific literature.

Global fossil crime is largely unchallenged and unchecked. Individual scientists can take

precaution in vetting fossils from questionable sources. The Society of Vertebrate Paleontology can bring public attention to the growing trade in fossils and encourage governments to draft laws to protect fossils.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Tooth development and resorption in
squamates: a comparison of living Teiidae
and fossil Mosasauridae**

Iftikhar, Fatima¹, LeBlanc, Aaron², Caldwell,
Michael W.¹

¹Biological Sciences, University of Alberta,
Edmonton, Alberta, Canada, ²Faculty of
Dentistry, Oral & Craniofacial Sciences, King's
College London, London, United Kingdom

Teeth have defining characteristics that can be used to construct evolutionary relationships. Despite the diagnostic power of dentition, it is trivial within squamate phylogeny as squamates have a wide variety of tooth attachment types. Most notably, hard tissue histology and computerized tomographic (CT) scans have revealed that 85 million year old fossil marine lizards within Mosasauridae differ from their primitive ancestors by having a deep, socketed geometry of attachment instead of a shallow, asymmetrical one. Considering this morphological variation, internal investigation through soft tissue histology is necessary to determine relatedness between living and extinct squamates. This reasoning has been used to show that extant lizards, particularly *Tupinambis* (Teiidae), share a socketed mode of tooth attachment, symmetrical root structure, and three-layered attachment tissue system with mosasaurs. Because of these similarities, further comparative investigation is necessary to fully understand the geometry and mechanisms underlying tooth structure and

resorption by odontoclasts (dentine resorbing cells) within Mosasauridae. Thin-sectioning and histological staining of tooth tissues in extant *Tupinambis* (Teiidae) will reveal the complex and unique attachment and resorption of teeth in teiid lizards, that will in turn help us understand the dynamics of mosasaur soft tissues at different stages of tooth development. Based on recent research findings, an analysis of tooth tissue development will be conducted at both the University of Alberta and King's College London with various historical stains—Tartrate-Resistant Acid Phosphatase (TRAP) staining (a marker for odontoclast activity) and Masson's Trichrome (a marker for collagen and other connective tissues)—in extant *Tupinambis* (Teiidae). The data produced will ultimately lead to various research outputs: a description of teiid tooth resorption, a comparison of mosasaur and teiid attachment geometry and tissues, as well as a description of mosasaur teeth that encompasses both tissue analysis and tooth reabsorption mechanisms.

Romer Prize Session (Thursday, October 31,
2024, 8:00 AM)

**The impact of taxonomic representation
and “representative taxa”; a novel,
comprehensive phylogenetic analysis of
early amniotes**

Igielman, Ben

Earth Sciences, University of Birmingham,
Ilford, United Kingdom

Amniotes comprise three-quarters of all tetrapod species and dominate every terrestrial environment, but the origins of crown Amniota during the Palaeozoic are poorly understood. Several clades have historically been considered relevant to amniote origins, including the crocodile-like anthracosaurs and the small-bodied, mostly aquatic lepospondyls. Other groups have

been associated with subsets of early amniotes, such as araeoscelids, long thought to be close to diapsid reptiles. Recent analyses have questioned these long-standing hypotheses and proposed novel relationships between Carboniferous and Permian tetrapods. Anthracosaurs have been recovered as tetrapods, rather than stem amniotes. The monophyly of lepospondyls has been challenged, with the tiny, limbless Aistopoda placed on the tetrapod stem and Microsauria recovered within the amniote crown. The close relationship between araeoscelids and diapsid reptiles has also been disputed, with a more stemward position for araeoscelids proposed. Although intriguing, the analyses that recover these novel relationships focus in detail on either the amniote stem or amniote crown, but not both, including just a limited number of “representative taxa” from the groups outside their central focus.

Here I present an expansive, novel phylogenetic analysis (77 taxa, 328 characters) of early tetrapods. I distinctly include near equal taxonomic representation of both stem and early crown amniotes, one of the first analyses to do so. This allows for thorough testing of trait evolution across the origin of amniotes, something which could not be investigated in detail by previous approaches. I incorporate new data on the enigmatic Carboniferous tetrapod *Westlothiana lizziae*, which has been considered close to both amniotes and lepospondyls. My results contrast with recent studies of tetrapod phylogeny: I find anthracosaurs in their more traditional position as stem amniotes; recover a monophyletic Lepospondyli, inclusive of aistopods, as the sister clade to amniotes; and find microsauria as a paraphyletic grade with respect to other lepospondyls. I recover araeoscelids as stem mammals, an entirely novel hypothesis. This topology extends the divergence of the major clades of crown tetrapods back into the early Carboniferous,

suggests that amphibians and amniotes diverged far earlier than previously thought, and demonstrates that more expansive taxonomic inclusion can have significant impacts on phylogenetic topologies.

Funding Sources This work was funded by the Oxford NERC DTP

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Potential taxonomic implications of endogenous ancient proteins in vertebrate fossils from the Paleogene Ergilin Dzo Formation, Mongolia

Inaba, Hayato¹, Chiba, Kentaro², Saneyoshi, Mototaka², Miyaji, Takaaki³, Kawakami, Asako³, Eda, Masaki⁴, Tanaka, Miu⁷, Kobayashi, Yoshitsugu⁴, Tsogtbaatar, Khishigjav⁶, Tsujigiwa, Hidetsugu⁵

¹Graduate School of Informatics, Okayama University of Science, Okayama, Okayama, Japan, ²Department of Biosphere-Geosphere Science, Okayama University of Science, Okayama, Okayama, Japan, ³Department of Genomics & Proteomics, Advanced Science Research Center, Okayama University, Okayama, Okayama, Japan, ⁴Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan, ⁵Graduate School of Science, Hokkaido University, Sapporo, Hokkaido, Japan, ⁶Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Tov, Mongolia, ⁷Department of Life Science, Okayama University of Science, Okayama, Okayama, Japan

Proteomic techniques have been increasingly applied in paleontological research, facilitating taxonomic assessments of extinct taxa through molecular biology. To date, taxonomically-informative ancient protein sequences have been recovered only from fossil materials up to approximately 6.5 Ma. The endogenous nature of recovered proteins

in older fossils and their taxonomic implications remain subjects of debate. In this study, improvements in histological staining and extraction techniques are employed to assess the preservation of endogenous collagen in late Eocene vertebrate fossils, and the resulting taxonomic implications are discussed.

A partial rhinocerotoid mandible, an anthracotheriid astragalus, and a testudinid carapace fragment were sampled from the upper Eocene (approximately 33.9 Ma) Ergilin Dzo Formation in Mongolia. Initially, the histological staining for assessing collagen presence in extant samples was conducted, and all samples were positive. Subsequently, protocols optimized for collagen extraction in modern samples were performed with SDS-PAGE. The extracts were separated into four bands in all samples, but the bands were absent in the negative control. The molecular weights of the bands from the fossil samples appeared to correspond to those of α -1, α -2, β , and γ chains of type-I collagen. Next, we employed mass spectrometry on some bands derived from each fossil sample. De novo sequencing of the spectra data using PEAKS recovered partial, relatively short sequences. Nevertheless, the recovered sequences exhibited repetitive occurrences of glycine in every three residues, characteristic of collagen. Additionally, database searches for spectra with common contaminants and type-I collagen sequences of extant vertebrates were iteratively employed using Mascot. The results indicated that the data of rhinocerotoid and anthracotheriid fossils matched most closely with perissodactyls and artiodactyls, respectively, in the laurasiatherian database. The spectral data of the testudinid fossil matched peptides in the type-I collagen of extant testudines in the archelosaurian database.

Our findings indicate the presence of taxonomically-informative endogenous collagen in the late Eocene vertebrate fossils examined here, surpassing previous studies

by a magnitude of five. This study represents methodological improvements, thereby extending the temporal range of molecular phylogenetic analyses on fossil vertebrates deeper into the fossil record.

Funding Sources JSPS KAKENHI Grant (20K20950, 24K04373) and Sasakawa Scientific Research Grant (2023-4101).

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

3D investigation of the mandibular post-canine dentition of the Eurasian Miocene hominoid *Ouranopithecus macedoniensis* (Greece)

Ioannidou, Melania¹, Koufos, George², de Bonis, Louis³, Harvati, Katerina¹

¹Paleoanthropology, Institute for Archaeological Sciences and Senckenberg Centre for Human Evolution and Palaeoenvironment, University of Tübingen, Tübingen, Germany, ²Laboratory of Geology and Palaeontology, Department of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece, ³Laboratoire de Paléontologie, Evolution, Paléoécosystèmes, Paléoprimatologie (PALEVOPRIM) - UMR CNRS 7262, Université des Poitiers, Poitiers, France

Ouranopithecus macedoniensis (~9.6 to 8.7 Ma) belongs to the hominoids that flourished during the Miocene epoch in Africa and Eurasia and is known from the late Miocene deposits of Northern Greece. It is found in 3 localities, which have yielded numerous fossils, including an almost complete face, maxillary and mandibular fragments, multiple isolated teeth, and two postcranial elements. Despite 50 years of research, the phylogenetic position of *O. macedoniensis* is still under discussion, and diverse hypotheses have been proposed. *O. macedoniensis* is hypothesized by different

researchers to be either a stem hominid, stem hominine, stem pongine, or early hominin.

Recent studies support using internal dental structures, such as root pulp canals, to study extant species diversity. As for extinct species, assuming low degrees of homoplasy, post-canine dental roots can possibly qualify as informative indicators of hominoid evolution. Although the dental remnants of *O. macedoniensis* have been studied extensively, their internal dental structure has not been investigated in depth. Here, we examine the post-canine mandibular root morphology and configuration of *O. macedoniensis* specimens deriving from the Ravin de la Pluie (RPL) locality, whose internal dental features are unstudied. The results are compared with published data on extant great apes and extinct hominoid taxa. Moreover, we explore the possibility of using root and pulp canal morphology to shed light on the phylogenetic position of *O. macedoniensis*.

Our results indicate that the specimens studied display almost always the same number of roots and pulp canals, with some degree of variability present, suggesting that this morphology may have been typical in *O. macedoniensis*. Our results are consistent with previous work conducted in other specimens from the RPL locality. Moreover, the *O. macedoniensis* dental root morphology resembles that of the great apes, as described in the literature. However, our results did not indicate a clear relationship between *O. macedoniensis* and any of the great apes in particular. Therefore, additional research is needed to clarify this issue further.

This study of previously unstudied material from the RPL fossiliferous locality in Northern Greece adds important information about the internal dental structure of *O. macedoniensis*, contributing to our understanding of this species.

Funding Sources This work was supported by the Senckenberg Gesellschaft für Naturforschung, the Leventis Foundation, and the Deutsche Forschungsgemeinschaft (DFG INST 37/706-1).

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

The importance of resolution and scale in paleoecological inference: a case study from the Upper Triassic of western North America

Irmis, Randall^{1,2}, Milner, Andrew³, Boeman, Emma², Diaz, Jimena¹, Johnson, Ann W.¹, Borthwick, Tylor¹

¹Natural History Museum of Utah, University of Utah, Salt Lake City, Utah, United States, ²Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, United States, ³St. George Dinosaur Discovery Site, St. George, Utah, United States

The paleoecology of extinct vertebrates is typically inferred from skeletal traits, paleoenvironmental proxies, skeletal tissue geochemistry, extant relatives, or some combination thereof. Ideally, multiple lines of evidence will agree, providing a robust hypothesis for the animal's paleoecology. In practice, it is quite common that different types of evidence suggest conflicting paleoecological inferences, in which case it can be difficult to make a strong hypothesis. As a means of examining how to resolve these conflicts, we investigate an example from the Upper Triassic of southwestern North America. The early archosauriform *Vancleavea campi* is well-known from numerous localities in the Norian-Rhaetian Chinle Formation and Dockum Group that span at least 10 million years of the Late Triassic Period. A suite of apomorphic morphological specializations, including dorsally-directed nares, reduced limbs,

pachyosteosclerotic limb bones, and an elongate dorsoventrally-tall tail, strongly suggest an aquatic ecology for *Vancleavea*.

We report what may be the stratigraphically highest occurrence of *Vancleavea* to-date, a partially articulated skeleton in mudstone from just below the top of the Chinle Formation in southeastern Utah. Despite skeletal evidence for an aquatic habitat implying the existence of perennial water bodies, and partially articulated actinopterygian fish associated with this specimen, our geological study of the site strongly implies arid conditions. Sedimentology indicates ephemeral stream flow and well-drained paleosols, as the fluvial Chinle Formation transitions into the overlying eolian Wingate Sandstone. Similarly, stable isotope and elemental geochemistry from paleosols suggest a warm, dry climate. Though it is possible that *Vancleavea* was more terrestrial than previously hypothesized, with some morphological traits reflecting the evolutionary history of the lineage rather than current function, this seems unlikely given the co-occurring fish fossils. We suggest instead that there is a mismatch in the spatial and temporal scale of the evidence; whereas the geological data records the longer-term paleoenvironment of the area, *Vancleavea* at this time inhabited water bodies whose spatial distribution was patchy. These habitats were semi-permanent across the lifetime of an individual, but ephemeral over geologic time. This highlights the importance of spatiotemporal resolution in comparing different lines of paleoecological evidence.

Funding Sources Canyonlands Natural History Association, National Geographic Society Committee for Research & Exploration, University of Utah

A new chondrichthyan genus and species from the Middle Pennsylvanian Minturn Formation of Colorado, USA, based on a tooth resembling those of *Venustodus*

Itano, Wayne¹, Snyder, Daniel²

¹Museum of Natural History, University of Colorado, Boulder, Colorado, United States, ²Northeast Iowa Community College, Peosta, Iowa, United States

Venustodus is a Carboniferous chondrichthyan genus known only from isolated teeth. Its affinities are uncertain, even to order. It has been placed by various workers in the Cochliodontiformes, the Orodontiformes, and the Petalodontiformes. In North America, teeth referred to *Venustodus* are common in the Mississippian but uncommon in the Pennsylvanian. Teeth of the type species, *V. venustus*, have two morphologies. Both types are characterized by a ratio of labiolingual width to mesiodistal length of about 0.3 and having several parallel ridges along the lingual and labial margins of the crown. The first type is characterized by an oblong outline in oral view, a gently rounded profile in lingual or labial view, and a low, rounded, central apex. The second type has an outline in oral view that is a rounded obtuse isosceles triangle, with the obtuse angle projecting labially, a sharply arched, angular profile in lingual or labial view, and an acuminate central cusp. The Minturn Formation of central Colorado was deposited along the eastern margin of the Central Colorado Basin (the western flank of the Ancestral Front Range) and is late Atokan to Desmoinesian in age. A tooth from the Minturn Formation near McCoy, Eagle County, Colorado, displays similarities to *Venustodus*, but also significant differences, and appears to represent a new genus and species. It differs from the teeth of all nominal species of *Venustodus* in having a larger ratio of labiolingual width to mesiodistal length (approximately 0.54). Parallel coronal ridges are present only on the

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

lingual face. The lingual and labial profiles are gently arched. The central cusp is more robust and bulbous than in *Venustodus*. The bed in which the new species was found is dated to the late Atokan (early Moscovian Stage of the Pennsylvanian) by fusulinacean biostratigraphy. The new species is similar to *Venustodus arcuatus*, known from the Vereian and Kashirian Horizons (early Moscovian) of Belarus and Russia. *V. arcuatus* is assigned to the new genus. The chondrichthyan fauna of the Minturn Formation includes *Lagarodus* (uncommon in North America) and *Polyrhizodus* (common in the Mississippian but uncommon in the Pennsylvanian of North America), both of which are common in the Middle Pennsylvanian of the Moscow Syncline.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Cranioskeletal elements elucidate the tempo and mode of ecomorphological adaptive radiation in Greater Antillean *Anolis* lizards

Jacisin, John¹, Urban, Carmen¹, Xu, Tianyi¹, Meza, Antonio^{2,1}, Boville, Alexandra¹, Lawrence, Curtis^{3,1}, Kemp, Melissa¹

¹Department of Integrative Biology, University of Texas at Austin, Austin, Texas, United States, ²Arizona State University, Tempe, Arizona, United States, ³Florida A&M University, Tallahassee, Florida, United States

Greater Antillean *Anolis* lizards are an exemplary case of adaptive radiation and ecological convergence, where various species have evolved into distinct ecomorphs, each possessing a unique ecology. Although the Quaternary Caribbean fossil record is abundant with fossil cranioskeletal elements of *Anolis*, few studies have explored their ecomorphological relationships, in part because little is known about how the cranioskeletal elements

recapitulate the adaptive landscape of the group. Here, we characterize the morphological diversity of individual skull elements in Greater Antillean *Anolis* species and build a methodological framework for understanding congeneric Quaternary fossils from the Greater Antillean islands of Puerto Rico, Jamaica, Hispaniola, and Cuba. We assembled a high-resolution CT dataset of more than 430 crania and mandibles, representing >80 species of Greater Antillean anoles, including all extant species from Puerto Rico and Jamaica. Using landmark-based geometric morphometrics, we explored how *Anolis* lizards partition morphospace and determined that differences exist between how well individual skull elements express a multi-peak adaptive landscape, and that additional differences exist between island assemblages despite similar convergent ecomorphologies. Elements such as the maxilla, dentary and parietal exhibited clearer divergence of morphologies across ecomorphs, while others such as the palatine, pterygoid, and premaxilla were less consistent across ecomorphs. Crown giant, twig, and trunk ground anoles were most easily differentiated from other ecomorphs in both PCA and hierarchical cluster analyses, while grass bush anoles commonly filled more morphospace. Finally, analyses of individual cranioskeletal elements indicate that they are each experiencing different rates of evolution, suggesting that some parts of the skull may be more constrained than other parts. Overall, our results suggest that ecomorph skull shapes independently converge across the islands over time, likely mirroring the ecomorph-specific functional demands on the skull. Finally, initial findings incorporating fossil data indicate that we can effectively identify multiple ecomorphs from isolated skull elements. Thus, this dataset provides a framework for characterizing ancient *Anolis* assemblages and uncovering the evolving phenotypic landscape of the *Anolis* radiation

during historical periods of environmental change.

Funding Sources This research is funded by NSF EAR grant 2050228, to Dr. Melissa Kemp.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Quantitative osteological ontogeny of alligatoroids

Jackson, Brett X.

Carthage College, Emmetsburg, Iowa, United States

Developmental causes of evolutionary novelties are not always obvious. This issue might be overcome by comparison of growth series. Alligatoroidea is a model clade for this work, given a phylogeny that spans tens of millions of years, numerous extinct taxa with growth series, and multiple living species. The primary goal was to recover growth series, using cladistic analysis, of fossil and living alligatoroids: *Leidyosuchus canadensis*, *Diplocynodon hantoniensis*, and *Alligator mississippiensis*. Secondary goals were to compare the growth series and identify ancestral growth patterns. Data for *L. canadensis* (14 specimens, 27 characters) and *D. hantoniensis* (24 specimens, 19 characters) was from the primary literature; data for *A. mississippiensis* (4 specimens, 43 characters) was from skulls.

One tree was retained for the *D. hantoniensis* mandible (CI: 1.0, RC of 1.0, 6 steps). There were four growth stages: Growth Stage (GS)1, three foramina in angular; GS2, dentary symphysis reaches caudal rim of alveolus four, distinct ridge on angular; GS3, dentary symphysis reaches middle of alveolus 5, lingual foramen on suranguloarticular suture.

Five trees were retained for the *D. hantoniensis* skull (CI: 0.83, RC: 0.0, 12 steps). One growth stage was recovered,

supported by straight or concave side of skull table, long squamosal rami, prominent preorbital ridge on lacrimals, and no steps in the frontal process of frontal.

Eighteen trees for *L. canadensis* were retained (CI: 0.77, RC: 0.46, 36 steps). Four growth stages recovered: GS1, rostrum twice length of postrostral region, reduced exposure of supraoccipital, choana ridge and depression present, naris width less than half width of rostrum, strongly convex rostral end of palatine, rostrum width 62% of skull width; GS2, orbital ridge reduced, interorbital groove curved, supraoccipitals subsumed, crest A and B present, small STF; GS3, wide rostral process of frontal, short and wide incisive foramen; GS4, nasals distant from naris, maxilla widely excluded from incisive foramen, narrow lateral flare of palatine, ear-shaped expansion of palatine.

One tree for *A. mississippiensis* was retained (CI: 0.92, RC: 0.66, 52 steps) with four growth stages. The growth changes were too numerous to list here.

Shared growth changes were seen between the taxa: 3 synontomorphies were shared between *A. mississippiensis* and *L. canadensis*, and 4 between *A. mississippiensis* and *D. hantoniensis*. These are evidence of the ancestral alligatoroid ontogeny.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Tooth imbrication as an adaptation for herbivory in sauropodomorph dinosaurs

Jackson, Lynnea S.^{1,2}, Wilson Mantilla, Jeffrey A.^{1,2}

¹Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States, ²Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States

Sauropodomorpha is one of the three main lineages of Dinosauria, all of which first appear in the Late Triassic. Two of these lineages, Sauropodomorpha and Ornithischia, independently evolved obligate herbivory. Sauropodomorpha includes a series of basally diverging forms that are sequential outgroups to Sauropoda, which is a predominantly Jurassic–Cretaceous clade. The earliest sauropods and their immediate outgroups have imbricated dentitions, in which sequential teeth are rotated within the jaw and partially overlap one another; the distal margin of each tooth overlaps the mesial margin of each subsequent tooth. Imbrication also characterizes early ornithischians as well as certain sharks and actinopterygians. The functional importance of this feature is unknown, but its development may be related to tooth crown breadth, tooth rotation, and snout shape.

Tooth crown breadth, measured relative to its height, varies markedly within Sauropodomorpha. The earliest sauropodomorphs had intermediate crown breadths, like those of contemporaneous ornithischians. By contrast, sauropods ranged from broad, spoon-shaped forms (*Camarasaurus*) to narrow, pencil-like forms (titanosaurids, diplodocoids). Imbrication may have allowed intermediate and broad-crowned teeth to pack within the tooth row without increasing jaw length. Imbrication is not present in narrow crowns, whose nearly circular cross sections do not allow them to stack and overlap. Accordingly, tooth imbrication disappears in the Cretaceous, when narrow-crowned taxa predominate. Tooth rotation is present in imbricated dentitions, which can be measured by comparing the long axis of each tooth in cross section relative to the mesiodistal axis of the jaw. Late Triassic–Early Jurassic basal sauropodomorphs, such as *Plateosaurus* and *Massospondylus*, have less rotation than broad-crowned sauropods, such as the Late Jurassic *Camarasaurus*. Snout shape also

may impact the way that teeth can fit along the curvature of the jaw. Basal sauropodomorphs tend to have a narrow, triangular snout, whereas sauropods develop a broader, more rounded snout—which increases the volume of intake and tooth enamel relative to jaw length.

Tooth imbrication is an early adaptation for herbivory in sauropodomorphs that disappeared during the Cretaceous. The functional utility and reason for its disappearance remain unknown, but it may have been important in broad-snouted, broad-crowned forms, where it may have enhanced cutting efficiency.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Drivers of late Cenozoic equid evolution: The bull of the recent

Janis, Christine^{1,2}, Brown, Sophie¹, Benton, Michael J.¹, Singh, Suresh¹, Silvestro, Daniele³

¹Bristol Palaeobiology Group, School of Earth Sciences, University of Bristol, Bristol, United Kingdom, ²Department of Ecology, Evolution and Organismal Biology, Brown University, Providence, Rhode Island, United States, ³Department of Biology, University of Fribourg, Fribourg, Switzerland

Equids (Perissodactyla: Equidae) represent a key lineage in mammalian macroevolutionary studies, but the drivers of their late Cenozoic diversity remain unclear. Like many large mammal families, equids experienced a mid-Miocene diversity peak before declining in the Late Miocene: by the end of the Pleistocene only a single equid genus remained. This diversity loss is often attributed to competition with ruminant artiodactyls, particularly bovids. Bovid and equids had a similar range of body sizes and diets, but the bovid ruminant digestive system has been held to be superior to the equid hindgut one,

and bovid diversity actually increased over the period of equid decline. However, late Cenozoic changes in climate, including decreasing temperature and atmospheric CO₂ levels, may have had a more important effect on equid diversity trends than competition. Generic trends in North America and Africa demonstrate a lack of correlation between diversification of bovid and equid families, with bovids being unknown from North America until the Pleistocene. Europe provides the appropriate spatiotemporal overlap for investigation of bovid/equid competition, the primary equids here being the hipparions (Hipparionini, Equinae), migrating to the Old World from North America in the Late Miocene.

An analysis of potential competition between European hipparion and bovid species, including a proxy for climate change through time, was performed using Bayesian inference (PyRate) to estimate rates of extinction and speciation while accounting for sampling heterogeneities in the fossil record. This was done under a Multivariate Birth-Death model, which assumes that the rates of hipparion speciation and extinction change as a function of continuous time variables. The diversity trends at the generic level of other European ungulates were also considered, and the taxon occurrence data for both analyses was sourced from the NOW database. Climatic change and bovid diversification were used as predictors of equid diversification. The results show that, as in other regions, the majority of ungulate lineages saw a decline beginning in the Late Miocene, including all but two of the artiodactyl lineages (bovids and cervids). More importantly, the Bayesian analysis found no evidence to support interclade competition between bovids and hipparions at the species level, and instead highlighted temperature as a significant driver of Old World equid decline.

Funding Sources None

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Additional avian remains, including the first carpometacarpus, from the late Eocene Khoer Dzan locality of Eastern Mongolia

Jargalsaikhan, Myagmarsuren^{2,1}, Munkh-Ochir, Badamkhand^{2,4}, Minjin, Bolortsetseg^{3,1}

¹Mongolian University of Science and Technology, Ulaanbaatar, Mongolia, ²Paleontology, Natural History Museum of Mongolia, Ulaanbaatar, Mongolia, ³Institute for the Study of Mongolian Dinosaurs, Ulaanbaatar, Mongolia, ⁴Vertebrate Paleontology, American Museum of Natural History, New York, New York, United States

We report a sample of 96 isolated fossil avian bones, collected from the late Eocene Ergiliin Dzo Fm. as exposed at the locality of Khoer Dzan in 2013. Specimens were collected from the white sands in the lower part of the section, which are highly fossiliferous but include remains that are predominately disarticulated and disassociated. Most of the avian fossils can be attributed to Eogruidae or Ergilornithidae, a clade of extinct, flightless birds that have been allied with Gruidae or with Struthothioniformes. Eogruidae or Ergilornithidae are mainly known from hindlimb elements, but a recently described partial skull, cervical vertebra, and femora from Khoer Dzan have been referred to that clade. Most of the bones in our sample are from the hindlimb, but we have one partially preserved carpometacarpus, which is 40 mm in length. The proximal end has a very small fovea carpalis caudalis and the dorsal edge of the trochlea carpalis dorsalis is fairly flat, instead of projecting proximally. The processus intermetacarpalis is absent, but the processus cranialis is present but broken. The processus extensorius is well below the level of the trochlear carpalis dorsalis. The

shafts of the 2nd and 3rd metacarpals are robust, and the 3rd metacarpal is strongly bowed, which are suggestive of the anatomy seen in flightless birds or in birds with limited flight. Its total length is approximately 25% of the length of the tarsometarsus of ergilornithids from Khoer Dzan. Although difficult to confirm, the most likely identification of this carpometacarpus is that it is an eogruid or ergilornithid, and if correct, it may yield additional morphological data to place this extinct clade of flightless birds.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

Taxon selection influences tree topology in the early evolution of Amniota

Jenkins, Kelsey M.^{2,1}, Meyer, Dalton¹, Bhullar, Bhart-Anjan S.¹

¹Paleobiology, Smithsonian Museum of Natural History, Washington, District of Columbia, United States, ²Earth and Planetary Sciences, Yale University, New Haven, Connecticut, United States

The basal dichotomy within Amniota (mammals and reptiles) was recognized early in the history of phylogenetic systematics, and with it developed a canonical understanding of the evolutionary relationships of basally branching clades. For at least thirty years, this influenced scientific perception of the evolution of amniotes and their colonization of terrestrial landscapes during the Carboniferous and Permian. In recent years, however, phylogenetic hypotheses of these basal branches have shifted dramatically among studies, impacting subsequent interpretations of evolutionary patterns in early amniotes. With such discordant hypotheses, inferring the evolution of important traits that inform interpretations of broader ecosystem interactions, like temporal fenestration or sensory structures, is difficult if not

impossible. Ostensibly, these discordant hypotheses result from the selective inclusion or exclusion of major clades across Amniota within phylogenetic datasets.

To bring clarity to this ongoing debate of the early evolution of amniotes, I compiled a large and taxonomically comprehensive phylogenetic dataset encompassing all major recognized clades of early crown amniotes and stem and crown reptiles. This includes 590 fully illustrated characters and 150 taxa representing all the major clades of ‘pelycosaurian’ stem mammals and stem reptiles, along with several outgroups. Analysis under both Bayesian and parsimony frameworks produced differing topologies at the family level.

To explore the effect taxon selection has on tree topology, I conducted three sequences of taxon exclusion analyses in both Bayesian and parsimony frameworks. This experiment showed that the inclusion and exclusion of taxa has a major effect on overall topology. Furthermore, many of the topologies recovered by the exclusion analyses bear striking similarities to those reported in recent studies. This suggests that while the unusual phylogenetic configuration of some clades in recent work is a result of taxon undersampling (e.g., Captorhinidae as stem amniotes), the configuration of others is more strongly supported (e.g., ‘Parareptilia’ as a paraphyletic grade). Furthermore, increased taxon sampling results in higher stability among branches. To properly assess the evolutionary relationships of early amniotes, and likely most extinct clades, increased taxon sampling is necessary, particularly if assessing macroevolutionary patterns.

Funding Sources National Science Foundation, Yale Institute for Biospheric Studies, Western Interior Paleontological Society

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

Postaxial rotations of the metapterygial axis promote the origin of postaxial dominance in tetrapod digital arch development

Jia, Jia^{1,2}, Anderson, Jason², Zhang, Mei-Hua³, Jiang, Jian-ping³, Wang, Yuan¹, Zhu, Min¹, Shubin, Neil⁴, Gao, Ke-Qin⁵

¹Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China, ²Faculty of Veterinary Medicine, University of Calgary, Calgary, Alberta, Canada, ³Chengdu Institute of Biology, Chinese Academy of Sciences, Chengdu, Sichuan, China, ⁴Department of Organismal Biology and Anatomy, The University of Chicago, Chicago, Illinois, United States, ⁵School of Earth and Space Sciences, Peking University, Beijing, China

The metapterygial axis in fish fin refers to the main stem of branching patterns from the metapterygia. The route of the axis is a cornerstone of defining homology across the fin-to-limb transition. The axis in the autopodium [digits and mesopodials (carpus/tarsus)] of amniotes and anurans is believed to sequentially run through the ulnare/fibulare (u/f) and distal carpal/tarsal (dc/dt) IV-III-II-I. Such a route of the axis is based on chondrogenesis patterns (called postaxial dominance) of the digital arch, where a postaxial dc/dt bifurcates to form its corresponding digit and the next preaxial dc/dt. Unfortunately, the same axis route cannot be found in most salamanders and possibly basal tetrapods because their digital arch develops by following the exact opposite preaxial dominance.

The metapterygial axis in early tetrapods is likely obscured by evolutionary reductions of carpals and tarsals. To find prototypic configurations of the mesopodium, we CT scanned 260 living and fossil salamanders, including almost all genera, and conducted

comparative analyses with tetrapods and their fish ancestors. Centralia (c) 3 and 4 are found as prototypic mesopodials because they are stably positioned in carpus/tarsus of many taxa in the primitive salamander clade Cryptobranchoidea (e.g., *Batrachuperus*, *Liua*) and basal tetrapods (*Tulerpeton*, *Greererpeton*, *Proterogyrinus*), and collectively form *Sauripterus*-like series of bifurcations along the central column, where the intermedium (i), c1, c2 and dc/dt1 each has a 1:2 ratio between proximal and distal components. Elements in the central column fuse to their postaxial counterparts in a stepwise order of c1+c4, c2+c3, dc/dt1+2 and i+u/f during evolution, and fusions occur earlier in tarsus than in carpus. In Cryptobranchoidea and basal tetrapods, the central column is the first ossified “pillar” to link digits and zeugopodium, and to conduct biomechanical forces during locomotion, and ossifications start from the anterodistal corner of the mesopodium. In amniotes, anurans and derived salamanders, however, ulnare/fibulare and dc/dt4 become the first bony “pillar” in the mesopodium, with ossifications starting from the postero-proximal corner. The metapterygial axis is argued to go through the central column in salamanders and basal tetrapods. Postaxial rotations of the axis with associated shifts in ossifications lead to the rising of postaxial dominance and locomotory posture changes in basal tetrapods.

Funding Sources National Natural Science Foundation of China (41702002/41672003/41872008); Natural Sciences and Engineering Council of Canada Discovery Grant (2017-0482)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Two major evolutionary events for Triassic ichthyosauromorphs: origin in the Early

Triassic and transition to an apex predator in the late Middle Triassic

Jiang, Da-yong¹, Motani, Ryosuke², Tintori, Andrea³, Fraser, Nicholas⁴, Rieppel, Olivier⁵, Zhou, Min¹

¹Department of Geology and Geological Museum, Peking University, Beijing, Beijing, China, ²Department of Earth and Planetary Sciences, University of California, Davis, California, United States, ³TRIASSICA-Institute for Triassic Fossil Lagerstaetten, Perledo, Italy, ⁴National Museums Scotland, Edinburgh, United Kingdom, ⁵Integrative Research Center, The Field Museum of Natural History, Chicago, Illinois, United States

Fossil records for Triassic ichthyosauromorphs have been reported from Spitzbergen, central Europe, British Columbia, Nevada and California, Japan, Thailand, and south China. The first major evolutionary event is the emergence of the group in the Spathian Substage of the late Olenekian (Early Triassic), as evidenced by the Early Triassic Chaohu and Nanzhang-Yuan'an Faunas, as well as those from Spitzbergen and British Columbia. Eleven species of ichthyosauromorphs, including two nasorostrans, four chaohusaurs, and five hupehsuchians, were found at Chaohu and Nanzhang-Yuan'an, while globally a total of twenty eight marine reptile species (six from Chaohu and ten from Nanzhang-Yuan'an) have been reported in an interval of just 2 myr in the Early Triassic. It appears that ichthyosauromorphs and sauropterygians emerged in the Early Triassic soon after the end-Permian mass extinction: the earliest fossil horizon was found to be 248.81 Ma in age, about 3.35 myr after the end-Permian mass extinction. The ichthyosauromorphs underwent a rapid radiation before the end of the Early Triassic, followed by a subsequent radiation wave of sauropterygians in the Middle Triassic. Large ichthyosaurs were reported from the Anisian and Ladinian of the

Middle Triassic of central Europe and Nevada, but the substantial evidence for the ecological transition from near-shore to ocean, is from the Ladinian Xingyi Fauna at Guizhou Province, southwestern China—one of these oceanic forms represents the first direct evidence of a marine reptile feeding on another large marine reptile. The 5.1 m thick fossiliferous bed yields 17 or more taxa of marine reptiles and can be subdivided into two assemblages. In the upper assemblage, one species of large shastasaurid ichthyosaur *Guizhouichthyosaurus* and one medium-sized euichthyosaur *Qianichthyosaurus* were excavated. They are phylogenetically close to their Californian sister taxa, and also have closer paleobiogeographic affinity to Panthalassa. The trunk remains of the thalattosaur *Xinpusaurus* was found in the stomach of the *Guizhouichthyosaurus* body, which indicates that an ichthyosaur with a length of five meters unequivocally fed on a thalattosaur with a length of about four meters, and demonstrates that ichthyosaurs acted as an apex predator in the late Middle Triassic marine ecosystem.

Funding Sources Funding for this work was received from NSFC Grant 41920104001.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Redescription and systematics of *Abrosaurus dongpoensis* (Dinosauria: Eusauropoda) from the early Middle Jurassic Lower Shaximiao Formation of China

Jiang, Shan^{1,2}

¹Research Center of Jurassic Stratigraphy and Paleontology, Zigong Dinosaur Museum, Zigong, Sichuan, China, ²Sichuan-Chongqing Joint Key Laboratory of Paleontology Paleoenvironment Coevolution, Zigong Dinosaur Museum, Zigong, Sichuan, China

The Dashanpu locality of the early Middle Jurassic Lower Shaximiao Formation of Sichuan Province, China, has yielded a rich vertebrate fossil record, including a particularly diverse array of ornithischian and saurischian dinosaurs. Sauropod specimens from this quarry and elsewhere in the Shaximiao Formation serve as important outgroups in most studies of eusauropod phylogenetic relationships and have been central to the hypothesis that East Asia was geographically isolated during the Middle–Late Jurassic. Despite their importance to ongoing debates about sauropod phylogeny and biogeography, most Dashanpu sauropods have not been critically re-evaluated since their original, often brief descriptions, limiting their usefulness to macroevolutionary studies.

Here, we redescribe and illustrate the holotype of *Abrosaurus dongpoensis* (ZDM 5038), represented by an exceptionally complete and articulated skull, based on both firsthand study and computed tomography (CT) scanning of the specimen. The original diagnosis is mostly inadequate, specifying features that are now known to have a wider distribution among sauropods. However, *Abrosaurus* may be autapomorphic in possessing five premaxillary teeth, an exceptionally slender ascending process of the maxilla, and (convergently with some flagellicaudatans) the loss of a contact between the squamosal and quadratojugal. Other noteworthy features include an ectopterygoid that articulates laterally with both the jugal and maxilla (evidencing the rostral migration of this articulation that occurs early in eusauropod evolutionary history), the presence of two distinct halves of the supraoccipital (revealed by the CT scans), and a laterally expanded, sheet-like crista prootica. The latter feature was recently considered a dicraeosaurid synapomorphy, but is instead widely present in sauropods such as *Bagualia*, *Mamenchisaurus*, and *Camarasaurus*.

Preliminary phylogenetic analysis recovers *Abrosaurus* as a non-neosauropod eusauropod that is slightly later-branching than Mamenchisauridae, a position supported by an anteroposteriorly compressed ventral process of the postorbital. However, the taxon also shares several features with *Qijianglong* and species of *Mamenchisaurus* (e.g., a relatively narrow distance between the supratemporal fenestrae; a relatively tall occipital condyle; a deeply embayed orbital rim of the frontal) that leave open the possibility that continued study will ally *Abrosaurus* with mamenchisaurids.

Funding Sources Stony Brook University
Department of Anatomical Sciences

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Variation in Columbian mammoth molars, and the issue of mammoth species in North America

Jimenez Gonzalez, Victor M.¹, Prothero, Donald R.², Dooley, Alton C.³

¹Cal State Polytechnic Pomona, Winchester, California, United States, ²LA Natural History Museum, Los Angeles, California, United States, ³Western Science Center, Hemet, California, United States

During the late Pleistocene, *Mammuthus meridionalis*, the Southern mammoth, migrated to North America. The latest research indicates that this species later gave rise to *Mammuthus columbi*, the Columbian mammoth. We have studied the teeth and jaws of *Mammuthus columbi* from both La Brea tar pits and from Diamond Valley Lake Reservoir. There used to be multiple different species of mammoths recognized in these regions of North America, such as *M. jeffersoni* and *M. imperator*, but they have all been synonymized with *Mammuthus*

columbi. This research was mainly conducted on mammoth molars, specifically their M3's or more mature teeth, which were analyzed due to the fact that they have the most distinctive features necessary to differentiate them from other mammoth species. Measurements were taken on their lamellar frequency, enamel thickness, plate count, and overall tooth size as well as width. Both the La Brea and the Western Science Center specimens showed some variation between localities and other localities that contain populations of *Mammuthus columbi*. This data will help assess intrapopulational and interspecific variation in molars and suggest a reconsideration of the idea that all late Pleistocene North American mammoths can be lumped into a single species, *Mammuthus columbi*.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Early fish assemblages from the Middle Devonian of Lake Manitoba, Canada

Jobbins, Melina E., Brink, Kirstin

Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba, Canada

The vertebrate fauna from Manitoba is mostly composed of Mesozoic and Cenozoic taxa, including marine reptiles and terrestrial mammals respectively. The Paleozoic vertebrate fossil record in the province is regarded as scarce, with fewer early vertebrate finds in the Dawson Bay and Winnipegosis formations with little to no description of the material and poor record of their conservation. Here we describe an early fish faunal assemblage from the Middle Devonian of Lake Manitoba, in Elm Point and Winnipegosis formations. Species previously described from the formations include the arthrodiran placoderms *Squamatoagnathus steeprocksensis*, *Homosteus manitobensis*, and *Eastmanosteus lundarensis*. We add to

this information additional remains of placoderms and sarcopterygians, and rarer chondrichthyans and lungfish. Placoderm remains include cranial elements of arthrodires *Eastmanosteus* and *Homosteus*, and mainly gnathal elements of ptyctodonts *Rhynchodus* and *Ptyctodus*. Small remains of chondrichthyans comprise patches of scales from *Ohiolepis*. Lungfish material is scarce and difficult to identify. Sarcopterygians, mostly *Onychodus*, are represented by teeth and occasional cranial elements. Scanning Electron Microscope (SEM) were performed to highlight morphological details of the different elements. The fragmentary remains suggest the water was shallow, which coincides with previous suggestion of a platform, possibly reef developing, environment. The description of this diverse fish fauna, and presence in multiple localities, leads the way to a better understanding of vertebrates from the Paleozoic of Manitoba and reconstruction of the ecology at the time.

Funding Sources K. Brink is funded by NSERC-DGECR-2021-00364.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Diverse mineralized tissues of the buckler skin denticles in the ray *Raja clavate* (Batoidea, Chondrichthyes)

Johanson, Zerina¹, Smith, Moya^{1,2}, Debiais-Thibaud, Melanie³, Manzares, Esther¹, Dean, Mason N.⁴, Underwood, Charlie^{1,5}, LeBlanc, Aaron⁶

¹Natural History Museum, London, London, United Kingdom, ²Centre for Craniofacial and Regenerative Biology, Faculty of Dentistry, King's College London, London, Choose Any State/Province, United Kingdom, ³Institut des Sciences de l'Evolution de Montpellier, ISEM, University of Montpellier, Montpellier, France, ⁴Department of Infectious Diseases

and Public Health, City University of Hong Kong, Hong Kong, Hong Kong, ⁵School of Natural Sciences, Birkbeck College, London, United Kingdom, ⁶Faculty of Dentistry, Oral and Clinical Sciences, Centre for Clinical, Oral and Translational Sciences, King's College London, King's College London, London, United Kingdom

Placoid scales (skin denticles) cover the head and body of chondrichthyans, and in sharks their morphology and location are related to hydrodynamic function and/or defence from predation. Less well-known are the scales in batoids (rays) which are present in a wide range of morphologies and include modified denticles with enlarged bases in both fossil and extant taxa, known as 'thorns'. These are often found at specific locations on the body, however, their ultrastructure and relation to shark denticles has barely been explored. In this study, we investigate a type of thorn known as a 'buckler' in *Raja clavata*, unique in the extreme enlargement of the base, which overgrows the central spine-shaped crown. The crown is composed of orthodentine, with odontoblasts lining an extensive pulp cavity that includes the crown base. The crown base of osteodentine is joined to the buckler base with Sharpey's fibres. The remainder of the buckler demonstrates an unusual histology more closely resembling bone than dentine. This basal tissue, here termed 'vacuolated tissue', contains a network of large, irregular spaces oriented towards the buckler pulp cavity in hard tissue sections. In paraffin sections of extant ray bucklers, deposition of the buckler base is associated with a cell-rich, periosteum-like structure that surrounds the base. Newly formed basal tissue closely resembles cellular bone, with the entombed cells situated between thick bundles of Sharpey's fibres originating from the 'periosteum'. In the histologically more mature vacuolated tissue, the cell spaces are mostly replaced by enlarged fluid- or cell-filled spaces. We interpret the development of the vacuolated tissue as a unique

mineralized tissue in chondrichthyans, sharing some similarities with bone, but with an unusual mature state where cells are somehow replaced by large fluid-filled vacuoles throughout the base. Although chondrichthyans have generally lost the bone that is characteristic of other jawed vertebrate skeletons, the ray bucklers demonstrate the chondrichthyan capacity to deposit unique bone-like tissues within the odontode module.

Funding Sources None

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Taxonomy and biostratigraphy of the tillodont *Esthonyx* (Mammalia) from the lower Eocene of the Bighorn Basin, Wyoming, U.S.A.

Johnson, John C.¹, Secord, Ross^{1,2}

¹Earth and Atmospheric Sciences, University of Nebraska- Lincoln, Greeley, Colorado, United States, ²Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska, United States

Esthonyx is an early Eocene tillodont found in North America, Europe, and India. The genus was named by E. D. Cope in 1874 based on specimens from the San Jose Formation in New Mexico. Since then, several new species of *Esthonyx* have been described from basins in North America. The richest record of *Esthonyx* comes from the central Bighorn Basin (BHB) in Wyoming, where it occurs in 220 localities over a 640 m thick stratigraphic sequence. Since the last summary of *Esthonyx* in the BHB, several hundred new specimens have been collected and curated at the Denver Museum of Nature and Science and the Smithsonian National Museum of Natural History. Here we provide a revised assessment of the taxonomy and stratigraphic distribution of *Esthonyx* from the

BHB. We recognize three species in the Wasatchian sequence: *E. spatularius*, *E. bisulcatus*, and *E. acutidens*. Species were identified using previous diagnoses, novel character combinations, and character quantifications. New characters used included the presence/absence of a metastylid and an i3. In addition to the three species, two unnamed species of *Esthonyx* and one of *Azygonyx* may also be present. However, due to the fragmentary nature of the specimens we refrain from naming new species. The general stratigraphic sequence of species found here is consistent with earlier studies but the stratigraphic ranges of species have changed. *Esthonyx spatularius* first occurs in Wa-0 (0 m) and ranges into Wa-5 (409 m). *Esthonyx bisulcatus* first occurs at the beginning of Wa-3 (160 m) and ranges into Wa-7. *Esthonyx acutidens* first occurs in mid Wa-5 (409 m) and ranges into Wa-7. Both *E. acutidens* and *E. bisulcatus* occur lower than previously reported. *E. spatularius* and *E. bisulcatus* overlap between 160–409 m and *E. bisulcatus* and *E. acutidens* overlap between 409–598 m, with possible additional overlap at higher levels. Of the three species, the range of *E. spatularius* changed the most. Of additional interest, we found the extinction or local extirpation of *E. spatularius* and origination of *E. acutidens* correlate with the previously recognized ETM2 hyperthermal at 409 m. ETM2 was the second transient warming event of the early Eocene, recognized in both marine and continental records. The refined biostratigraphy presented here, and the underlying chronostratigraphic framework, will aid in the correlation of strata to other early Eocene continental basins across North America.

Funding Sources Funding provided by AAPG and Nebraska Geological Society's Yakola-Edwards Grant (JCJ), NSF grants EAR 2124939 (RS), and University of Nebraska State Museum endowments.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Craniocervical morphology and feeding function in Spinosauridae (Dinosauria: Theropoda)

Johnson-Ransom, Evan D.¹, Lopez-Vaca, Alejandro², Wyenberg-Henzler, Taia C.³, Snively, Eric⁴, Sereno, Paul C.¹

¹Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ²University of California, Merced, Merced, California, United States, ³Biological Science, University of Alberta, Edmonton, Alberta, Canada, ⁴Anatomy and Cell Biology, Oklahoma State University-College of Osteopathic Medicine at the Cherokee Nation, Tahlequah, Oklahoma, United States

Using updated, three-dimensional skeletal models of two spinosaurids, *Suchomimus tenerensis* and *Spinosaurus aegyptiacus*, we evaluated the craniocervical morphology and feeding function of Spinosauridae. The elongate, transversely-tapering snout and terminal dental rosette of spinosaurids are well known; less appreciated are the extraordinarily deep, proportionately narrow occiput and the “cervicalization” of the anteriormost dorsal vertebrae. These features, and the evolution in advanced spinosaurids of an interdigitating dentition, suggest that spinosaurids specialized in capturing fish in shallow water with a targeted, heron-like dorsoventral strike.

Comparing the craniocervical anatomy of the spinosaurids to more well-known theropods (e.g. *Tyrannosaurus* and *Allosaurus*), we used a combination of linear measurements, jaw muscle force estimates, and finite element analysis. Measurements of skull length, width and height, and craniocervical lever arm measurements of the occipital region, were subjected to a principal component analysis (PCA) to identify relationships between skull shape and relative potential for different types of movement of the head and neck.

We estimated the jaw muscle forces of spinosaurids by measuring and multiplying the adductor chamber area with a specific muscle tension, assuming the contributions of individual jaw muscles were similar to that of an adult *Tyrannosaurus* during adduction. These muscle forces were then used in finite element analyses (FEA) to evaluate cranial stress in the skull of spinosaurids, with properties of dense compact bone.

The PCA results show spinosaurids having relatively lower cranial heights and longirostrine crania with relatively longer ventroflexor lever arms than other theropods such as allosauroids and ceratosaurs, but relatively shorter dorsiflexor moment arms than tyrannosaurids. Spinosaurids also showed calculated jaw muscle forces and cranial stresses that were relatively lower compared to those of brevirostrine theropods (e.g. *Tyrannosaurus*). The craniocervical results suggest that spinosaurids lacked a slow crushing bite and possibly had rapid jaw movements to ensnare fast-moving prey, coupled with their relatively longer ventroflexor lever arms (e.g. a relatively low gracile skull and a relatively long neck).

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Evaluating the efficacy of a public science project (Cretaceous Creatures) to educate and engage students in identifying vertebrate microfossils from the Upper Cretaceous Hell Creek Formation

Jones, Elizabeth D.¹, Kanipe, John¹, Avrahami, Haviv M.¹, Cullen, Thomas², Zanno, Lindsay E.¹

¹Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ²Auburn University, Auburn, Alabama, United States

Paleontology education and outreach projects abound but few directly include the public in collecting and analyzing fossil data for research purposes—an approach known as public science. Cretaceous Creatures is a public science project designed to both educate and engage students in research by involving 8th-grade classrooms in discovering and identifying vertebrate microfossils in sediment from the Hell Creek Formation, Montana. Classrooms receive a 2-day lesson plan, microfossil sediment, and an online interactive identification module through which students help build an original paleobiodiversity database. To determine project efficacy, we assess student learning, hypothesizing that before participation, students will have little to no knowledge of how to identify microfossils and that their competency will improve via participation. To test this, we designed a mixed-method pre- and post-assessment using 3D digital renderings of five microfossils to specifically evaluate students' ability to recall vocabulary, understand concepts, and apply critical thinking skills.

September 2023 to May 2024, approximately 9,000 students across 80 schools in North Carolina participated in Cretaceous Creatures. In the pre-assessment, students were asked to identify five microfossils through four open-ended answers: 1) element, 2) taxon, 3) justification for their identification, and 4) perception of fossil preservation quality. We codified these qualitative answers into a quantitative score of average improvement in identification accuracy. Preliminary results from five classrooms (375 students) demonstrate improvement in their fossil identification skills by average percent growth per classroom (C1=14.24%; C2=7.65%; C3=10.4%; C4=15.36%; C5=11.84%). Results also indicate a taxonomic discrepancy in student improvement. Some taxon-element combinations are more difficult to identify due to complexity and preservation quality

(Gar scale=18.96%; *Myledaphus* tooth=12.83%; Amiid jaw=10.02%; Gar vertebrae=11.78%; *Triceratops* tooth=5.44%). Initial results demonstrate the overall efficacy of Cretaceous Creatures in educating students by engaging them in active scientific research, which is a key outcome given that the success of student learning directly impacts the quality of the science being produced. This also suggests the value of combining education objectives with public science methods for a more robust approach to public engagement.

Funding Sources This project is made possible by an Anchor Grant from the Bank of America Charitable Foundation to Dr. Lindsay Zanno.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Conservation Academy: Digging Deeper, an introduction to museum conservation methods for 11-12 year-olds at the Lubbock Lake Landmark

Jones, Lila^{1,2}, Westfall, Madison^{1,2}

¹Lubbock Lake Landmark, Texas Tech University, Lubbock, Texas, United States, ²Museum of Texas Tech University, Texas Tech University, Lubbock, Texas, United States

The Lubbock Lake Landmark hosts two summer youth programs in the Conservation Academy series for students aged 11 to 12. *Conservation Academy: Digging Deeper* is a hands-on experiential program where the students are introduced to conservation principles and concepts and engage in conservation activities. A prerequisite is attendance in *Conservation Academy: Agents of Deterioration* where the students learn through hands-on involvement about preventative conservation and collections

management. Focused on vertebrate remains, the goal of *Conservation Academy: Digging Deeper* is for students to gain an understanding of conservation methods using collections in a museum setting. Over the course of two weeks, the students participate in excavation practices, create and excavate pedestals and jackets, make conservation-grade polyvinyl acetate solutions and adhesives, engage in methods of bone stabilization, and complete the documentation used when performing conservation techniques. Students conclude with a poster presentation of their results, conveying their newly learned skills to Conservation Academy attendees and parents visiting the exhibition. A five-question assessment is completed by each student to evaluate concepts learned throughout the program. Students scoring 80% or more on the assessment indicate that the museum conservation concepts were imparted successfully. Parents also are canvassed for their observations. Students graduate from the summer program with first-hand knowledge and budding skills in the conservation methodology used and the initial processing of field-generated collections at the Lubbock Lake Landmark. Conservation Academy provides a foundation for higher-level concepts at an early age. The programming allows the students an opportunity to explore future careers as museum professionals, archaeologists, or paleontologists in the fields of conservation and collections care and management.

Funding Sources Funding for this program was through a Holly Maxson Conservation Grant from the Foundation for Advancement in Conservation.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The early middle Eocene bat fauna of Powder Wash, Utah, USA

Jones, Matthew F.¹, Baez, Justin R.^{1,2}

¹School of Life Sciences, Arizona State University, Tempe, Arizona, United States, ²Department of Geophysical Sciences, University of Chicago, Chicago, Illinois, United States

Middle Eocene (Bridgerian through Duchesnean) bat faunas are poorly known in North America. Contemporaneous faunas in North Africa preserve multiple taxa thought to belong to living bat lineages, whereas those of Europe include both supposed crown bats and stem bats. The only thoroughly described middle Eocene bat fauna in North America—the early middle Eocene Elderberry Canyon fauna of Nevada—includes three named species, two of which are thought to belong to stem lineages and one possibly among crown Vespertilionoidea. We present here a previously undescribed bat fauna from the early middle Eocene Powder Wash locality of eastern Utah. This fauna preserves isolated dental remains of several bat species, including one which shows affinities with the late middle Eocene *Wallia* from Saskatchewan, Canada, and another which may represent a late occurring member of the stem family Onychonycteridae. This locality substantially improves our knowledge of middle Eocene bat faunas in North America, and presents an opportunity to evaluate the hypothesis of a global turnover from stem to crown bats during the middle Eocene.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Reassessment of *Yurgovuchia* pelvic material and Theropod diversity in the lower Yellow Cat Member of the Cedar Mountain Formation of Central Utah

Jorgensen, Rachel^{1,2}, Loewen, Mark^{1,2}, Kirkland, James I.³, DeBlieux, Donald D.³, Zanno, Lindsay E.^{4,5}

¹Geology and Geosciences, University of Utah, Taylorsville, Utah, United States, ²Natural History Museum of Utah, Salt Lake City, Utah, United States, ³Utah Geological Survey, Salt Lake City, Utah, United States, ⁴North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ⁵North Carolina State University, Raleigh, North Carolina, United States

The Doelling's Bowl Bone Bed in the lower Yellow Cat Member of the Lower Cretaceous Cedar Mountain Formation is one of the oldest fossil producing sites in North America. It is Berriasian in age 145-140Ma and has produced several important dinosaurs including the oldest putative dromaeosaurid material in North America represented by *Yurgovuchia doellingi*. UMNH VP 26015, a complete pelvis, represents a previously unrecognized theropod taxon in Doelling's Bowl. The lack of a supraacetabular ridge on the ilium differentiates it from ornithomimids and tyrannosauroids. The anteroventral process of the ilium, the supraacetabular hood and the shape of the cuppedicus and brevis fossae are most similar to the basal therizinosaur *Falcarius*. The pubis is comparable to that of allosaurids, ornithomimids, tyrannosaurids, *Falcarius*, and *Achillobator* in the propubic orientation of the pubis but differs from allosaurids, ornithomimids, tyrannosaurids, *Falcarius*, *Deinonychus*, *Achillobator*, *Adasaurus*, and *Velociraptor* in lacking a prepubic component to its pubic boot. The blade-like ischial shaft with a distal anterior obturator process of UMNH VP 26015 is similar to *Falcarius*, *Deinonychus*, and most known dromaeosaurids and differs from allosauroids, compsognathids, tyrannosauroids, and *Achillobator* which have rod-shaped ischial shafts. The socket on the ischium for articulation with the ilium is most like the condition in *Falcarius*. The Doelling's Bowl Bone Bed has yielded pelvic material

from two dromaeosaurs, the holotype of *Yurgovuchia* and an unnamed dromaeosaurid (UMNH VP 21752). The pelvis of *Yurgovuchia* (UMNH VP 20211.18) was described as a proximal left pubis, but upon further inspection, it is a distal right pubis and does not represent the same size of individual as the holotype. The pelvis was found close to the holotype of *Yurgovuchia*, however, the cross-sectional shapes of the pubic shafts are different. Continued excavation at Doelling's Bowl has revealed additional theropod material. Several isolated allosaurid teeth and an isolated therizinosaur tooth have been recovered, along with possible allosaurid skull elements. The three pubes, isolated teeth, and skull elements found in this area indicate a diverse theropod ecology in the Yellow Cat Member during the Lower Cretaceous. Further collection of material is needed to further refine the affinities of the taxon UMNH VP 26015 represents.

Funding Sources Thank you to NHMU, the University of Utah, Geological Society of Utah, North Carolina Museum of Natural Sciences and North Carolina State University

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Unveiling the oldest *Hystrix*: a comprehensive study of *Hystrix parvae* from Kohfidisch, Austria

Kalthoff, Daniela C.¹, Winkler, Viola², Daxner-Höck, Gudrun²

¹Zoology, Swedish Museum of Natural History Stockholm, Stockholm, Sweden, ²Geology and Paleontology, Natural History Museum Vienna, Vienna, Austria

Until very recently, the stratigraphically oldest porcupines of the genus *Hystrix*, specifically *Hystrix parvae*, were known from just a very few specimens in Late Miocene localities at Csákvár in Hungary, Salmendingen in

Germany, and Crevillente 2 in Spain. However, this changed when the fossil site at Kohfidisch in Austria yielded important and extensive collections of fossil vertebrates, including more than 100 cranial and dental elements of *Hystrix parvae*. These porcupine fossils represent at least ten adult and ten juvenile individuals. Kohfidisch is located in the Austrian part of the Pannonian Basin, and represents a karstic cave and fissure system within Devonian limestones, filled with fossil-rich clay. It is renowned as the richest Pannonian fossil deposit in Austria. The fauna from this site dates to the Late Miocene (lower Turolian, MN 11), around 8.6 million years ago. For the first time, this extensive collection enabled a detailed description of this smallest and oldest species of *Hystrix*, shedding light on the interspecific and ontogenetic variability of this stratigraphically significant rodent. The study revealed that tooth wear represents a wide span of ontogenetic stages from very young pups to senile individuals. The crown height of all milk premolars and lower adult teeth is low (brachydont), while the upper teeth are of medium high (mesodont). Compared to stratigraphically younger *Hystrix* species from Eurasia, these earlier taxa exhibit a moderate increase in crown height, followed by a sudden and significant increase from Late Pliocene onward. The paleoenvironment surrounding the Kohfidisch cave and fissure system obviously provided suitable conditions for nesting dens, feeding grounds, and shelter, facilitating the successful breeding of this small porcupine species.

Funding Sources The current research was granted by the Austrian Science Fund, FWF-project: P-15724-N06.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

A new emydopoid dicynodont from the middle Permian of the Karoo Basin and the systematics of the Kingoriidae

Kammerer, Christian F.^{1,3}, Araújo, Ricardo M.^{2,4}, Rubidge, Bruce S.³, Macungo, Zanildo^{3,4}, Chambule, Nelma⁴, Massingue, Amélia⁴, Angielczyk, Kenneth D.⁵

¹Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ²Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa, ³Instituto de Plasmas e Fusão & CERENA, Instituto Superior Técnico, Universidade de Lisboa, Lisbon, Portugal, ⁴Museu Nacional de Geologia, Maputo, Mozambique, ⁵Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Kingoriidae is a long-ranging clade of emydopoid dicynodonts characterized by occlusion of the mandibular fenestra by a dentary lamina and constriction of the pineal foramen in the intertemporal bar. Four species in two genera are currently accepted as valid: *Dicynodontoides recurvidens* (late Permian, South Africa), *D. nowacki* (late Permian, Tanzania), *Kombuisia antarctica* (Early Triassic, Antarctica), and *K. frerensis* (Middle Triassic, South Africa). *Thliptosaurus imperforatus* (latest Permian, South Africa) and *Rastodon procurvidens* (middle Permian, Brazil) have also been suggested to be kingoriids, but their relationships are controversial. *Dicynodontoides recurvidens* has the largest sample and longest stratigraphic range among kingoriid species, with more than 60 confirmed records in the *Endothiodon* through *Daptocephalus* Assemblage Zones of the Beaufort Group. We present a new specimen (BP/1/7302) representing a novel kingoriid from the middle Permian *Tapinocephalus* Assemblage Zone near Beaufort West (Western Cape Province, South Africa). The specimen differs from late Permian records of *Dicynodontoides* by its

broad intertemporal skull roof posterior to the postorbital bar, and an unconstricted, relatively anteriorly-positioned pineal foramen surrounded by a collar-like pineal boss. The specimen also exhibits an exceptionally elongate interpterygoid vacuity (one third of basal skull length), even compared to other kingoriids. A comprehensive reexamination of kingoriid records globally reveals an underappreciated species richness for the clade. Late Permian Karoo records of “*D. recurvidens*” differ substantially in intertemporal morphology, representing minimally two morphospecies. *Oudenodon sakamenensis*, known from a single skull from the lower Sakamena Formation, Madagascar, is shown to be a *Dicynodontoides*-type kingoriid. New records from Mozambique, Tanzania, and Zambia include multiple taxa and reinforce the distinction of *D. nowacki* from South African taxa. Inclusion of these morphotypes in a phylogenetic analysis recovers BP/1/7302 as the earliest-diverging kingoriid and “*Dicynodontoides*” as a paraphyletic assemblage outside of *Kombuisia*, necessitating genus-level taxonomic revisions. Rather than being a rare and depauperate group as historically believed, kingoriids were important components of terrestrial Permian Gondwanan ecosystems, likely contributing to their unique survival among non-kannemeyeriiform dicynodonts into the Middle Triassic.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

A comparison of molecular and morphological phylogenetics of Carcharhiniformes sharks from North Carolina since the Cretaceous

Kane, Miriam^{1,2}, Gates, Terry A.^{1,2}

¹Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²North Carolina Museum of Natural

Sciences, Raleigh, North Carolina, United States

Historically, morphological phylogenetics has been the gold standard analysis used to determine evolutionary relationships for sharks. In the last decade, extant shark phylogenetics has gained traction with increased sequencing of genes across the clade, changing the way we investigate evolutionary relationships. Although shark teeth are abundant in the fossil record, articulated skeletons are rare, thus creating preservational biases in morphological phylogenetic analyses. Additionally, tooth morphology is less frequently used to recreate evolutionary relationships, despite its frequent use to time calibrate molecular datasets. Here we test the validity of using tooth characteristics to investigate evolutionary relationships by comparing tooth morphology phylogenetics to molecular phylogenetics of Carcharhiniformes sharks. The morphological phylogeny consists of 51 taxa comprising 17 extant and 34 fossil taxa spanning across five families, and ranging temporally from the Cretaceous to present day. The taxa were scored for 51 characters ranging from full jaw observations to isolated tooth traits. A Bayesian phylogeny of the tooth character matrix was performed in Mr. Bayes (version 3.2.7a; 10,000,000 generations; variable rates with a gamma rate prior) using *Abdounia enniskilleni* as the outgroup taxon. Bree et al. 2022, a recent molecular phylogeny, was compared to a morphological phylogeny. Though limited in our current dataset, we find there is phylogenetic information in shark teeth that can be used to recreate phylogenetic relationships. In the morphological phylogeny, we recovered Atelomycteridae as sister taxa to Triakidae, which contrasts to the molecular phylogeny where these two clades are very distinct and separate from each other by five branches. In the morphological phylogeny, all other families are shown in a polytomy. We interpret this result as a combination of

coding style (in which we coded each specimen as an individual) and character construction. Future steps will involve expansion of taxonomic coverage as well as augmenting morphological characters to better understand the evolutionary relationships that can be discovered using tooth morphological characters. Finally, given the useful but limited information that can be acquired from tooth morphological traits, it will likely be more beneficial to combine morphological traits with genetic data in phylogenetic analyses.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Public involvement in the production of microfossil datasets: A case study of the biodiversity and methodology of the public science project Cretaceous Creatures

Kanipe, John^{1,2}, Jones, Elizabeth D.^{1,2}, Avrahami, Haviv M.^{1,2}, Cullen, Thomas³, Zanno, Lindsay E.^{1,2}

¹Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ²Department of Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ³Department of Geosciences, Auburn University, Auburn, Alabama, United States

The latest Cretaceous Hell Creek Formation is one of the most intensely studied fossil bearing rock units in North America. In addition to an abundance of macrovertebrate fossils, the Hell Creek Fm. also preserves rich and abundant vertebrate microfossil bonebeds (VMBs) offering the potential for rapid, site-specific biodiversity assays. The processing of sediment from VMBs represents a unique opportunity to involve the public in the generation of valuable scientific data—a longstanding challenge for paleontology. Recently, the North Carolina

Museum of Natural Sciences (NCSM) launched Cretaceous Creatures (CC), a public science project involving dozens of 8th grade classrooms across North Carolina. Small teams of participating students sort and identify specimens from VMBs and return specimens and metadata to the NCSM. Specimen identifications are then validated or revised by NCSM paleontologists. Here we report on student sorting bias, microfossil biodiversity between microsites, and detail aspects of public science practice that may contribute to these issues.

Classrooms from the first two years of the CC project have already processed >175 kg of sediment from three VMBs from lower to middle Hell Creek Fm, all preserved as sandy channel deposits, with varying intensity. : WM (12 classrooms, ~ 24.7 kg of processed sediment), CNS (33, ~ 81.6 kg), and NC (35, ~ 70.3 kg). Each team of 2–3 students receive approximately 25g of sediment to sort and identify. Validated fossil identifications were compared across sites using rarefaction in the R package Vegan to assess the scale of public involvement required to adequately sample a VMB at the family level. To contextualize our findings, we subsampled our data in R, accumulating biodiversity totals from individual classrooms until the number of classes reached a biodiversity threshold. We found a median of 47 classrooms are required to achieve sufficient sampling depth to estimate site-specific diversity, with all sites reaching a family level asymptote at or before 200 fossil identifications. The compilation and analysis of the CC dataset demonstrates the appeal of public science practices, which offer a novel way to produce VMB datasets that further the understanding of ancient ecosystems and deepen relationships between scientists and the public.

Funding Sources This project is made possible by an Anchor Grant from the Bank of America Charitable Foundation to Dr. Lindsay Zanno.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Occurrences of fossil Carnivora and
Creodonta in localities of the Lower
Eocene Willwood Formation (~56-53 Ma),
Bighorn Basin, Wyoming, USA**

Kapernekas, Jason A., Nichols, Kimberly,
Bown, Tom

Anthropology and Geography, Colorado State
University, Fort Collins, Colorado, United
States

The ecological relationship between faunivorous mammals within an ecosystem provides insights on interspecies competition and niche partitioning. This poster reports on the results of frequency analyses of relative occurrences of extinct faunivorous mammals of the Order Carnivora (*Didymictis*, *Viverravus*, *Miacis*, *Oodectes*, *Uintacyon*, *Vassacyon*, and *Vulpavus*) and the Order Creodonta (*Oxyaena*, *Dipsalidictides*, *Arfia*, *Galecyon*, *Prolimnocyon*, *Prototomus*, and *Tritemnodon*) at AMNH, CSU, USGS, UW, and WSGS localities of the Willwood Formation. Focusing on predators of different body masses, my hypotheses concern relative predator abundances over time, proximity to streams, and in relation to relative time taken to form an ancient soil (paleosol stage data). As the relative creodont/carnivore abundances change over time, it is indicative of prey loss or changes in ecological variable(s). Lower in the Willwood stratigraphic section, percentages of Creodonta are slightly higher than those of Carnivora (4-5% of total mammal faunal populations). Higher in the section, Creodonta form a much lower percentage of the population than Carnivora, which range from 2.5-6.5%. In contrast, Creodonta range from 0.7-3.5% of faunivores, yet never account for more of the population than the Carnivora after the lowermost part of the section. Paleosol data show that all

faunivores tend to be found in paleosol stages 4-5 throughout the beginning of the section but move to the 2-3 stages until high in the section where they are mainly found in stages 0-1. These results indicate a shift closer to water sources in response to gradual climatic change to warmer and dryer conditions.

Funding Sources N/A There was no funding for this project

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A novel pathology in the feeding apparatus of a *Pachyrhinosaurus lakustai* (Ceratopsia: Centrosaurinae) skull from the Pipestone Creek bonebed of the Upper Cretaceous Wapiti Formation in Alberta, Canada

Kastroll, Lindsay M.¹, Beguesse, Kyla A.^{2,3}, Sullivan, Corwin¹

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States, ³Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States

The ceratopsian dinosaur fossil record preserves numerous cases of pathologies affecting almost every bone in the face, but data on premaxillary pathologies is extremely limited. Considering that the rostral-premaxilla region would have routinely come under stress during food acquisition, pathologies affecting the premaxilla could have imposed a significant handicap on an individual. Several examples of craniofacial pathologies in the centrosaurine ceratopsid *Pachyrhinosaurus lakustai* from the Pipestone Creek bonebed, near Grande Prairie, Alberta, have been previously described, but here we report a heretofore

undescribed premaxillary pathology in a partial skull collected in 2011 (UALVP 62634). This specimen consists of a nearly-complete left side save for the jugal horn and parietal, and a much more fragmentary right side represented by only the rostral and dorsal regions. Most of the ventral length of the right premaxilla is irregularly and mediolaterally expanded by approximately 1.5 times the maximum width of the left. Two cavitated lesions measuring approximately 2.9 x 2.6 x 0.6 cm and 5.0 x 2.2 x 2.2 cm focally disrupt ventromedial and ventral areas of the premaxilla, respectively. This abnormality is interpreted as the result of a chronic soft tissue penetrative trauma with focal infection, abscess formation and bone loss. It is uncertain whether this region of the premaxilla was overlain by a continuation of the beak that presumably covered the rostral bone, or hard scales overlying minimal soft tissue as seen in modern-day reptilian analogs. Regardless, either type of integumentary structure would have allowed very limited space for an expansile soft tissue mass to develop due to trauma and subsequent infectious-inflammatory pathology, likely resulting in compression on the bone. Because *P. lakustai* has been modeled as having a strong anterior bite, this pathology may have induced pain during feeding and thus posed a severe impediment for UALVP 62634. Following the interpretation of the taphonomy of the Pipestone Creek bonebed as the remains of herd members that failed to survive a dangerous event, such as a river crossing, the casualties potentially represent herd members that were most susceptible to environmental hazards. The effect of the premaxillary pathology, while probably not fatal on its own, may have weakened this individual and contributed to its death.

Funding Sources Funded by Natural Sciences and Engineering Research Council of Canada and endowment funds associated

with the Philip J. Currie Professorship at the University of Alberta

Colbert Prize Session

Taphonomy of an excavated Early Pleistocene hyena (*Pachycrocuta brevirostris*) den at the Haro River Quarry, northern Pakistan

Kaur, Anubhav Preet¹, Pobiner, Briana³, Behrensmeyer, Anna K.⁴, Jukar, Advait M.², Saunders, Jeffrey J.⁵

¹Humanities and Social Sciences, Indian Institute of Science Education and Research Mohali, Chandigarh, Chandigarh, India, ²Human Origins Program, Department of Anthropology, Smithsonian Institute, Washington DC, District of Columbia, United States, ³Paleobiology, Smithsonian Institute, Washington DC, District of Columbia, United States, ⁴Department of Natural History, Florida Museum of Natural History, Gainesville, Florida, United States, ⁵University of Arizona, Tucson, Arizona, United States

Prehistoric hyena dens are an important source of information about palaeoecology, predator-prey dynamics, and site formation processes. Additionally, they also provide valuable insights into the behavior and ecology of hyenas and other associated carnivores. Fossil hyena dens are well known and well-studied throughout the Early to Late Pleistocene in Africa and Europe but are relatively rare on the Indian subcontinent. In this study, we present data from taphonomic analysis of an Early Pleistocene (1.6-1.2 Ma) hyena den at the Haro River Quarry, northern Pakistan, attributed to *Pachycrocuta brevirostris*. It is the only one known to be *in situ*. Previous analyses by Saunders and Dawson in 1998, after three seasons of excavation (1982-1984), documented bone damage patterns at the site and attributed these to *Pachycrocuta brevirostris*. In this study, we build on their analyses and

reconstruct the full taphonomic history of the site, exploring a larger spectrum of potential agents responsible for bone accumulation and modification. By analyzing the bone fragmentation patterns, tooth marks, other surface modifications, and chewing damage, this study differentiates between bone accumulations caused by hyenas and other processes such as fluvial reworking and deposition. Spatial distribution and bone orientation patterns highlight pods 1 and 2 as the primary occupation levels of the den. The site's sedimentary features appear to represent a single flood event as the cause of burial of the den. The assemblage includes remains of ungulates (bovids and cervids), various carnivores (hyenas, mustelids, canids, and viverrids), hyena coprolites, chelonians, and crocodilians, providing a comprehensive view of the ecosystem of the local area of the site during the Early Pleistocene. In addition to hyena damage, the bones have been further modified by termites, three different species of rodents, compaction (due to sediment loading), trampling, weathering, and chemical dissolution due to water action. This study reconstructs the taphonomic history of bone accumulation at the site since its deposition, burial, and excavation. Furthermore, it highlights the importance of the site as a window into the behavioral ecology and feeding strategies of *Pachycrocuta brevirostris* in the Himalayan Foreland basin and presents it as a reference point for future similar studies in the region and beyond.

Funding Sources The Leakey Foundation

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Ontogenetic changes in trabecular anatomy of the Carboniferous tetrapod *Ossinodus*

Kaytor, Natalie¹, Bishop, Peter², Hocknull, Scott A.³, Bevitt, Joseph⁴, Pierce, Stephanie E.², Whitney, Megan¹

¹Loyola University Chicago, Chicago, Illinois, United States, ²Harvard University, Cambridge, Massachusetts, United States, ³Queensland Museum, South Brisbane, Queensland, Australia, ⁴ANSTO, Sydney, New South Wales, Australia

The tetrapod conquest of land that commenced ~380 million years ago is one of the most significant evolutionary transitions in vertebrate history. Our understanding of animals that came strictly before the transition (i.e., Devonian) and those that came strictly after (i.e., Permian) is much clearer than our understanding of animals that existed during the transition window of the Carboniferous. Increased investigation of taxa from the Carboniferous period can therefore fill gaps in our knowledge of the water-to-land transition. A major lingering question is how life histories changed as tetrapods became more terrestrially adapted. While this can be challenging to discern from gross anatomy, bone histology can provide a unique record of skeletal and functional development across ontogeny. The composition of trabecular bone in particular can provide insight into the type and degree of mechanical loading experienced by bone and, as a result, can give insight into potential changes in locomotor behaviors during the course of an animal's lifetime. In the current study, we used synchrotron scanning to non-destructively obtain 3D histological-level images of trabecular bone structure in an ontogenetic series of femora from the Australian stem tetrapod *Ossinodus* (~333 Ma). This series included femora from a very young juvenile, an older juvenile, and an adult. 3D image analysis revealed some significant differences across the sample, including: 1) high trabecular number in the very young juvenile, 2) high trabecular spacing in the older juvenile, 3) high levels of anisotropy in the very young juvenile, and 4)

low levels of trabecular connectivity in the adult. Our data demonstrate that a combination of limb development and locomotor-induced loading likely played a role in the formation of early tetrapod trabecular structure, supporting the use of our approach in clarifying early tetrapod life histories. As a result, continued efforts to parse the roles of development and locomotor loading in trabecular bone formation, especially in other Carboniferous taxa and modern analogous species (e.g., amphibians), will help to establish the utility of these measurements in developing lines of inquiry into Carboniferous tetrapod terrestriality.

Funding Sources Loyola University Chicago Biology Department Fellowship, ANSTO Australian Synchrotron beamline access grant M17466.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024,
1:45 PM)

Tools for distinguishing the isolated and undistinguishable: a new digital protocol for identifying isolated teeth using Late Triassic Archosauriformes as case study

Keeble, Emily, Nesbitt, Sterling J.

Geosciences, Virginia Tech, Blacksburg,
Virginia, United States

The Late Triassic is an ideal case study in expansive diversification of life after mass extinction. By focusing on microvertebrate sites, we record greater diversity than with macrofossils alone, allowing us to produce a more complete picture of Triassic vertebrate diversity. Teeth are the most common fossils in these deposits due to their relative hardness, but are often isolated, leading to difficulty in identifying their clades. Identifying taxa from these isolated teeth is crucial to understanding the radiations of

successful groups such as Archosauria. The hypothesised plesiomorphic tooth shape of archosaurs is recurved, serrated, and laterally compressed, indicating carnivory. Despite forays into other morphotypes (e.g herbivory in aetosaurs, omnivory in silesaurids), a great number of archosaurs retained (or possibly reverted) to this ancestral state. The similarity complicates identifying isolated archosaur teeth, hampering studies of faunal composition, diversification, and ecology. To address this problem, we compare teeth from jaws of known taxa from across archosaurian clades. We separated tooth types by premaxilla, maxilla, and dentary when possible to test the full spectrum of tooth shape and identify trends in these mouth regions. We compared the teeth using both quantitative and qualitative approaches. We placed five homologous fixed landmarks and draped a disk of semilandmarks over the model for 3DGM to describe gross morphology. To complement this quantitative approach, NMDS was used to provide further separation between taxa and tooth type using discrete characters. Results from both analyses show that many taxa plot closely together, with teeth from each individual tending to plot in clusters. We did not record any recurring signal between how the different regions of the mouth plot in any taxon within our sample. *Euparkeria* in both analyses plots centrally – as hypothesised for the ancestral tooth shape from which other morphologies derived. The aetosaur *Coahomasuchus* and erpetosuchid *Parringtonia* plot away from the main clusters in both quantitative and discrete analyses, suggesting these may be the most distinct teeth in the sample. Dinosaur and pseudosuchian teeth occupy distinct areas of morphospace, indicating that our methods successfully distinguish between major clades of Archosauriformes. This work is transferrable to other animal clades, and we hope that it will become a useful tool, particularly in the study of microsites.

Funding Sources Virginia Tech Department of Geosciences, NSF EAR 1943286

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Fossil lab in a neighborhood: new connections, future visions

Keillor, Tyler, Sereno, Paul C., Fitzgerald, Erin, Schwartz, Jessica

University of Chicago, Chicago, Illinois, United States

The *Fossil Lab* at the University of Chicago moved from campus to Washington Park, an underinvested neighborhood located a short shuttle trip West of campus. Reviving a century-old brick warehouse with a wood-beam arched roof, the new *Fossil Lab* was announced with fanfare, generating interest on the part of many students, neighborhood schools and retirees. While not a public museum, the lab was specifically designed with continuous engagement in mind. How could a state-of-the-art paleontological facility contribute to neighborhood STEAM learning and participation?

Engaging the neighborhood begins with the facility's façade, featuring an expansive, impossible to overlook *Spinosaurus* mural and lighted sign. Visitors entering the facility stroll along the 'bone gallery' lined by large windows into the 'prep lab,' to enter the large 'learning room' that functions flexibly for research, teen engagement classes, community meetings or public lectures or announcements. At its opening in May 2024, media, local politicians, community leaders, clergy, educators, and families were present and touring its spaces. After school and summer programs in the works led by staff, university students and others use the *Fossil Lab*, an adjacent park, and other spaces, and are developed with the input of local educators and students. Rigorous

assessment tools for out-of-school-time programs have been developed to measure effectiveness in different settings.

The larger aim of the *Fossil Lab* is to function as a steppingstone to a neighborhood science center in-planning, *Scitopia Chicago*. Designed as a free neighborhood-based destination, *Scitopia Chicago* would bring together under one roof all three urban informal science components: library, museum and conservatory, with makerlabs spanning the sciences and connecting to an adjacent university and city college hub. The *Fossil Lab* and what may come next open teen opportunity by creating new arenas that foster beneficial social infrastructure.

Colbert Prize Session

“Ground-toothings” ecomorphological, isotopic, and dental microwear paleoecology proxies in a modern Texas small mammal community

Keller, Jonathan S.¹, Pardi, Melissa I.², DeSantis, Larisa³, Lyons, Kate⁴, Newsome, Seth¹, Smith, Felisa A.¹

¹Biology, University of New Mexico, Albuquerque, New Mexico, United States, ²Research and Collections Center, Illinois State Museum, Springfield, Illinois, United States, ³Biological Sciences, Vanderbilt University, Nashville, Tennessee, United States, ⁴Biological Sciences, University of Nebraska, Lincoln, Nebraska, United States

Dietary reconstruction methods applied to the fossil record require ground-truthing in modern communities to make robust inferences. We applied dental ecomorphology, dental microwear texture analysis, and $\delta^{15}\text{N}/\delta^{13}\text{C}$ stable isotopic proxies to 135 modern museum specimens representing one small mammal community to (1) evaluate congruence between widely

used proxies and (2) characterize intra- vs interspecific variation. We extracted six microCT-derived dental ecomorphology measures, created casts for dental microwear texture analysis, and isotopically sampled bone collagen from specimens (~15/taxon) of *Geomys*, *Chaetodipus*, *Neotoma*, *Onychomys*, *Reithrodontomys*, *Thomomys*, and two *Peromyscus* clades trapped in or around Kerr County, Texas. A discriminant function model accurately classified all 3D dental models into six dietary categories corresponding to interspecific dietary variation. Intraspecific variation among these dental ecomorphological variables was significantly lower within this community than prior continental-scale results. Across all species, stable isotope data spanned 1.2 to 17.0‰ $\delta^{15}\text{N}$ (>3 trophic levels) and -26.2 to -10.2‰ $\delta^{13}\text{C}$ (C3 to C4 plants). Species-level standard ellipse areas captured intraspecific and interspecific variation consistent with ecomorphology-assigned diet categories (e.g., rootivores eating C3 roots, omnivores occupying intermediate trophic levels, etc.). Ecomorphological results complemented isotopic results by discriminating among rootivorous, granivorous, frugivorous, and folivorous diet types indistinguishable by isotopes alone. Conversely, stable isotope results complemented ecomorphology by providing information about the photosynthetic pathway of consumed plants, degree of faunivory vs omnivory, and the trophic level of prey species. Microwear data provided a unique signal that correlated with neither intra- nor interspecific variation. However, microwear surface complexity distinguished unexpected interspecific variation (e.g., cryptic *Geomys knoxjonesi* from *Geomys bursarius*). Our results reveal interspecific-sensitive ecomorphology variables and intraspecific-sensitive stable isotope analyses corroborate and complement one another, detecting subtle dietary variation often inaccessible in paleoecology. These findings establish a

framework for applying complementary proxies together to infer precise paleodiet at the individual level and interpret inter- vs intra-specific dietary variation at the community level.

Funding Sources NSF DEB (#1555525), Geological Society of America (Paleo Society), American Society of Mammalogists, the UNM Rogers Research Award, and the UNM Biology Gaudin Scholarship

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

One thousand fossils to restore the exhibition of the Museu Nacional/UFRJ, Brazil - results of the RECOMPOE donation campaign

Kellner, Alexander W.

Department of Geology and Paleontology, Museu Nacional/UFRJ, Rio de Janeiro, Rio de Janeiro, Brazil

As is common knowledge, the Museu Nacional/UFRJ suffered a major fire in 2018 that destroyed about 85% of its estimated 20 million objects, including the paleontological collection. Since then, the institution has been working very hard to be rebuilt, and is expected to partially open to visitors in 2026.

Launched in 2019, the RECOMPOE donation campaign (www.recompoe.mn.ufrj.br) focuses on obtaining new objects for the exhibition. Despite success in several areas (e.g., ethnography, zoology), little progress has been made regarding paleontology, especially considering vertebrate fossil collections, which is one of the driving forces of a natural history museum.

Most recently, the Museu Nacional received an exceptional gift of a total of 1,104 specimens from the Araripe Basin. The material belonged to the private collection of

the Pohl family, who learned about the situation of the Museu Nacional through Frances Reynolds (from the non-profit Inklusartiz Institute), a patron of arts who is helping the Museum acquire original objects, and decided to make the donation.

Most of the specimens came from the Crato Formation (Aptian-Albian) and are made of invertebrates, for all insects (Odonata, Coleoptera, Blattodea and Orthoptera), arachnids, and some shrimps. There is also a very interesting palaeobotanical collection, consisting of leaves, seeds, potential angiosperm flowers and many gymnosperms, some quite complete. There are also several fossil reptiles such as pterosaurs, crocodylomorphs, lizards, anurans, and turtles. All of these specimens are not only very important for the future exhibitions, but they are also scientifically relevant and some are already been studied by Master and PhD students.

Internationally, so far most of the success of the RECOMPOE campaign, including paleontological objects, comes from the support of private entities and people. Very little has been achieved so far regarding public institutions despite all the efforts being made.

This important donation of fossils was recently presented at a very successful press conference. We hope that this action by the Pohl Family encourages others to follow this path and help Brazil's largest natural history museum in its reconstruction efforts, demonstrating what cooperation in the cultural and scientific field involving different countries can achieve.

Funding Sources Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) #308707/2023-0, #406779/2021-0, and #406902/2022-4 (INCT PALEOVERT), and FAPERJ #E-26/201.095/2022.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

***Miotragocerus* (Bovidae) from the Middle Miocene Chinji Formation of Pakistan**

Khan, Muhammad A., Asim, Muhammad

Zoology, University of the Punjab, Lahore, Lahore, Punjab, Pakistan

In Bovidae, Boselaphini represents a variety of genera in the Siwalik Group i.e., *Helicoportax*, *Elachistoceras*, Boselaphini sp. indet, *Eotragus*, *Strepsiptorax*, *Miotragocerus* and *Tragoportax*. *Eotragus*, *Helicoportax* and *Elachistoceras* are small sized, while *Miotragocerus* and *Tragoportax* are medium-sized boselaphines. *Miotragocerus gluten* is a Middle Miocene genus that lived with other boselaphines in the Chinji outcrops (14.1 Ma – 11.2 Ma), and it is uncommon in the Middle Siwalik Subgroup (11.2 Ma – 5.3 Ma).

25 specimens of *M. gluten* were recovered from the middle Miocene sites of Pakistan (Rakh Wasnal, Bhilomar, Dhok Bun Amir Khatoon, Lawa, Parrewala and Jand). Quantitatively, *Miotragocerus* is the most dominant taxon among the bovids of the Middle Miocene in the Pakistani Siwalik Group. The new specimens include deciduous premolars and rarely described postcrania. This new material provides detailed descriptions of *Miotragocerus gluten* including skull, horn cores, maxillae, mandibles, isolated dentition, and postcranial elements. The deciduous premolars and postcrania provide important new insights into the morphometric and anatomical characteristics of *M. gluten*.

Funding Sources Having acceptance I would apply to Higher Education Commission of Pakistan for funding.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Harnessing machine learning to detect macroevolutionary transitions in Neogene fossil horses (family Equidae) in North America

Killingsworth, Stephanie

Geology & Florida Museum of Natural History, University of Florida, West Palm Beach, Florida, United States

The concept of Artificial Intelligence (AI) dates back to the 1950s, and while computer sciences, industry, and scientific fields such as biology, have readily incorporated AI, paleontology has been slower to embrace it. Renewed interest in AI technology in the field of paleontology shows promise by innovating ways in which we analyze the fossil record.

We apply machine learning (ML), a branch of AI that utilizes computer algorithms for pattern detection, to build and train models for interpreting phenotypic variation in fossil horse tooth populations. From an evolutionary standpoint, the ML model provides a non-destructive and informative tool for analyzing microevolutionary changes in populations. However, in paleontology, where datasets are often limited and samples are frequently fragmentary, the conventional requirement of huge datasets for accurate machine learning models poses a challenge. Here, our focus is on pushing the boundaries of these models to ensure their effectiveness, accuracy, and reliability in paleontological applications.

The datasets are composed of high-resolution 2D-images of the occlusal surface of upper and lower M1 and M2 molars for the three equid species being analyzed in this study (*Dinohippus interpolatus*, *Dinohippus mexicanus*, and *Equus simplicidens*). Training and validation image classifier datasets for both bookend species (the more primitive *Dinohippus interpolates* and the sister taxa and most primitive *Equus*, *Equus simplicidens*) will provide the framework to run test datasets of *Dinohippus mexicanus* to

determine the degree of variation (primitive versus more advanced characters) within *Dinohippus mexicanus* populations. Outcomes will be studied to determine what characters or features the ML models select for classifying the tooth images in addition to how those variations elucidate the macroevolutionary origin of *Equus*, and demonstrate whether computer models can perform better than or equal to humans.

Funding Sources Funding for this work was received from the Florida Museum of Natural History Dickinson Fund and the Wilder and Gapenski Endowments.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

A taphonomic study of the Lower Cretaceous dinosaur nesting colonies preserved in braided stream deposit, in Hwaseong City, South Korea

Kim, Seongyeong¹, Lee, Yuong-Nam², Gihm, Yong Sik¹, Kim, Noe-Heon³

¹Kyungpook National University, Daegu City, Korea (the Republic of), ²Seoul National University, Seoul, Korea (the Republic of), ³Princeton University, Princeton, New Jersey, United States

A dinosaur nesting colony from the Lower Cretaceous Sihwa Formation in Hwaseong City, South Korea, shows a unique preservational trend in that many of the faveolooithid eggs are preserved in conglomerates (representing braided river deposits). The nesters likely buried the eggs with surrounding materials, based on the numerous pore canals (multituberculate pore canal system) observed in the eggshells. Based on the taphonomic and lithologic features of the fossil eggs and the egg-bearing deposits, we established three taphofacies. Taphofacies I represents *in situ* clutches in sandstones deposited on a floodplain or mid-

channel bar. Taphofacies II is composed of parautochthonous clutches or clusters filled with sandy sediments within conglomerates. Abandoned and old nesting sites could have been destroyed by the invasion of crevasse channels and splays or main trunk channels. The erosive streams possibly moved the matrix-filled eggs (parautochthonous), which is supported by smaller size of pebbles in the egg-bearing deposits. A few clusters are characterized by eggs filled with breccia and gravel with various roundness in channel conglomerates (Taphofacies III). Torrential streams (main channel) could have moved eggs short distances and buried them before hatching. The matrix difference between the inside and outside of the specimens can be used as a new taphonomic criterion to identify parautochthonous fossil eggs. The paleoenvironment of the nesting colonies is interpreted as proximal floodplain with crevasse splay in the lower section and mid-channel bar associated with braided rivers in the upper section. This suggests that the nesters (sauropod) used a different colonial nesting strategy as the paleoenvironment changed with channel expansion. The mid-channel bar surrounded by streams could have served as a nesting site to the nesters with advantages to minimize accessibility of the nests to predators.

Funding Sources Global - Learning & Academic research institution for Master's, PhD students, and Postdocs(LAMP) Program (No. RS-2023-00301914)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A new juvenile species of *Birgeria* (Osteichthyes, Actinopterygii) from the Upper Triassic freshwater deposits of South Korea

Kim, Su-Hwan¹, Lee, Yuong-Nam¹, Nam, Gi-Soo², Park, Jin-Young¹, Lee, Sungjin¹, Son, Minyoung³

¹School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea (the Republic of), ²Gongju National University of Education, Gongju, South Chungcheong Province, Korea (the Republic of), ³Department of Earth and Environmental Sciences, University of Minnesota Twin Cities, Minneapolis, Minnesota, United States

The study of juvenile fish fossils provides valuable insights into their developmental processes and the evolutionary history of fishes. However, these fossils are challenging to discover and examine due to their fragile, incompletely ossified bone elements and the brief duration of the juvenile stage. Here, we report a new species of *Birgeria* from the Upper Triassic Amisan Formation of South Korea, represented by three specimens. *Birgeria* is a large predatory fish reported from Triassic marine deposits with a worldwide distribution. The new species represent the juvenile stages based on their small size, ranging from 39.06 mm to 54.74 mm in standard length without fully formed cranial elements. This new species is distinguished by having the combination of characters: oval suboperculum that is much smaller than operculum; horizontally arranged postmandibular branchiostegal rays; short seven gill rakers on ceratobranchial; posteriorly dorsal fin opposite the middle of the pelvic fin; dorsal and anal fins of nearly the same size with rounded margin; trunk lateral line canal enclosed in ossified tubes; scaleless body except for the upper caudal lobe; strongly heterocercal caudal fin with more elongate ventral lobe than dorsal one. The age of the Amisan Formation has been variably dated to the Late Triassic, Late Triassic-Early Jurassic, or Middle Jurassic based on fossil records and paleomagnetic and U-Pb isotope data. However, the presence of *Birgeria*, previously known only from the Triassic, restricts the Amisan Formation's age to the Triassic. The occurrence of only juvenile specimens of the new *Birgeria* species and *Megalomatia*

minima in the Myeongcheon-dong and Hwasan-dong sections of the Amisan Formation suggests a possible habitat separation between the juvenile and adult assemblages of some basal actinopterygians. Furthermore, the discovery of *Birgeria* in the terrestrial deposits of the Amisan Formation indicates that *Birgeria* may have been an anadromous fish. Additionally, the independent development of the trunk lateral line canal without association with the scale plate in the new *Birgeria* specimens suggests this feature is a plesiomorphic trait in gnathostomes.

Funding Sources National Research Foundation of Korea (Grant number 2022R1I1A2060919) to Yuong-Nam Lee

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Two-dimensional geometric morphometric analysis reveals a range of *Merycoidodon* skull morphospace

King, James L.¹, Ames, Eric A.^{1,2}

¹School of Earth Sciences, University of Bristol, Bristol, United Kingdom, ²South Dakota School of Mines and Technology, Rapid City, South Dakota, United States

Merycoidodon was a genus of artiodactyl and was among the most abundant groups of mammals during the early Late Eocene and Early Oligocene of western North America. However, the number of recognized species of *Merycoidodon* has varied since its original description, with many older studies representing examples of species over splitting and more recent studies resulting in lumping them into a few notable species. Although various techniques have been conducted to verify species validity, no dedicated study of geometric morphometrics of *Merycoidodon* species has been conducted, despite the effectiveness of this

technique in describing morphological differences among similar taxa. Here, *Merycoidodon* crania (n = 14) from Badlands National Park housed in SDSMT's Museum of Geology collections, one of which labelled as *M. culbertsoni* and the other 13 belonging to indeterminate species, were photographed and compared to crania classified as *M. bullatus*, *M. culbertsoni*, and *M. major*. The software TPS and MorphoJ were used to digitize 16 2D natural landmarks along photos and illustrations of *Merycoidodon* crania (n_{total} = 29). These landmarks were normalized using a Procrustes Analysis and then used to produce a principal components analysis to visualize shape variation among the crania. Cranial variation was compared to the most recent scientific literature pertaining to described species of *Merycoidodon*. We find that many of the Badlands specimens meet similar morphological trends attributable to either *M. culbertsoni*, *M. bullatus*, or *M. major*. However, some of the Badlands specimens occupy their own morphospace with no overlap with labelled species and demonstrate morphometric diversity in the shape of the cranium, even when taphonomic distortion is considered. *M. bullatus* and *M. major* can be categorized as having a narrow range of PC1 scores with a broad distribution of PC2 scores, while *M. culbertsoni* exhibits wide ranges of both PC1 and PC2 scores. The indeterminate specimens used in this study had a roughly equivalent PC2 distribution, but their PC1 scores were considerably higher than even *M. culbertsoni*. This is indicative that the indeterminate specimens from Badlands National Park either represent different species within *Merycoidodon*, or even represent different genera of oreodont with unique morphological trends. Given the few valid species of *Merycoidodon*, our results have implications for the biodiversity of oreodonts within Badlands National Park.

Funding Sources No funding to report.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

An Early Jurassic ankylosaur from the Lufeng Formation of Yunnan Province, China and its implications for early ankylosaur evolution

King, Logan^{1,2}, Wang, Yan-Chao¹, Lei, Jia¹, Ren, Xin-Xin³, Xu, Xing^{1,4}, Singh, Suresh², Benton, Michael J.², You, Hai-lu¹

¹Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China, ²School of Earth Sciences, University of Bristol, Bristol, United Kingdom, ³Key Laboratory of Stratigraphy and Paleontology of the Ministry of Natural Resources, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China, ⁴Centre for Vertebrate Evolutionary Biology, Yunnan University, Kunming, China

Ankylosaurs (Thyreophora: Eurypoda) are some of the most iconic non-avian dinosaurs with their tank-like bauplan and ornate osteoderms. Though most well-known for their common occurrences in Late Cretaceous formations across North America and Asia, the earliest unequivocal instance of an ankylosaurine dinosaur is from the Middle Jurassic El Mers III Formation of Morocco. The earliest evolution of ankylosaurine eurypodans is still poorly understood. Here, we introduce the first confirmed instance of an Early Jurassic ankylosaur from the Sineurmanian-aged Lufeng Formation of China's Yunnan Province. The specimen is represented by a nearly complete braincase; a partially crushed left humerus; a sacrum consisting of three fused sacral vertebrae and a badly damaged left ilium; and the first anterior caudal vertebra. A 50% strict consensus phylogenetic analysis retrieves this new ankylosaur as an ankylosaurine eurypodan that falls just outside of Ankylosauridae. By being included within

Ankylosauria, the age of the clade is extended by up to 30 million years with the genesis of Ankylosauridae lying somewhere in the intervening millennia between the Early and Middle Jurassic. Furthermore, a principal components analysis and comparisons of muscle scarring along the humerus indicates that Early Jurassic ankylosaur taxa were already massive animals when compared to other basal, non-eurypodan thyreophoran taxa. In comparison, the humeri of the coeval *Scutellosaurus* and *Scelidosaurus* are proximally and distally narrower than the Early Jurassic taxon. Similarly, the deltopectoral crest of the Early Jurassic specimen is more expanded anteriorly and in total length. Along the proximomedial surface of the humerus, the Early Jurassic specimen has clearly incised insertion points for the M. pectoralis and M. coracobrachialis. This implies that early ankylosaurs and basal non-eurypodan thyreophorans were inhabiting different ecological niches in the earliest Jurassic. The temporal deepening of the clade Ankylosauria now opens new questions. Considering that the Hettangian stage of the Jurassic is approximately a couple of million years long, when did Eurypoda originate during the Mesozoic? Future work of this specimen includes calculating when and, potentially, geographically where eurypodans split from basal thyreophorans based on biogeographical data retrieved from specimens within Ankylosauria.

Funding Sources This work was supported by grants from the National Natural Science Foundation of China [42288201, 42372030].

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Paleoecology of Middle Pleistocene fossil chimpanzee (*Pan*) site, Tugen Hills Succession, Kenya

Kingston, John, MacLatchy, Laura M.

University of Michigan, Ann Arbor, Michigan, United States

Paleontological evidence of the chimpanzee (*Pan*) lineage(s) is limited to a single fossil site (Loc 99) at the base of the Kapthurin Formation in the Tugen Hills Succession, Kenya Rift Valley, dated to ~545 kyr. Fossil remains from Loc. 99 include several teeth of at least 1 individual that have been identified as *Pan* sp., with affinities to *P. troglodytes*. Faunal vertebrate remains directly associated with the *Pan* fossils include bovids, suids, equids, rhinos, rodents, cercopithecoid primates, and aquatic fauna (catfish and crocodiles). Based on faunal assemblages and lithofacies analyses, previous paleoecological reconstructions of the Kapthurin Fm. tend to converge on open woodland/grassland habitats with well-established grazing herbivore guilds. However, Loc. 99 has also been interpreted to represent a more mesic interval set within oscillating semi-arid conditions based on analyses of paleosols and lithofacies associations. Isotopic analyses of 92 fossil herbivore enamel specimens from the Kapthurin Fm. succession, with 16 samples directly associated with the *Pan* fossils at Loc. 99., provide a new overview of foraging strategies (grazing, browsing, mixed feeding) that reflect aspects of vegetation physiognomy. In general, the carbon isotopic values of enamel ($\delta^{13}\text{C}_{\text{enamel}}$) yielded a wide range of C_3 and C_4 dietary signals (-13.6‰ to 2.9‰), dominated by evidence of C_4 grazing and mixed C_3/C_4 feeding. ^{13}C depleted dietary values of -13.6‰ to -9.4‰ reflect obligate browsing, especially with tragelaphines, and indicate a wooded component to the habitat(s). There is no clear evidence for any closed-canopy foraging and the range of $\delta^{13}\text{C}_{\text{enamel}}$ values in the Kapthurin Fm. consistently converge on open woodland/grassland habitats with well-established grazing herbivore guilds. These data indicate that the fossil *Pan* were living in open woodland to grassland habitats,

possibly similar to modern ‘savanna’ chimpanzee environments such as Fongoli (Senegal) or Ugalla (Tanzania). While it is possible that preservation of the *Pan* site represents a taphonomic outlier (forest sites typically are not well represented in the fossil record), emerging evidence of hominoids in open woodland habitats 21 Ma suggests that interpretations of hominoid evolution should not be tethered to forest ecosystems.

Funding Sources Leakey Foundation

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Reinvestigating the appendicular skeletal morphology of *Confuciusornis* using high-resolution μ CT scanning

Kinney-Broderick, Grace¹, Navalon, Guillermo^{1,2}, Field, Daniel J.^{1,2}

¹Earth Science, University of Cambridge, Cambridge, United Kingdom, ²Museum of Zoology, University of Cambridge, Cambridge, United Kingdom

Of the exceptionally preserved Mesozoic avialans from China, *Confuciusornis sanctus* is one of the most commonly represented taxa with over one thousand specimens unearthed to date. Most existing anatomical research on *Confuciusornis* has been limited to two-dimensional investigations of slab-prepared fossils. Here, we aim to document the skeletal morphology of *C. sanctus* using high resolution x-ray computed tomography (CT) data from two specimens to reevaluate its morphology in light of improvements in our understanding of Mesozoic avialan morphology gained in the 25 years since its most recent monographic treatment. The pectoral region of *Confuciusornis* is of particular interest due to unusual features of the scapulocoracoid and humerus, which may be relevant for understanding the early stages of avialan powered flying potential.

The ability to visualize these elements using high-resolution three-dimensional data reveals previously unappreciated morphological details of the scapulocoracoid, humerus, and manus. Our results yield morphological insights previously undescribed in the pectoral girdle and forelimb which will facilitate new research into the flight capabilities, ecomorphology, and biology of *Confuciusornis*.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Closing in on the Jurassic-Cretaceous terrestrial faunal boundary in Euramerica: Is the loss of the Morrison "style" dinosaur assemblage linked to a giant shield volcano in the northwest Pacific's Shatsky Rise, the Morokweng meteor impact in South Africa, or both?

Kirkland, James I., DeBlieux, Donald D.

Geological Mapping & Paleontology, Utah Geological Survey, Salt Lake City, Utah, United States

Along the North American cordillera, the Cretaceous (J-K) unconformity spans 20-25 million years (my). A revised Berriasian age (145–142 Ma) for the base of the lower Yellow Cat Mbr. (YC) of the Cedar Mountain Fm. (CM) in the Paradox Basin of eastern Utah is indicated by microfossils (ostracods, charophytes, palynomorphs), chemostratigraphy, and radiometric U-Pb dating of palaeosols reduces unconformity to 5-7 Ma. This revised age shows that local deposition began much earlier than previously proposed, likely due to salt tectonics, and that most of the J-K unconformity in this region is Late Jurassic. Combining dinosaur records across Euramerica indicates that Morrison “style” dinosaur faunas dominated by diverse

sauro pods (mostly diplodocids), stegosaurs, small to medium ornithopods, diverse large theropods (ceratosaurs, megalosaurids, and allosaurids), and uncommon coelurosaurs persisted for the last 10 my of the Jurassic. In contrast, over the next 25 my of the Lower Cretaceous, Wealden “style” dinosaur faunas are dominated by a low diversity of turiasaur and titanosauriform sauro pods, polacanthid ankylosaurs, large ornithopods, low diversity large megalosauroid spinosaurids (exclusive to Europe) and allosauroid carcharodontosaurid theropods, and an increased abundance of larger coelurosaurs. This transition happened much quicker than background faunal change suggesting a mass extinction event. A mega-shield volcano at Shatsky Rise dates close to the J-K boundary and flood basalts are tied to other mass extinctions. South Africa’s Morokweng impact is also a candidate for the driver of this faunal turnover. A massive impact into Precambrian continental crust would have different environmental effects than an impact into a coastal barrier reef system such as the Chicxulub impact.

Furthermore, the Berriasian Cretaceous paleosol sequence at the base of the YC and lateral to the Buckhorn Conglomerate Mbr. of CM consists of basal ferruginous paleosols (oxisols) overlain by silicified peat (histosols) which are in turn overlain by calcareous paleosols (vertisols and aridosols). Thus, the earliest Cretaceous in Utah is characterized by a short interval of wet paleoclimates following those of the drier Morrison and before the drier remainder of the Early Cretaceous. A giant shield volcano, large impact, and/or an interval of local tectonic quiescence between the Elko and Sevier orogenies might explain a short-term climatic shift at the J-K faunal boundary.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

The largest Triassic neotheropod and the early evolution of *Averostra*

Kirmse, João P.¹, Foth, Christian², Rauhut, Oliver³

¹Departament für Geo- und Umweltwissenschaften, Ludwig-Maximilians-Universität München, Munich, Bavaria, Germany, ²Institut für Biowissenschaften, Allgemeine & Spezielle Zoologie, Universität Rostock, Rostock, Germany, ³Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Bavaria, Germany

Our understanding of the phylogenetic relationship of early theropods has recently undergone considerable changes. Once all thought to be part of Coelophysoidea, many species are now regarded as stem-line *Averostrans*, indicating a broader diversity in the Triassic. Nonetheless, a few taxa still fluctuate between groups. The goal of this study is to clarify the phylogeny of early theropods through re-evaluations of Triassic forms from Europe and the presentation of new specimens. *Liliensternus* is based on a syntype consisting of at least two individuals from the Norian Feuerletten of Thuringia, Germany. Proposed autapomorphies of the taxon are uncertain – ridges on the humerus are present in other taxa or might be pathological, while the lack of posterior pleurocoels has a more complex distribution. One issue is that the type consists of subadults, as shown by partially open neurocentral sutures in the vertebrae and only partial fusion of the sacral vertebrae. New theropod specimens from the Late Norian Trossingen Formation of Bavaria, Germany, might help to clarify the diagnosis and phylogenetic position of *Liliensternus*. The material includes a maxilla, quadrate, vertebrae, humeri, ilia, ischia, and femora from various individuals. The cervical vertebrae have lateral ridges akin to *Liliensternus*, which delimit shallow, elongate pleurocoels. The sacral elements are unfused, and the femur has a prominent

dorsolateral trochanter – features also present in *Liliensternus* but attributed to its immaturity. The new specimens represent mature individuals, based on the presence of features associated with maturity, such as a trochanteric shelf, but especially on its body size, with the largest elements indicating an individual of 7-9m or even more in body length, bigger than any known Triassic neotheropod. Preliminary phylogenetic analyses recover the specimen as sister-taxon to *Liliensternus* on the stem-line of *Averostra*. Moreover, similarities such as the ridges and keeling on cervical vertebrae and denticle pattern on maxillary teeth suggest they belong to the same species, at distinct levels of maturity. The work adds to the knowledge of Triassic stem-*averostrans* and shows there was a significant phylogenetic diversity at the time. Moreover, it gives insight into early theropod ontogeny and suggests that even the slight increase in theropod size observed across the Triassic-Jurassic boundary might be an artefact of our knowledge of the fossil record.

Funding Sources This work is supported by funding by Deutsche Forschungsgemeinschaft (DFG) project number RA 1012/31-1 to Oliver Rauhut.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Exceptionally diverse lepidosaur assemblage from the Late Triassic of equatorial Pangaea fills gap in squamate origins

Kligman, Ben T.^{4,5}, Marsh, Adam⁵, Melstrom, Keegan M.^{1,2}, Stocker, Michelle R.³

¹Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, D.C., District of Columbia, United States, ²Department of Resource Management and Science, Petrified Forest National Park, Petrified Forest,

Arizona, United States, ³Department of Biology, University of Central Oklahoma, Edmond, Oklahoma, United States, ⁴Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States, ⁵Department of Geosciences, Virginia Tech, Blacksburg, Virginia, United States

Highly incomplete fossil records are a persistent hurdle to understanding the origins of most living tetrapod groups, a pattern exacerbated by taphonomic and sampling biases linked to small body sizes during clade origins. A striking example of this is Lepidosauria, which includes two lineages that diverged prior to or during the Triassic Period: the diverse Squamata (~11,000 living species, including lizards, snakes, and amphisbaenians) and the Rhynchocephalia (represented today only by *Sphenodon punctatus*). Gaps in the early Mesozoic record of lepidosaurs and their stem lineage combined with conflicting morphological and molecular hypotheses of squamate evolutionary relationships and diversification timing has generated uncertainty in the tempo and mode of early lepidosaur evolution. The lack of unambiguous pre-Jurassic squamate fossils implies that new fossils from the Triassic are key for resolving questions of squamate origins. A new exceptionally diverse lepidosaur assemblage collected from continental microvertebrate bonebeds in Upper Triassic (~220–215 Ma) sediments deposited in equatorial Pangaea (lower Chinle Formation in Petrified Forest National Park, Arizona, U.S.A.) adds new evidence for the stepwise acquisition and transformation of craniodental features at the divergence of rhynchocephalian and squamate lepidosaurs. Importantly, some of these fossils exhibit features apparently homologous with those of extant squamates such as gekkotans, scincomorphs, and xantusiids. Phylogenetic analyses suggest that these squamate-like features were first acquired by Triassic lepidosaurs at least 220

million years ago, and their presence in post-Triassic squamates are conserved plesiomorphies. These findings introduce the first morphological evidence from the timeframe of squamate origins consistent with molecular-based phylogenies in which gekkotans are the earliest-diverging crown squamate group. Dietary reconstructions of the new Triassic forms indicate an extensive radiation in insectivorous lepidosaurian ecomorphologies prior to 220 million years ago, possibly linked to the concurrent radiation of holometabolous insects. The presence of this assemblage from the humid paleotropics of Late Triassic Pangaea suggests that this spatiotemporal setting not only hosted the highest lepidosaur species richness known from the Triassic, but also illuminates key steps in the origins of living lepidosaur craniodental disparity.

Funding Sources Petrified Forest Museum Association

David R Wones Geological Scholarship

USA National Park Service

Virginia Tech

National Science Foundation

National Museum of Natural History

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

The herpetological fauna of Eocene Balkanatolia

Knoff, Johan², Mulcahy, Kevin D.¹, Beard, K. Christopher², Georgalis, Georgios³

¹KU Biodiversity Institute & Natural History Museum, University of Kansas, Lawrence, Kansas, United States, ²Ecology, and Evolutionary Biology, University of Kansas, Lawrence, Kansas, United States, ³Institute of Systematics and Evolution of Animals, Polish Academy of Sciences, Krakow, Poland

During the Middle to Late Eocene (~45-35mya), Balkanatolia was an island continent comprised of modern-day Turkey and the Balkans. By this time, Balkanatolia had been isolated from mainland Europe and Asia for several million years since the end of the Paleocene. As a result, the endemic fauna was unique and included many distinct lineages not found in other contemporaneous strata, including several taxa of metatherians and “condylarths”. Prior and ongoing research into the fossil record of Balkanatolia has shed light on the mammalian fauna of the time, however, the Herpetological fauna remains under-researched and undescribed. Here, we present specimens from the University of Kansas Vertebrate Paleontology (KUPV) collection, representing various lineages of reptiles and amphibians. These include crocodilian teeth, squamate vertebrae and dentulous jaw fragments, and assorted postcranial amphibian material. One particularly interesting specimen is comprised of two jaw fragments that we believe represents a choristodere (a group of enigmatic reptiles with a fossil record ranging from the middle Jurassic to the Miocene), bearing morphological similarities to the mainland European *Lazarussuchus*, albeit substantially larger. Considering its unique biogeographic provenance and size, this new Balkanatolian choristodere may represent an important missing link in the history of Cenozoic choristoderes, for which, Eocene specimens have yet to be described. -As such, the description of this specimen along with the rest of the relevant KUPV material may have broad implications on the biogeography and evolution of Cenozoic non-avian reptiles and amphibians.

Funding Sources Funding provided by the David B Jones Foundation and NSF EAR 214115

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Functional morphology and adaptive implications of manual unguals in a therizinosaur with didactyl hand from southern Mongolia

Kobayashi, Yoshitsugu¹, Chinzorig, Tsogtbaatar², Fiorillo, Anthony³, Tsogtbaatar, Khishigjav⁴, Barsbold, Rinchen⁴

¹Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan, ²North Carolina Museum of Natural Sciences, North Carolina State University, Raleigh, North Carolina, United States, ³New Mexico Museum of Natural History & Science, Albuquerque, New Mexico, United States, ⁴Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia

A partial skeleton of an unnamed therizinosaur from the Bayanshiree Formation at the Urtibe Khudak (UK) locality near Khanbogd town in Ömnögovı Province, southern Mongolia in 2012 exhibits peculiar features, such as a substantially reduced metacarpal III and the presence of only two functional manual digits. This specimen also preserves a well-preserved keratinous sheath, which is the first recorded occurrence among non-paravian dinosaurs. This study discusses the implications for the function of manual unguals of the UK taxon.

The ranges of motion of the elbow, wrist, and digits in the UK taxon are compared to those of other non-paravian taxa. At maximum flexion, the antebrachium of the UK taxon cannot flex beyond a right angle from the humerus, unlike in *Segnosaurus*. The wrist joint angle between the semilunate carpal and the radius is smaller in the UK taxon compared to *Alxasaurus* but similar to *Therizinosaurus*. The manual phalangeal motion in the UK taxon is like that of *Therizinosaurus*, *Tyrannosaurus*, and *Oksoko*. The ungual of the UK taxon flexes nearly perpendicular to the preceding phalanx, allowing it to grasp objects approximately 10 cm in diameter with a keratinous sheath,

whereas there is very little movement in *Therizinosaurus*.

Digit reduction evolved convergently in non-avian dinosaurs like tyrannosauroids, alvarezsaurids, and oviraptorosaurs. This reduction is linked to shorter forelimbs, loss of specific digits (I and II), reduction or loss of metacarpal III, and enlargement of digit I. Uses of reduced forelimbs vary: digging (alvarezsaurids), reduced grasping (oviraptorosaurs), and group feeding (tyrannosaurids). The UK taxon, like tyrannosaurids, has a reduced metacarpal III and lost digit III, but differs with elongated forelimbs, indicating a different function for its reduced digits compared to other groups.

The angle of ventral curvature and attack in the UK taxon implies the claws were used for grasping branches (amplexorial function) rather than for scansorial (climbing) or tenasorial (seizing prey) purposes. This is consistent with its hypothesized herbivorous diet, as therizinosaurids likely used their claws to grasp branches. The UK taxon had better control for selecting preferred tree branches for feeding compared to *Therizinosaurus*, which had extremely elongated and straight claws and a limited range of motion in its digits.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Planning mounts for holotypes and fossils of significance for research access

Koehn, Joni M.^{1,5}, McCord, Robert³, McCullough, Gavin², Hummel, Rudolph R.⁴

¹Rio Salado College, TEMPE, Arizona, United States, ²Southwest Paleontological Society, Mesa, Arizona, United States, ³Arizona Museum of Natural History, Mesa, Arizona, United States, ⁴Research Laboratory, Arizona Museum of Natural History, Mesa, Arizona,

United States, ⁵Denver Museum of Natural Science, Denver, Colorado, United States

In a paleontological research facility, the vault inevitably holds fossils of varying degrees of importance. These include fossils used in identifying a holotype and those identified as having particular scientific significance. Upon publication, these fossils are among the most frequently accessed and researched in the collection. There are several possible approaches in storing these fossils for preservation as well as for optimal access for researchers. This poster introduces a novel method of organizing and housing published specimens using published figures as guides for specimen housing.

In this approach, the initial research paper that identified the holotype or other described material is used as a planning guide for cavity mounts. Housing fossils according to the published images facilitates quick identification and frees researchers from looking through the collection to find the appropriate fossil. All fossils used in the identification of the holotype will be housed together in drawers and marked as such. Paratypes and other associated fossils are housed separately for access by researchers. In the case of non-holotype specimens, the housing will reflect the published figures wherever possible. This process ensures that fossils of significance can readily be found, identified and used in research.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Hear today, gone tomorrow: first record of ossicle descriptions from a fossil seal (*Leptophoca proxima*) using micro-CT technology

Koper, Lindsey¹, Crowell, Madelyn G.²,
Rahmat, Sulman J.¹

¹Howard University, Washington, District of Columbia, United States, ²Albany Medical College, Albany, New York, United States

The skull of *Leptophoca proxima*, a fossil phocid (true seal) dating roughly 15-20 Ma from the Calvert Formation of Maryland (USA) was micro-CT scanned to explore internal auditory morphology. Within the middle ear of the left side of the skull, three ossicles (malleus, incus, and stapes) were identified and isolated through imaging software. The information from these scans allowed for 3D printing to create detailed reproductions of the ossicles at different scales, including normal size and enlarging up to 15x. This study identifies and compares modern phocid ossicular morphology and details the first record of fossil phocid ossicle descriptions. In general, phocids have unique ossicular morphology, especially the malleus, that can be used to identify individuals down to the genus level, and in some cases the species level. Similarly, juveniles can also be identified since they are born with almost full-sized ossicles. Micro-CT analyses confirm that this fossil *Leptophoca* specimen demonstrates characters unique to the Family Phocidae, but also displays enough variation to not allow direct association to any specific modern phocid. This fossil specimen also establishes that the specific phocid ossicular morphology evolved first, followed later by the increase in ossicular size that is a well-known characteristic of modern phocids. This preliminary study demonstrates the ability to use non-invasive scanning methodology to describe and identify fossil material. Future work will increase scanned specimens, compare fossil material with modern phocids, pinnipeds, and carnivorans, and attempt to clarify the evolution of hearing patterns from the land to sea transition of early pinnipeds.

Funding Sources Funding for this study was received from a Duke University SMIF Grant for micro-CT scanning and from the Howard

University Bridge Funds and Pilot Study Awards Program.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Vertebrate trace fossils of the Coleraine Formation at Hill Annex Mine State Park, Calumet, Minnesota USA

Korf, Jason¹, Westgaard, John G.², Hastings, Alex K.¹, Hanks, H. D.²

¹Science Museum of Minnesota, Stanchfield, Minnesota, United States, ²Minnesota Discovery Center - Museum of the Iron Range, Chisholm, Minnesota, United States

The Coleraine Formation is comprised of sandstones, shales, and conglomerates that were deposited from transgressions and regressions of the Western Interior Seaway along the Mesabi Iron Range and parts of the Cuyuna Iron Range of northern Minnesota during the Cenomanian to Turonian (100 – 90 Ma; Late Cretaceous). The paleoenvironment ranges from marine to near-shore along the eastern edge of the Western Interior Sea, fed by adjoining riverine systems. The first reports of trace fossils in the Coleraine Formation were made by Stauffer and Thiel in 1933 on limestones and marls of Minnesota, which mentioned Ophiomorpha burrows. Other trace fossils associated with invertebrates have been documented and reported in further publications from the Coleraine Formation. In more recent times, trace fossils associated with vertebrates have come to light.

In 2015, a large burrow was found downslope of its original location along in situ Coleraine exposure. The specimen was horizontal when it was discovered and is quite large at 165.5 cm long. The specimen is consistent with tetrapod burrows associated with the Maastrichtian crocodyliform *Labidiosuchus amicum* from Brazil and the Cenomanian

orodromine dinosaur *Oryctodromeus* from Idaho and Montana. Currently, *Terminonaris robusta* is the only crocodylomorph described from the Coleraine Formation, but neither *Terminonaris* nor its close relatives are known to burrow. Moreover, the specimen is 32 cm in diameter, which is much too small to accommodate an adult *Terminonaris*. At least one dinosaur bone has been found in the Coleraine Formation along with a hadrosaur caudal vertebra from Crow Wing County, Minnesota. Neither are associated with burrowing structures.

Additionally, in 2018, a shark coprolite (4.9 cm long; 1.9 cm wide) was discovered in the Coleraine Formation. This specimen exhibits a spiral morphology that is diagnostic with shark coprolites. More recently, a specimen that is consistent with crocodylomorph coprolites has been recovered, which is 6 cm long and 2.5 cm wide at its widest. These coprolites may provide further valuable insight into diet for these large marine predators.

These specimens provide valuable information to the ichnology of western Appalachia and the eastern margin of the Western Interior Seaway.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Estimating neck mobility in stem tetrapods: a novel method using the extant analogue *Acipenser fulvescens*

Korneisel, Dana E.

Earth Sciences, Carleton University, Ottawa, Ontario, Canada

The vertebrate transition from water to land required a series of evolutionary innovations across the tetrapod stem. One such consequential trait is a mobile neck separating the cranium from the pectoral girdle. This decoupling occurred well before

the origin of differentiated cervical vertebrae, in the earliest necks consisting almost entirely of a notochord. I hypothesized that this free neck would allow increased head elevation and more anterior lateral mobility than known in related fishes and allow the earliest twisting motions of the head. To test whether these novel mobilities are feasible in stem tetrapods, I developed a model using *Acipenser fulvescens*, the lake sturgeon. Sturgeon retain a notochord into adulthood, as did stem tetrapods, and the lake sturgeon is broadly comparable in size with stem tetrapods like *Tiktaalik roseae*. I measured the flexural stiffness of the lake sturgeon axial column using three-point bending and the torsional stiffness on a universal testing machine. I then applied these material properties to the anteriormost axial column of *T. roseae* to estimate the limits of lateral bending, dorsal flexion, and rotation of the head relative to the trunk, as constrained by its axial column anatomy. Although each of these ranges would be decreased somewhat *in vivo* by additional tissues, the neck of *T. roseae* was capable of 50 degrees of lateral bending, up to 10 degrees of dorsal flexion, and very little if any twisting of the head. The inability to twist differs considerably from the well-established function of the tetrapod neck in turning the head. These data both inform the functional potential of the earliest mobile necks and the material properties can be applied to any extinct organism with a similar axial column, using, for example, measurements of a notochordal pit in the occiput. These results also illuminate some of the many shifts in skeletal structure and function that make up a major anatomical shift in the tetrapod-line, ultimately facilitating terrestrialization. These shifts include from a kinetic to stabilized skull, from dermal bones to an axial column as the main support for and constraint on head motion, from a body in which the head leads motion followed by the suspended postcrania to a more modular body plan where a robust

specialized vertebral column supports an independent head.

Funding Sources This work was partially funded by the Steven Cohen Award for Student Research, granted to DEK in 2022.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Finding ecological analogues for an extinct clade: The pelvic anatomy of hyaenodonts in comparison to extant mammals

Kort, Anne E.

Museum of Paleontology, University of
Michigan, Ann Arbor, Michigan, United States

Extant carnivorans are often used as ecological analogues for hyaenodonts because of their similar size and diet. However, it is unclear whether this comparison extends to locomotor mode. Unlike carnivorans, hyaenodonts have relatively short limbs, ungrooved astragalar heads, and revolute lumbar articulations. These systematic anatomical differences across clades may skew the results of ecomorphological analyses if only carnivorans are used. I tested similarity in the shape of postcrania between two hyaenodonts, *Sinopa* and *Thinocyon velox*, and a range of extant mammals to see if the hyaenodonts grouped closely with carnivorans or another group of mammals. I chose to compare the pelvis because most hindlimb extensors and rotators originate from the pelvis, and the complex shape allowed for more variation to be measured. I used linear morphometrics to compare pelvis shape between 20 small to medium-sized mammals across 10 orders and the two hyaenodonts. Row normalization was applied to all measurements to remove size from the dataset. I then performed a principal components analysis (PCA) to find the major axes of variation, and a cluster analysis to

identify extant taxa most similar in shape to the hyaenodontids. The length of the pubic symphysis and the width of the pubis most directly contributed to PC1 (46.3% of variance explained), while the dimensions of the obturator foramen and the length of the ilium most directly contributed to PC2 (20.7%). Both hyaenodontids showed relatively long pubic symphyses with elongate obturator foramina and shorter ilia. *Sinopa* was most similar in shape to *Lynx rufus*, the bobcat, out of the mammals surveyed, likely due in part to the long pubic symphysis seen in both. *Thinocyon* did not cluster closely with any one extant mammal or *Sinopa*. Despite showing some similarity in overall shape with carnivorans, both hyaenodonts had distinct features in the pelvis that could suggest differences in musculature between the two clades. The hyaenodonts had more prominent gluteal crests and femoral tubercle in comparison with the carnivorans observed. These results suggest that carnivorans are good but imperfect ecomorphological analogues to hyaenodonts for analyses of locomotion. Nevertheless, any assessment of hyaenodont locomotion and postcrania would benefit from incorporating a larger taxonomic breadth of small to medium-sized mammals.

Funding Sources Michigan Society of Fellows

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Novel growth changes in neurovasculature correlates of the dentary in *Cyclurus fragosus* (Actinopterygii, Amiidae) of the Hell Creek Formation (67-66 mya) of Southeastern Montana

Krakora, Joseph W.

Department of Biology, Carthage College,
Lake Bluff, Illinois, United States

The phylogeny of amiids identifies sister group relationships but not how evolutionary changes arise. Recovering the growth series of sister taxa has the potential to uncover the changes in growth that produced evolutionary novelties. Amiids have a robust fossil record that includes species with large sample sizes that contain growth series. *Cyclurus fragosus* is an amiid that frequented the river systems of Laramidia during the Late Maastrichtian. Previous studies of *C. fragosus* have not considered growth, providing the rationale for this study.

The primary goal was to recover the growth series of *C. fragosus* from dentaries based on study of specimens in the collections of the Dinosaur Discovery Museum (Kenosha, WI) and the Burpee Museum of Natural History (Rockford, IL). Cladistic methods were used to recover a character-based, quantitative growth series for *C. fragosus*. Secondary goals included a correlation test of maturity and size. It was hypothesized that growth and maturity will have a positive and significant correlation. The cladistic data matrix included 49 specimens and 33 characters that were compiled in Mesquite and a heuristic analysis was executed in PAUP. SPSS was used to obtain descriptive statistics and run the correlation test.

Forty-five trees were recovered, each with a length of 135 steps, a consistency index (CI) of 0.26, and a rescaled consistency index (RC) of 0.15; the strict consensus tree has 25 growth stages. The main growth changes include: a rostral shift of the foramina along the lateral side of the dentary, the absence of a hook at the rostral end of the dentary, and an increase in both the rostral length from the angulation and width at the angulation relative to the depth of the dentary.

A histogram of the frequencies of dentary depth (mm) at the angulation was obtained and has a normal distribution. The mean value was 6.19, and the standard deviation was 1.99. A positive correlation was seen

between size and maturity: a correlation test of dentary depth (mm) at angulation per specimen vs. growth stage recovered an r -value of 0.468, and a p -value of 0.004, however homoscedasticity was violated. Based on this foundation, future work will focus on the growth series of *Amia calva*, the closest living relative of *C. fragosus*.

Funding Sources Carthage College

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

***Taeniolabis simmonsae* (Multituberculata, Taeniolabidae) from the early Paleocene of the Denver Basin, Colorado: implications for taeniolabidid systematics, Paleocene bio/geochronology, and paleoenvironmental reconstruction**

Krause, David W.^{1,2}, Weaver, Lucas N.^{3,4}, Hummel, Rudolph R.⁵, Chester, Stephen G.^{6,7}, Weissenburger, Ken¹, Lyson, Tyler¹

¹Earth Sciences, Denver Museum of Nature & Sciences, Denver, Colorado, United States, ²Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ³Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ⁴Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States, ⁵Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States, ⁶Anthropology, Brooklyn College, Brooklyn, New York, United States, ⁷Anthropology, City University of New York, New York, New York, United States

Taeniolabis taoensis is a large, iconic multituberculate mammal of early Paleocene (Puercan 3 or Pu3) age known from abundant craniodental remains from the San Juan Basin, several skulls or partial skulls from the Denver Basin, and a few gnathic and dental specimens from several other Pu3 localities in the Western Interior of the U.S.A. A recently

discovered multituberculate cranium with complete cheektooth dentition (DMNH EPV.134107) from the D1 Sequence (aka Denver Formation), Corral Bluffs study area, Denver Basin, Colorado, represents a species of taeniolabidid that is demonstrably smaller than that of *T. taoensis*. Preliminary results suggest that it, as well as an isolated upper molar (M1; DMNH EPV.134086) recovered from the same horizon, pertain to a species described in 2016 from the Nacimiento Formation of the San Juan Basin, New Mexico, which was placed in a new genus and species, *Kimbetopsalis simmonsae*. However, examination of almost all specimens of *T. taoensis* reveals that the differences in cheektooth sizes, M1 cusp counts, and P4/M1 length ratios between *T. taoensis* and *K. simmonsae* are less than previously indicated. We therefore conclude that *K. simmonsae* is not sufficiently distinct from *Taeniolabis* to warrant establishment of a new genus, and therefore refer the species to *Taeniolabis* in a new combination, *Taeniolabis simmonsae*. Questions remain as to whether *T. simmonsae* is morphologically distinct from *T. lamberti* from the Tullock and Ludlow members (Fort Union Formation) of eastern Montana. *T. simmonsae* occurs demonstrably below *T. taoensis* in the composite stratigraphic section in the Corral Bluffs study area and therefore earlier in time than *T. taoensis* and other mammals that characterize the *Taeniolabis taoensis*/*Periptychus carinidens* Interval Zone (Pu3) of the Puercan North American Land Mammal Age. Because of its association with other mammalian taxa that precede the Pu3 Interval Zone, *T. simmonsae* therefore is taken to lie within the *Ectoconus*/*Taeniolabis taoensis* Interval Zone (Pu2). Significantly also, *T. simmonsae* co-occurs with the first appearance of legumes during a warming interval in the Corral Bluffs section, suggesting that mammalian biogeography and stratigraphic succession may have been shaped, at least in part, by

changes in climate and vegetation in the early Paleocene.

Funding Sources National Science Foundation Frontier Research in Earth Sciences grant EAR-2317666

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Soft tissue preservation in Cenozoic fossils from John Day Fossil Beds National Monument, Oregon

Kringstad, Megan R.¹, Ullmann, Paul¹, Terry, Dennis², Famoso, Nicholas A.^{3,4}

¹Harold Hamm School of Geology and Geological Engineering, University of North Dakota, Grand Forks, North Dakota, United States, ²Department of Earth and Environmental Science, Temple University, Philadelphia, Pennsylvania, United States, ³John Day Fossil Beds National Monument, U.S. National Park Service, Kimberley, Oregon, United States, ⁴Department of Earth Sciences, University of Oregon, Eugene, Oregon, United States

Numerous studies have revealed remarkable preservation of diverse organic microstructures in fossil vertebrates from various eras and depositional paleoenvironments, including cells, structural tissues, and, in some cases, even their component biomolecules. To date, the only well-supported proxy for such exceptional preservation remains exquisite morphological preservation, which implies that lagerstätten and other localities yielding abundant, well-preserved fossils are the most viable targets for studies of soft tissue and molecular preservation. To build on recent tests of this hypothesis by several members of our research team examining Eocene–Oligocene fossils from Badlands National Park in South Dakota, we set out to

investigate the extent and nature of organic preservation in Cenozoic vertebrate fossils from John Day Fossil Beds National Monument in Oregon. Ten fossil samples were collected and immediately tested for cellular and soft tissue preservation by demineralization in 0.5 M ethylenediamine-tetraacetic acid (EDTA) pH 8.0, including six fossil specimens from the Miocene Rattlesnake Formation and four specimens from the Oligocene Turtle Cove Member of the John Day Formation. Transmitted-light microscopy of demineralization products revealed frequent, yet variable, preservation of potentially-endogenous microstructures in all samples, including cellular structures morphologically consistent with osteocytes, cylindrical and hollow structures consistent with original blood vessels, and semitranslucent, thin sheets of tissue consistent with fibrous/proteinaceous bone matrix. All 10 specimens yielded osteocytes, but vessels and fibrous matrix were variably recovered and, where present, they exhibited narrower ranges of coloration. Osteocytes recovered from bones from the Rattlesnake Formation also generally exhibited darker color and more elongate and intricate filopodia than those acquired from specimens from the Turtle Cove Member of the John Day Formation. Cumulatively, the observed quality of preservation suggests that taphonomic conditions within paleoenvironments recorded by the John Day and Rattlesnake formations not only facilitated preservation of numerous fossils, but also that vertebrate fossils from the National Monument and nearby outcrops are potentially fruitful targets for paleomolecular analyses. Our findings thus greatly advance understanding of the taphonomy and diagenesis of fossils from John Day Fossil Beds National Monument.

Funding Sources Funding provided by University of North Dakota

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A typical pre-evaporitic Messinian fauna in southeast Tunisia

Ksila, Oumeima¹, Lihoreau, Fabrice², Aridh, Kais¹, Melki, Fetheddine¹

¹geology, Faculty of Sciences of Tunis El Manar, Saint Priest, France, ²Institut des Sciences de l'Evolution, Montpellier, France

A significant evolutionary shift, which affects the faunas of Africa, occurred during the very Late Miocene. The advent of modern mammalian communities, including the first hominids, coincided with the Messinian expansion of grasslands. However, fossil remains of this period are scarce in Africa, particularly in northern Africa including Sahabi, Libya and Menacer, Algeria. We present an original vertebrate fauna recently unearthed from the upper Miocene sands of Oudhreh located in southeast Tunisia. The preliminary fauna is characterized by the presence of the anthracothere *Libycosaurus bahri*, proboscideans *Stegotetralodon syrticus*, *Deinotherium*, and *Anancus*, a large diversity of bovids, some large carnivores including machairodontine felid, a giraffid, and a suid, and diversified hipparionines such as *Hipparion* and *Cremohipparion*.

This distinctive assemblage sheds light on a hitherto unknown period in Tunisian paleontology. The Oudhreh fauna is chronologically younger than the Bled Douarah (Begli Fm.) and Djebel El Artsouma (Segui Fm.) faunas. This indicates the presence of a pre-evaporitic Messinian deposit in the Gabes basin. The Oudhreh fauna is more comparable to Late Miocene assemblages from Sahabi (Libya), the Anthracothere Unit of Toros Menalla (Chad), and Menacer (Algeria).

This study opens the door to discussions regarding Tunisia's role in the distribution

patterns of vertebrates across North and East Africa. These discussions could potentially include migration routes to Europe, as indicated by fossils found in southern Italy and Greece. Unveiling the dynamics of this period is particularly crucial for understanding the early evolutionary history of hominids.

Funding Sources ERASMUS and the Tunisian government fund this research through a grant program.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Early Cretaceous troodontid (Dinosauria: Theropoda) from the Ohyamashimo Formation of Japan reveals the early evolution of Troodontinae

Kubota, Katsuhiko¹, Kobayashi, Yoshitsugu², Ikeda, Tadahiro³

¹Museum of Nature and Human Activities, Hyogo, Sanda, Hyogo, Japan, ²Hokkaido University Museum, Hokkaido University, Sapporo, Japan, ³University of Hyogo, Sanda, Japan

An articulated partial skeleton of a new troodontid from the fluvial deposits of the Ohyamashimo Formation of the Sasayama Group (early to middle Albian) at Nishikosa, Tamba Sasayama City, Hyogo Prefecture represents the only confirmed occurrence of a troodontid in Japan and provides valuable morphological insights. The Nishikosa troodontid is distinguished by four unique characters: a pair of proximodistally extended depressions on the proximodorsal surface of manual phalanx I-1, long dorsal and ventral proximal lips on manual phalanx III-2 facilitating tight articulation with phalanx III-1, a proximodistally longitudinal medial ridge on the anterior surface of the femur proximal to the medial condyle, and distorted distal condyles with a widely convex distoventral

margin on pedal phalanx III-3. Additionally, it is characterized by the combination of two features: the thickest width near the middle portion or lateral margin of the distal end of the ulna, and an angle of less than 11 degrees between the anterior edge of the cnemial crest and the anterior edge of the tibial shaft. Our phylogenetic analysis positions the Nishikosa troodontid as the oldest and one of the most basal troodontines, forming a monophyletic clade with *Gobivenator*. The Nishikosa troodontid exhibits an intriguing posture, characterized by a loosely fold forelimb lateral to the gastralia, tightly folded ankles, and unbent pedal digits positioned under the gastralia, resembling the sleeping style of *Mei* and *Sinornithoides*. The discovery suggests that small-bodied troodontids adopting a sleeping posture were prevalent not only in environments characterized by volcanic and eolian events or alluvial systems but also in fluvial systems. The geometric morphometric analysis of manual unguals reveals considerable morphological variation in manual unguals I and III of the Nishikosa troodontid compared to non-troodontine troodontids. Digit III of the Nishikosa troodontid functioned as effectively as digit I, reflecting the transition in manual motion within Troodontinae. Moreover, the Nishikosa troodontid has mosaic features in the pes related to cursoriality. The discovery of the Nishikosa troodontid illuminates the occurrence of an asymmetrical arctometatarsus by the Albian along with morphological changes such as shorter digit IV than III and non-ungual phalanges of digits III with roller joints and IV with weakly ginglymoid articulation, emerging during the early Late Cretaceous.

Funding Sources This work was supported by a part of the Foundation of Kinoshita Memorial Enterprise.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Dental development in Early Eocene adapoids

Kufeldt, Chrisandra¹, Laudicina, Natalie M.², Yokley, Todd³, Anemone, Robert L.⁴

¹Human and Evolutionary Biology, University of Southern California, Los Angeles, California, United States, ²Biomedical Sciences, Grand Valley State University, Allendale, Michigan, United States, ³Sociology and Anthropology, Metropolitan State University of Denver, Denver, Colorado, United States, ⁴Anthropology, University of North Carolina Greensboro, Greensboro, North Carolina, United States

Primate fossils from the Eocene are fundamental to understanding the evolutionary divergence of the strepsirrhine and haplorrhine lineages and provide an important context for studies of primate evolution. Teeth remain the most abundant fossil material for Eocene primates and reconstructing dental development based on enamel incremental features provides critical information on the life history of extinct taxa. Dental hard tissues preserve a record of growth in the form of short- and long-period incremental lines in enamel and dentin, which can be quantified to estimate pattern and timing of growth. Teeth begin formation and mineralization during intrauterine development. The neonatal line is an accentuated line found in first permanent molars that allows the distinction of pre- and postnatal enamel and determining the relative position of the neonatal line allows insight into early stages of growth and development. Here we explore dental development in the Eocene adapoid *Cantius* based on a fossil sample from Carnegie Museum Locality 3631 (Virgin Hills) near Tipton Buttes in the Great Divide Basin of

southwestern Wyoming. We measured enamel growth (i.e., daily secretion rate, enamel thickness, crown formation times, periodicity, and enamel extension rate) in histological thin sections from six individuals and estimated the prenatal enamel based on the presence of the neonatal line in three individuals. By using the neonatal line as day zero, it was determined that M₁ formation began between 42 and 57 days before birth. We then compared the results with data from two species of living strepsirrhine primates, *Otolemur* and *Perodicticus* which have body sizes similar to the estimate for *Cantius* (~2 kg). The duration of prenatal enamel growth in the extant strepsirrhines is double that observed in *Cantius* – 80 days in *Otolemur* and 108 days in *Perodicticus*. Results also show that the average rate of enamel secretion is comparable in *Cantius* (3.0 µm/day) and both living lorisiforms (3.4 µm/day), but the duration of total crown formation time is longer in the fossil taxon (218 days) compared to the living taxa (136 days). The differences in timing and duration of prenatal enamel development and total crown formation times between *Cantius* and the living lorisiform primates suggest varying life history schedules and may correspond to differences in body size, brain size, and relative encephalization.

Funding Sources All fossils were collected under the auspices of BLM paleontological collecting permit 287-WY-PA95.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Late Triassic (Carnian) lower Popo Agie Formation, part II: faunal notes on the purple unit

Kufner, Aaron M.^{1,2}, Fitch, Adam J.², Miller, Hannah R.⁵, Deckman, Max E.³, So, Calvin⁴, Price, Brandon R.², Lovelace, David M.^{1,2}

¹Department of Geoscience, University of Wisconsin-Madison, Madison, Wisconsin, United States, ²Geology Museum, University of Wisconsin, Madison, Wisconsin, United States, ³School of Design, University of Kentucky, Lexington, Kentucky, United States, ⁴Ethos Geological, Inc., Bozeman, Montana, United States, ⁵Department of Biological Sciences, George Washington University, Washington D. C., District of Columbia, United States

The Late Triassic Popo Agie Formation of Wyoming has been studied by paleontologists for more than a century. The earliest fossil collections occurred in the early 20th century with more sporadic efforts into the latter half of the 20th century. Vertebrate fossil collection efforts were revived in the 2010s largely by the UW Geology Museum and continue to the present. The Popo Agie Fm consists of a lower (lower carbonate and purple units) and an upper (ochre and upper carbonate units) interval. Notably, published collections from the Popo Agie Fm, with the exception of a rhynchosaur from the lower carbonate published in 2002, are exclusively from the upper Popo Agie Fm. Recent CA-ID-TIMS detrital zircon ages from the ochre unit placed a maximum depositional age of the analcime-rich transitional zone between the lower and upper Popo Agie purple and ochre units at ca. 229 Ma (i.e., coeval with Carnian-aged dinosaur-bearing faunas in Brazil and Argentina). Although it is likely that earlier workers identified vertebrate remains from the purple unit of Wyoming, nothing was reported until 2017. Isolated *ex situ* remains have been surface collected at 14 purple unit sites in western Wyoming, but primary collection efforts have focused on two sites: Nobby Knob (NK) and Garrett's Surprise (GS).

The NK site is preserved in low-energy deposits with a vertic paleosol overprint within 1 m of the purple unit base near Dubois, WY. The NK site is a monodominant metoposaurid bone bed with partial

articulation and fragmentary remains of Redfieldiiformes and Equisetales(?), isolated archosauriform teeth, and unionid bivalve molds. In contrast, the GS site is located 15 km to the northeast in similar low-energy deposits, although the vertic paleosols are better developed. All fossils at the GS site were collected *ex situ* through screen washing of regolith and surface collection. The outcrop of the Popo Agie Fm at GS is missing the upper Popo Agie due to an erosional contact with the overlying Wind River Formation. Fragmentary remains, often encased in carbonate nodules were recovered from GS including a partial lungfish tooth plate, a dinosaur astragalus and proximal femur, a sulcimentasaurian silesaurid proximal femur, archosauriform teeth, and indeterminate amphibian fragments. These sites demonstrate a relatively diverse and previously unrecognized vertebrate assemblage in the purple unit of the lower Popo Agie Fm distinct from the upper Popo Agie.

Funding Sources David B. Jones Foundation, Friends of the Geology Museum, and the Sherry Lesar Fund for Geological Wonder.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

The geologically oldest insights into synapsid life history revealed through synchrotron tomography and femoral histology of *Clepsydropus* (Synapsida: Ophiacodontidae)

Kulik, Zoe T., Benson, Roger B.

Division of Vertebrate Paleontology, American Museum of Natural History, New York, New York, United States

The earliest synapsids provide important data on mammalian ancestry and the mammal-reptile split and are hypothesized to have had

a reptile-like physiology, largely due to similarities of their skeletal morphology to that of early sauropsids. This perspective was recently challenged by the bone histology of the early Permian synapsid, *Ophiacodon*, that revealed rapidly deposited, fibrolamellar bone. Histological studies of other large-bodied Permian synapsids show a mosaic of different tissue types and inferred life histories that are unlike the growth patterns of early sauropsids or crownward stem amniotes. However, the growth dynamics and life history of earlier diverging, smaller bodied synapsids from the Carboniferous are almost entirely unknown. To investigate the ancestral life history of synapsids, we histologically analyzed the bone tissue composition of *Clepsydropus* femora from the Pennsylvanian (Late Moscovian, Early Kasimovian) of Illinois to reveal the geologically oldest insights into synapsid life history. Using synchrotron phase-contrast micro-computed tomography, we compared changes in bone tissue composition across a size series of *Clepsydropus* femora that span an inferred ontogenetic series. Our preliminary observations indicate that rapidly deposited fibrolamellar bone characterizes the earliest growth phase of small *Clepsydropus* femora. Growth continues in larger individuals, by accumulation of slower, more gradually deposited parallel-fibred and lamellar tissue that show numerous growth marks. This gradual deceleration of growth differs from *Ophiacodon* that shows abrupt shifts in growth phases separated by thick annuli. Considering that *Clepsydropus* represents one of the earliest synapsids, our results suggest that rapidly deposited bone tissue during early ontogeny may be ancestral for Synapsida and may distinguish synapsids from contemporaneous sauropods and stem amniotes. Continued histological investigations of other smaller bodied early amniotes and stem amniotes from the Carboniferous are needed to rigorously evaluate this.

Funding Sources ZTK was funded by NSF EAR 2304875

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Fossil-calibrated molecular phylogeny sheds light on the evolutionary radiations and biogeography of old-world rats and mice (Muridae: Murinae)

Kumar, Rohit¹, Bansal, Mahi⁴, Gilbert, Christopher C.², Patel, Biren A.³, Patnaik, Rajeev¹

¹Department of Geology, Panjab University Chandigarh, 160014, Chandigarh, Chandigarh, India, ²National Centre for Biological Sciences, Tata Institute of Fundamental Research, Bangalore, Karnataka, India, ³Department of Anthropology, Hunter College of the City University of New York, 695 Park Avenue, New York, NY 10065, USA; PhD Program in Anthropology, Graduate Center of the City University of New York, 365 Fifth Avenue, NY 10016, USA; New York Consortium in Evolutionary Primatology, New York, NY, USA; Division of Paleontology, American Museum of Natural History, Central Park West at 79th Street, New York, New York, New York, United States, ⁴Department of Integrative Anatomical Sciences, Keck School of Medicine, University of Southern California, Los Angeles, CA 90033, USA; Human and Evolutionary Biology Section, Department of Biological Sciences, University of Southern California, Los Angeles, CA 90089, USA., Los Angeles, California, United States

Rodents comprise the most diverse mammalian order, representing over half of all mammalian species. Understanding the evolutionary radiations and geographic distribution of rodents is crucial for unraveling the complex dynamics of mammalian diversification and biogeography. Murinae, a subfamily of Muridae, stands out

as the most successful mammalian subfamily, encompassing 135 genera and approximately 656 species. In this study, we propose an improved set of fossil calibrations utilized to reconstruct the subfamily's dated phylogeny. We employed a multilocus dataset that includes nine mitochondrial and six nuclear gene segments, covering 336 species from 117 murid genera within the Murinae subfamily.

Through a meticulous analysis of the fossil record, our work distinguishes itself from earlier research on murid or muroid rodents by implementing five significant fossil constraints. Notably, we have used *Parapodemus badgleyae* [10.5 million years ago (Mya)] as a new calibration point for constraining the Apodemini tribe, which is older than previously used calibrations within the Murinae subfamily. We applied the tip dating approach (total-evidence phylogeny), which provides a more precise and deeper age estimation by including fossil ages in the analysis and accounting for uncertainty in fossil position, thereby incorporating all available paleontological data instead of solely relying on the oldest fossil for a specific node.

Using this method, we have elucidated the monophyly of several tribes within the Murinae subfamily, with the resulting phylogeny being compatible with earlier phylogenetic research on murids and muroids. Our inferred temporal timeline, based on five controlled fossil calibrations, suggests that the Murinae subfamily likely originated between 13.8 - 14.8 Mya during the Middle Miocene. The majority of the major lineages, or tribes, began to diversify around 11 to 12 Mya.

Based on historical biogeographical investigations, the Murinae subfamily is believed to have originated in Southeast Asia, a hypothesis supported by the extensive fossil record found in Siwalik deposits across the Indian subcontinent. Murine rodent

migration commenced in the Middle Miocene, spreading outside of Southeast Asia and reaching recognized centers of diversity and endemism in the Philippines, Wallacea, Sahul shelf, West Palearctic, and East Palearctic regions.

Funding Sources Funding for this work was received from the university grant commission (UGC) of India .

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Allometric growth in the limbs of the Pleistocene "mountain deer" *Navahoceros fricki*

Kuo, Evan R.¹, Prothero, Donald R.²

¹Geological Sciences , Cal Poly Pomona, Temple City, California, United States, ²Vertebrate Paleontology, Natural History Museum of L.A. County, Los Angeles, California, United States

Navahoceros fricki was described by Kurtén in 1975 as a late Pleistocene deer with distinctively robust limb bones compared to other deer like *Odocoileus* (white-tailed deer and mule deer) and *Cervus elaphus* (elk). It is known from huge samples of juvenile limb bones from San Josecito Cave in Nuevo Leon, Mexico. Using a flexible metric measuring tape, we measured all the unbroken juvenile and adult humeri, radii, femora, and tibiae in the sample, focusing on the diaphyseal shaft length (minus the epiphyses) vs. the midshaft diameter. Data were then plotted and reduced major axis (RMA) slopes of the data were calculated using PAST software. Since the adults have robust limbs, we wanted to see if they matured in a significantly more robust pattern than isometric growth (i.e., slope significantly <1.0). The humerus slope was 0.788 ($r^2 = 0.816$), significantly more robust than isometry. The radius slope was 1.054 ($r^2 = 0.928$) but it was not significantly

different from isometry. The femur slope was 0.788 ($r^2 = 0.816$), also significantly more robust than the isometric slope. The tibia, however, gave a slope of 1.087 ($r^2 = 0.927$), on the gracile side of isometry, but this was not significant at the 95% confidence level. Thus, in proximal limb elements (humerus, radius), *Navahoceros* did indeed exhibit negative allometry (growing more robust as it grew larger), consistent with the expectation based on the adult robustness. Surprisingly, the distal limb elements (radius and tibia) shows no significant difference from isometry. This contrasts with previous studies of growth in the white-tailed deer (*Odocoileus virginianus*), which was isometric in the humerus and radius, but gracile in the femur and robust in the tibia.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Tracing macroevolutionary transformations of avian quadrate morphology

Kuo, Pei-Chen^{1,2}

¹Field Museum, Cambridge, Cambridgeshire, United Kingdom, ²University of Cambridge, Cambridge, United Kingdom

In birds, the quadrate acts as a hinge between the lower jaw and the skull, playing a key role in cranial kinesis. Given its role in the feeding apparatus, the evolution of avian quadrate form may be closely associated with feeding mechanics; however, the extreme variability of quadrate morphology among extant birds has dissuaded previous work on this important component of the avian feeding apparatus, and has seemingly led to the application of inconsistent terminology and homology concepts to this anatomically complex skeletal element. Here, I investigated morphological evolution of the quadrate across 249 taxa spanning all major lineages of extant birds and key crown- and stem-bird fossils. I generated the first

comprehensively illustrated and homology-led anatomical atlas of avian quadrate morphology, and applied high-dimensional geometric morphometrics to quantitatively explore morphological evolution of the quadrate, articulations with neighbouring bones, and muscle attachments. These analyses enabled the investigation of ecomorphological relationships between the quadrate and an array of ecological categories, and underpinned fossil-informed ancestral shape reconstructions to trace the evolution of quadrate form throughout avian evolutionary history. I found feeding ecology do not predict quadrate morphology, whereas non-ecological factors, such as allometry and phylogeny, are strongly associated with quadrate form. This work illustrates that the quadrate of crown birds has evolved as an integrated unit, exhibiting strong associations with the morphologies of neighbouring bones with which it articulates; collectively, these results suggest a complex macroevolutionary scenario in which quadrate morphology evolved jointly with other elements of the avian kinetic system. My results also illustrate the importance of incorporating fossil taxa into three-dimensional reconstructions of ancestral shape, as fossil-informed ancestral geometric reconstructions differ substantially from three-dimensional reconstructions of quadrate shape lacking fossils. These ancestral reconstructions help elucidate important aspects of the morphology and function of the avian feeding apparatus early in crown bird evolution. Altogether, this work casts light on the evolution of a critical, yet oft-overlooked component of the avian feeding apparatus and provides an important case study reaffirming the necessity of fossils in macroevolutionary investigations of skeletal form.

Funding Sources This work was funded by UKRI grant MR/X015130/1, the European Research Council Starting Grant: TEMPO (ERC-2015-STG-677774), and Taiwan Cambridge Scholarship.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Inferring the life histories of herbivorous megafauna from Rancho La Brea

Kurre, Aditya R.¹, DeSantis, Larisa^{2,3}

¹Biological Sciences, Vanderbilt University, Brookfield, Wisconsin, United States, ²Biological Sciences | Earth and Environmental Sciences, Vanderbilt University, Nashville, Tennessee, United States, ³La Brea Tar Pits and Museum, Los Angeles, California, United States

Rancho La Brea, a late Pleistocene lagerstätte, allows for the opportunity to study entire extinct mammalian communities. Though carnivorous mammals are often the focus of these studies, the examination of mammalian herbivores from Rancho La Brea can help improve our understanding of the availability of potential prey-resources. Previous work that assessed the relative abundance of juvenile and adult specimens, suggested migratory patterns in La Brea's bison. Further, stable isotopes from fossils at Rancho La Brea have revealed seasonal competition for resources between late Pleistocene bison and horses, indicating potential seasonal migration patterns of these herbivores. Here, we build on this work by examining serial stable isotope samples of bison (*Bison antiquus*), horses (*Equus occidentalis*), and camels (*Camelops hesternus*) from three different pits (Pits 77, 13, and 61/67) to better characterize the dietary ecology of these mammals over time and relative to one another. These pits span glacial to interglacial periods; therefore, allowing us the ability to reconstruct the dietary ecology of these mammals in different climatic regimes. Notably, *Equus occidentalis* shows clear evidence of C4 grass consumption with seasonal variation. Furthermore, while average $\delta^{13}\text{C}$ variability in a single individual (of all taxa) is typically less

than 3-4 ‰, some individuals exhibit a broad range of $\delta^{13}\text{C}$ variability (e.g., > 8 ‰) that may indicate either seasonal variability in resource utilization or seasonality driven movement. Oxygen isotopes ($\delta^{18}\text{O}$ values) also indicate a range of patterns from aseasonal to more seasonal variability, though more serial sample data from a larger number of samples is necessary to make conclusive inferences regarding climate. Data from an increased breadth of taxa and time periods improves our understanding of dietary and climate inferences in herbivorous mammals at Rancho La Brea and underscores the efficacy of serial stable isotope analysis in life history studies.

Funding Sources This project is supported by the National Science Foundation (award number 1757545).

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

The neoichnology of *Nihilichnus* in the Serengeti

LaBarge, Thomas W.¹, Njau, Jackson K.^{1,2}

¹Earth and Atmospheric Sciences, Indiana University, Bloomington, Indiana, United States, ²The Stone Age Institute, Gosport, Indiana, United States

The ichnogenus *Nihilichnus* is used to describe tooth traces generated by vertebrates. Recently, the ichnotaxonomy of *Nihilichnus* has been revised to better correspond to established taphonomic indices for predator identification. Four ichnospecies are currently used for tooth traces on bone: *N. nihilicus*, a polygonal to rounded puncture; *N. hastarius*, a lenticular puncture; *N. clavus*, a rounded pit; and *N. sicarius*, a lenticular pit. Some of these morphologies have been proposed to represent diagnostic criteria for identifying

taphonomic agents in the fossil record. We observe each of these trace morphologies in a modern setting to evaluate their potential for differentiating trace makers. Using field observations of abandoned carcasses in Serengeti National Park and the Ngorongoro Conservation Area, Tanzania, we quantify the distribution of these tooth traces in relation to possible taphonomic agents. Trace makers were identified based on direct observation of carcass consumption, gross patterns of skeleton modification, and bone accumulation settings (e.g., leopard tree caches, crocodile pools). Some trace morphologies show significant correlations to certain trace maker species (i.e., *N. hastarius* and crocodiles), while other morphologies, such as *N. nihilicus* and *N. clavus*, do not correlate strongly to individual predator species and are instead found across a variety of ecological contexts. Using these trace to trace maker correlations, we aim to better discern taphonomic agents in Serengeti fossil assemblages and develop statistically robust methods for delineating ecological relationships in the fossil record.

Funding Sources This research was supported by Indiana University and the Explorers Club.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Revising the timeline of discovery at the Lakes-Marsh “*Atlantosaurus* Beds” quarries at Morrison, Colorado

LaCount, Erin¹, Mossbrucker, Matthew T.²

¹Education Programs Director, Friends of Dinosaur Ridge, Morrison, Colorado, United States, ²Director & Chief Curator, Morrison Natural History Museum, Morrison, Colorado, United States

Letters sent by Arthur Lakes to O.C. Marsh spanning 1876 to 1879 have corrected the

timeline of fossil discoveries in the Upper Jurassic Morrison Formation at Dinosaur Ridge (Morrison, CO). These letters also clarify the “Saurian” nomenclature used by Lakes as field names given to individual specimens, not excavation site names. Examination of written documents cross-referenced with an analysis of paleontological and geological samples has refined the timeline of discovery and sorted both specimen and site.

A detailed review of the correspondence has revised the timeline of discovery at the historic Lakes-Marsh Quarries at Morrison. The correspondence includes shipping information, telegrams from O.C. Marsh, 39 letters by Arthur Lakes, 40 by Benjamin Mudge, 5 by Samuel Williston, 5 by William Nugent, and 3 by Henry C. Beckwith.

Lakes’ letters to Marsh contradict the accepted timetable of discovery. Written on June 15 and 20 of 1876, two multi-page letters with illustrated diagrams by Lakes to Marsh housed in the collections at Yale University indicate the discovery of fossils in Morrison were made more than nine months prior to March 26, 1877. The latter accepted date is derived from Arthur Lakes’ “field journal”, which is a collection of anecdotes written after the excavations in Morrison, CO had occurred.

Previous scholars have indicated that the nomenclature for each site shifted as the excavations were processed and consequently created phantom quarries. Lakes’ writings, however, indicate the numbered “saurians” reflect the interpretation of individual animals collected, with multiple specimens at each site. Referencing the unique lithology preserved on unprepared bone and the consequent variation in fossil permineralization, six fossil quarries were processed by the Lakes crew and are in Yale Peabody Museum collections.

This multidisciplinary approach has refined the understanding of the area where the first giant dinosaurs were found in the American West.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Shed antler age-frequency distribution reflects caribou (*Rangifer tarandus*) calving ground trends recorded by wildlife monitoring in Ivvavik National Park, Yukon, Canada

Laker, Rachel M., Franseth, Roya, Miller, Joshua H.

Geosciences, University of Cincinnati, Cincinnati, Ohio, United States

Migratory caribou are a keystone species in Arctic North America, whose populations’ success is thought to be closely tied to access to their calving grounds. Although the exact location of calving varies annually, this variability generally falls within a geographically broader “calving ground” that is relatively stable across multiple decades. It is hypothesized that annual shifts in calving locations are influenced by environmental factors, including spring food availability and winter snowfall. However, the relatively brief timescales available from biomonitoring data limit our ability to understand the temporal and spatial scales by which calving locations change and how modern climate change is likely to impact herds’ geographic requirements. To characterize historical caribou calving geography, we take advantage of a resource unique to caribou: pregnant females annually grow antlers, which are shed within days of giving birth to their young. Shed female antlers can persist on tundra landscapes for centuries or more, providing a skeletal record of historical calving ground locations. To evaluate historical calving activity of the Porcupine Caribou Herd within Ivvavik National Park (Yukon, Canada), we

surveyed for antlers using eight standardized surveys along the Firth River, which yielded 40 antlers. We estimated year-of-shed for each antler using a combination of radiocarbon dating and weathering characteristics. We then reconstructed the local calving history using an age-frequency histogram partitioned into 20-year time bins. Results show that the number of antlers shed between 1980-2000 was significantly higher than 2000-2020, aligning with the recent observations of caribou calving more westward and within the Arctic National Wildlife Refuge (Alaska). Additionally, the antler age-frequency distribution is distinct from the “L”-shaped distributions more common of modern death assemblages (bones, shells), further indicating that historical Firth River calving activity was higher than in recent decades. Interestingly, while antlers from the Little Ice Age (1300s-1800s) were recovered in low abundance, no antlers were recovered from the 1900s-1940s, despite the overall high level of preservation observed across recovered antlers. The similarity between biomonitoring and antler records demonstrate that skeletal records can complement wildlife management data, while also extending the timescales across which seasonal landscape use may be evaluated.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Cheek tooth morphology is not a reliable taxonomic indicator for Beringian *Equus*

Landry, Zoe^{1,2}, Miller, Joshua H.^{3,4}, Zazula, Grant^{2,5}, Bataille, Clément^{1,6}, Fraser, Danielle^{2,4}, Orlando, Ludovic⁷, Tiffin, Helen⁸

¹Earth Sciences, University of Ottawa, Ottawa, Ontario, Canada, ²Canadian Museum of Nature, Ottawa, Ontario, Canada, ³Geosciences, University of Cincinnati, Cincinnati, Ohio, United States, ⁴Paleobiology, National Museum of

Natural History, Washington, D.C., District of Columbia, United States, ⁵Government of Yukon, Whitehorse, Yukon, Canada, ⁶Biology, University of Ottawa, Ottawa, Ontario, Canada, ⁷Centre for Anthropobiologie and Genomics of Toulouse, Toulouse, France, ⁸William & Mary, Williamsburg, Virginia, United States

Throughout the Pleistocene, horses were among the most abundant land mammals in North America and are well-represented in the fossil record. However, there are no widely accepted conclusions regarding how many species may have co-existed on the continent or their taxonomic nomenclature. This lack of consensus is particularly problematic in Beringia due to both fewer studies having been conducted in this region and the possibility of bidirectional gene flow across the Beringian Land Bridge. Research has demonstrated that species of *Equus* from the Pleistocene of North America exhibit complex enamel patterns that may be taxonomically informative, but this has not yet been rigorously tested in Beringian horses. Here, we use 2D geometric morphometric analysis to determine whether species of horses from Beringia significantly differ in the shape of the enamel pattern for upper and lower 3rd and 4th premolars, and whether they form distinct taxonomic groups consistent with those that have been previously erected. We photographed 149 teeth; 96 teeth had been previously attributed to three species of *Equus*, while the remaining 53 teeth were only identified to the genus level and were treated as an indeterminate group. For the upper teeth, we digitized 24 landmarks spanning the entire surface of the tooth and, for the lower teeth, we digitized 50 evenly spaced landmarks to outline the “double knot” feature on each tooth. We then performed Generalized Procrustes Analyses of Points, Principal Component Analyses, and Linear Discriminant Analyses to test whether morphology was correlated with *a priori*

identifications and how the indeterminate specimens fit into the multivariate space. We show that the morphology of the upper teeth from Beringian horses provides taxonomically useful information, while the lower teeth are morphologically indistinguishable among species. While the upper teeth with *a priori* species identities are successfully recovered, many taxonomically indeterminate specimens do not group with any of the three species. We suggest that, although we can identify upper teeth using morphological characters to the species level, the teeth of *Equus* species exhibit notable variation that limits their utility as taxonomic indicators using morphology alone. We suggest that future research aimed at resolving taxonomic uncertainties of *Equus* should not use dental characters in isolation, but should combine them with other methods of species identification.

Funding Sources This work was supported by a CMN Research Activity Grant, a NSERC Discovery Grant (RGPIN-2018-05305), and a NSERC Postgraduate Scholarship (CGSD-569954-2022).

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Tracing transformations: investigations into the evolution of brain shape in Primates and their kin

Lang, Madlen

Anthropology, University of Toronto, Aurora, Ontario, Canada

The unique characteristics of the primate brain have often been studied in living groups, but few of the analyses that include fossils have moved beyond simple comparisons of size. Using landmark based geometric morphometrics, I capture variation in endocranial shape for living and fossil Euarchontoglires (Primates [stem, Haplorhini

+ Strepsirrhini], Dermoptera, Scandentia, Rodentia, Lagomorpha). The goal of study is to trace major evolutionary transitions in brain shape and investigate the possible factors contributing to this variation. Virtual endocasts of 140 extant and 24 extinct species of Euarchontoglires were landmarked with 28 fixed and 8 semi-landmarks using a landmark set designed to capture variation across a morphologically diverse group and allow for the inclusion of incompletely preserved fossils. Principal component analyses (PCAs) on Procrustes shape variables show that early primates and rodents of the Paleocene are distinct from their living relatives, sharing morphological similarities including small neocortices, large olfactory bulbs, and an unflexed basicranium. Contrary to previous assumptions, early crown primates of the Eocene are more similar in shape to extant Scandentia than to living primates. By the Oligocene, endocranial shape in the stem anthropoid, *Simonsius*, converges on that of the extant anthropoids, suggesting that the major transitions that resulted in the modern anthropoid brain shape took place between the mid Eocene and early Oligocene. Among these clades, rodents, haplorhines, and strepsirrhines show the greatest levels of morphological diversity. Correspondingly, they also show relatively high evolutionary rates. When the phylogeny is mapped onto the PCA two distinct evolutionary patterns emerge. In Rodents, the diversity of endocranial shape was achieved convergently, as species do not cluster by phylogeny, a pattern likely attributed to their ecological diversity. Conversely, primate brain evolution shows more directionality (likely following an adaptive trajectory centered on specialization in vision at the expense of olfaction, and complex social behaviours). In sum, these analyses document the shared brain Bauplan from which endocranial shape in Euarchontoglires emerged, demonstrates the distinct courses of diversification between these closely related clades, and establishes

a timeline for major transitions in brain evolution for Primates, the group to which we as humans belong.

Funding Sources Ontario Graduate Scholarship to MML.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Late Cretaceous marine fishes from the middle part of the Jetmore Chalk (lower Turonian) in north-central Kansas, USA

Laser, Owen, Shimada, Kenshu

Biological Science, DePaul University, Chicago, Illinois, United States

The Jetmore Chalk Member (lower Turonian) of the Greenhorn Limestone is a sedimentary rock unit deposited under the Western Interior Seaway of North America during the Late Cretaceous. The upper part of the Jetmore Chalk is known to contain remains of diverse marine vertebrates, but the vertebrate fossil record of other parts of the stratigraphic member is poorly known. In this study, vertebrate composition in the middle part of the Jetmore Chalk in west-central Republic County, Kansas, USA, was examined through surface collecting in the field and acid treatment of sediment samples in the laboratory. The taxa identified consist of at least four chondrichthyan (*Ptychodus* cf. *P. whipplei*, *Cretoxyrhina mantelli*, *Squalicorax* cf. *S. falcatus*, and *Batomorphii* indet.) and ten osteichthyan fishes (cf. *Hadrodus* sp., *Caturidae*(?) indet., non-teleostean *Actinopterygii* indet., *Pachyrhizodus minimus*, *Ichthyodectiformes* indet., *Plethodidae* indet., *Enchodus gladiolus*, and *E. shumardi* as well as at least two other types of teleosts). Whereas isolated teeth of *Caturidae*(?) indet. represent the most abundant vertebrate remains in this study, the collection also includes remains of several isolated placoid scales of *Selachii*

indet. as well as small phosphatic pebbles representing coprolites of indeterminate species, with at least one specimen containing fragmentary teleostean bones as inclusions. The diversity of marine fishes was high at this location during the early Turonian, evidenced by the range of species occupying different trophic levels, from small pelagic bony fishes (e.g., *Caturidae*(?), *Plethodidae*, and *Enchodus*) to large macrophagous (*Cretoxyrhina* and *Squalicorax*) and durophagous (*Ptychodus*) sharks. This study is important as it represents the first examination of fossil vertebrates from the middle portion of the Jetmore Chalk. Our findings have revealed that the overall taxonomic composition of the assemblage is largely consistent with the upper part of the Jetmore Chalk. This observation suggests that the ecosystem during the deposition throughout the middle–upper part of the Jetmore Chalk was relatively stable and ecologically complex.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Tooth or consequence: case studies using dental impression putty, vinyl polysiloxane (VPS), as an alternative to conventional molding materials

Lash, Catherine

North Dakota Geological Survey, Bismarck, North Dakota, United States

Many conventional and historical molding materials such as silicone, polyurethane, and latex rubber, can leave a fossil and/or the matrix appearing discolored or ‘wet’ after demolding. This is especially visible if only a portion of the specimen is molded. Vinyl polysiloxane (VPS) is a hydrophilic molding material used in the dental profession to make tooth and gum impressions. It can produce a high-quality mold retaining micron-level detail, cures quickly in under 5-minutes,

and once mixed is chemically safe for a person's mouth. Because the release agent is water, it is gentle on the molding surface, and leaves no visible residue. To compare the properties of these molding materials, peels from three large trackways were considered. Two of these trackways, PEFO 2569 (unidentified arthropod feeding trace) and WUPA 29969 (*Chirotherium* prints), were molded using conventional materials such as silicone rubber and an unknown molding material, respectively. WUPA 29969 and an additional trackway, YPM VP 000207 (*Allopus littoralis* prints), were both molded using Scott's Hydroclone VPS dental impression material. Platinum-cure silicone rubber (Polytek Platsil 73-25) left a 'wet' looking residue on a portion of the arthropod trace (PEFO 2569) specimen when it was molded in 2012 and is still present today. The unknown material(s) (possibly latex rubber) used to mold one *Chirotherium* track (WUPA 29969), in the 1970s, also retains a visible 'wet' appearance today. A second peel of two *Chirotherium* tracks (WUPA 29969) was taken in 2019 using VPS impression material, covering a new area and overlapping the previously molded area; it left no visible residue on either area five years later. Because the *Allopus* trackway (YPM VP 000207) is a holotype specimen, only VPS material was used to take peels of several portions of the trackway in 2023, again showing no visible residue. For the *Allopus* trackway, a shape template was created with ethafoam, the selected area of the specimen was sprayed with water, and the VPS was pressed onto the specimen into the foam template. The peel only needed a 4-minute cure time and required minimal health and safety precautions (i.e. gloves) while mixing the VPS putty. VPS is versatile and can be used for several other applications, including archeological artifacts where leaving a residue is not acceptable, speedy texture peels for exhibits, and biological specimens containing a high quantity of detail such as small scales.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Vertebrate coprolites from the Maastrichtian phosphates (Late Cretaceous) of Morocco

Lauer, Bruce H.², Duffin, Christopher J.^{1,2}, Ward, David J.^{1,2}, Lauer, Rene²

¹Lauer Foundation For Paleontology, Science and Education, Wheaton, Illinois, United States, ²Earth Sciences, Natural History Museum, London, United Kingdom

The Ouled Abdoun Basin lies to the west of the Atlas Mountains in Morocco. The largest (9000km²) of five major phosphate basins in the country, it is worked commercially and contains deposits ranging from Late Cretaceous (Maastrichtian) to Early Paleogene (basal Lutetian) in age. Believed to be related to offshore nutrient upwellings, the phosphates were deposited in warm, shallow seas at a paleolatitude of around 25° North. Surface collecting from phosphate quarry spoil heaps by locals is permitted, resulting in a wealth of specimens being passed on to state-licensed dealers, accounting for most of the material entering the fossil marketplace. The highly productive Sidi Chennane area exposes a somewhat condensed sequence, the stratigraphical scheme for which is rather informal. The coprofauna of the Couche III Upper Bone Bed of the enormous Sidi Chennane quarry complex (12 km long) includes two new taxa so far limited to this, the type area. *Struocopros catapitastromata* is characterised by a relatively high number of spiral folds (up to five), foreshortened antero-posterior and lengthened lateral axes, occasional lateral offsetting of adjacent coils and occasional angular declination of the inter-coil junctions to the long axis. The changes in shape were probably brought about by the ribbon of plastic fecal material entering a relatively large rectum or cloaca

and then deforming either by compaction along the antero-posterior axis or collapse at an angle. Final extrusion through the cloacal sphincter conferred the “taco-like” folding on the stack of coprolitic coils and elongation along the lateral axis. This confirms that this ichnomorph is a true (anally passed) coprolite rather than a phosphatised spiral valve cast or enterospirae. The most likely producer of the coprolites was one of the medium to large sharks in the diverse chondrichthyan fauna. *Alococopros milnei* coprolites are straight to slightly curved, ridged longitudinally with some examples having pinch-and-swell structures dividing the coprolite into segments representing pauses and pulses in coprolite extrusion; possible producers include crocodilians and chelonians. The species honours Alan Alexander Milne (1882-1956), creator of the children’s fictional anthropomorphic bear, Winnie-the-Pooh, famous for the pastime of ‘Pooh-sticks’.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Using maxillary morphology to identify ecomorphological affinities in Jamaican *Anolis* lizards

Lawrence, Curtis¹, Jacisin, John², Meza, Antonio^{3,2}, Kemp, Melissa²

¹Florida A&M University, Jacksonville, Florida, United States, ²Department of Integrative Biology, University of Texas at Austin, Austin, Texas, United States, ³College of Liberal Arts & Sciences, Arizona State University, Tempe, Arizona, United States

Greater Antillean *Anolis* lizards serve as a model example of ecomorphological adaptation — the development of habitat specialist groups represented by unique morphologies. However, the skull morphologies of Greater Antillean anole ecomorphs are at present poorly understood, along with the extent to which they are

represented in the fossil record. To help address this gap in knowledge, we used 3D geometric morphometrics to investigate shape variation in the maxillae of Jamaican anole skulls and test if maxillary shape could be used to identify or distinguish between ecomorphs. 3D models of 33 specimens representing all extant Jamaican species and ecomorph groups were generated using CT data, after which maxillae were segmented out in Avizo 3D and landmarked in 3D Slicer using a homologous 10-landmark scheme. Principal component analysis of the landmark data revealed several axes of shape variation showing statistically significant morphological differences between ecomorphs. We then created and landmarked — using the same 10-landmark scheme — 3D models of 33 fossil specimens from Jamaica, which had not been identified to a particular ecomorph group. Discriminant function analysis of the fossil specimens resulted in several specimens being assigned to extant ecomorph groups with high support, whereas the ecomorphological assignment of other fossils was less certain. These results emphasize the potential of skull morphology — particularly individual cranial elements — to distinguish between ecomorphs in living anoles, as well as to identify ecomorphs in fossil anoles. If applied to additional *Anolis* fossils across the Caribbean, this may provide insight into patterns of anole community stability and diversity over geologic time.

Funding Sources This project was funded by the Stengl-Wyer Endowment at the University of Texas at Austin and the National Science Foundation (EAR - 2050228).

Colbert Prize Session

Description and phylogenetic relationships of the "Glen Rose Form", a small crocodyliform from the Early Cretaceous Antlers Formation of Texas

Leaphart, Daniel R.¹, Adams, Thomas L.², Carrano, Matthew T.³, Brochu, Christopher A.¹

¹Earth and Environmental Sciences, University of Iowa, Iowa City, Iowa, United States, ²Curatorial, Witte Museum, San Antonio, Texas, United States, ³Paleobiology, Smithsonian Institution, Washington, District of Columbia, United States

The Aptian-Albian “Glen Rose Form” is an operational taxonomic unit often used as an outgroup in phylogenetic analyses on Crocodylia, traditionally represented by two skulls: MCZ VPRA-4453, from the Albian Cloverly Formation of Montana, and USNM-20239, from the Albian Antlers Formation of Texas. Both skulls have been noted as bearing similarities to extinct forms like *Theriosuchus* and *Wannchampsus*, as well as extant forms like *Osteolaemus*. Despite the similarities between the Montana and Texas specimens, their status as conspecific has been challenged by recent studies. Despite being used as an outgroup in several phylogenetic analyses of Crocodylia, the Antlers skull has never been officially described or named. The skull has a well-preserved rostrum but is cut off behind the orbits. It has a palate bordered anteriorly by the palatines and laterally and posteriorly by the pterygoids, heterodont dentition, with conical anterior teeth, and labiolingually compressed posterior teeth, procumbent dentary teeth, and large palpebrals.

A maximum parsimony analysis recovers this skull as new species, being a basal paralligatorid, sister to *Wannchampsus kirpachi*, from the Aptian Twin Mountains Formation of Texas. This new taxon is supported by a transverse ridge between the orbits, not seen in *W. kirpachi*, and nearly parallel lateral margins of the nasals. The Cloverly skull is recovered as sister to the Antlers skull and *W. kirpachi*. Paralligatoridae is recovered in a derived position within Eusuchia, forming a clade with *Bernissartia* and Atoposauridae, sister to Crocodylia. This

position within Eusuchia suggests that the “Glen Rose Form” and other closely related taxa should not be selected as outgroup taxa in phylogenetic analyses regarding Crocodylia or Eusuchia as a whole. A new outgroup outside of Eusuchia would better polarize character state changes and clarify relationships at the base of Eusuchia, and further clarify ancestral states for Crocodylia.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Lizards lost, lizard found, lessons learned: Changes in a Central Texas lizard community over the last 16,000 years

Ledesma, David T., Kemp, Melissa

Integrative Biology, University of Texas at Austin, Austin, Texas, United States

Currently, rapid environmental changes induced by human activities are causing a loss of biodiversity and disruptions in the functionality of ecosystems. Long-term ecological studies, although scarce, are crucial for understanding principles guiding the responses of biota to environmental changes. The fossil record fills a crucial gap in our knowledge by serving as a natural archive of long-term ecological data, helping to disentangle the effects of environmental changes on biota and ecosystems. In this study, we used lizard fossils from a late Quaternary site in Central Texas, Hall’s Cave, to test the contributions of climatic and vegetation in driving lizard community change over the last 16,000 years. We employed an apomorphy-based fossil identification framework to reconstruct past lizard community composition and discovered substantial community changes related to past shifts in the vegetational landscape and climatic regime. Climate was the primary driver for changes in lizard community composition, but we also found strong relationships between lizard taxa and

reconstructed vegetational landscapes that are consistent with present-day observations. We performed a quantitative taphonomic analysis on microfossils from Hall's Cave for the first time and discovered evidence for multiple agents of fossil accumulation acting in Hall's Cave. This analysis revealed that taphonomic variables had minimal impact on community reconstruction, reinforcing the role of climate and vegetation as the main factors shaping the lizard community. Additionally, we observed a shift in the body size distribution of the lizard community at the end of the Pleistocene, mirroring body size changes in the mammalian community and suggesting a broader shift in ecosystem dynamics during that time. Cross-validation predictive modeling of the lizard community composition from Hall's Cave at the family level showed promising accuracy, and we postulate that models trained at lower taxonomic levels could achieve even greater accuracy. Lizard community responses to environmental change, as revealed by the Hall's Cave fossil record, align with modern long-term observations, demonstrating the fossil record's reliability in documenting long-term ecological trends. Our results provide valuable insights into how lizard communities respond to environmental shifts, offering conservation managers useful information for predicting the impacts of landscape changes on local biodiversity.

Funding Sources Funding for this work came from the University of Texas Planet Texas 2050 Bridging Barriers initiative and the University of Texas Stengl-Wyer graduate fellowship.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Bite marks on a small dromaeosaurid:
intraspecific aggression?**

Lee, Sungjin, Lee, Yuong-Nam, Park, Jin-Young, Kim, Su-Hwan

School of Earth and Environmental Sciences,
Seoul National University, Seoul, Korea (the
Republic of)

Bite marks found in non-avian dinosaur fossils are valuable sources of understanding their behaviors and biology. Usually, bite marks are considered to be associated with predation or scavenging but have been regarded as evidence of intraspecific aggression in rarer cases. However, bite marks possibly related to intraspecific aggression have been restricted to large-bodied theropods such as tyrannosaurids. As display rather than physical aggression is dominant in extant birds, the latter might be plesiomorphic, although when the former evolved is a mystery. Here, we report bite marks on the holotype (MPC-D 102/114) of a duck-sized dromaeosaurid, *Natovenator polydontus*. This specimen bears a row of very small (less than 1 mm in diameter) bite marks (five on the left and four on the right) on the dorsal surface of each nasal near the maxilla-nasal contact. They are considered bite marks based on cracks around some of them and damaged bones along the rows. All the bite marks do not show any sign of healing. In addition, the degree of distortion of the skull further indicates the bite was potentially fatal. The bite marks are circular in shape without any denticle marks and vary slightly in size and spacing. Therefore, these bite marks are likely caused by a quick, single bite without any scratch, often observed in feeding-related bite marks. In addition, the skeleton is well articulated, and there are no additional bite marks. Thus, they are unlikely to have been caused by scavenging or predation. Unfortunately, no teeth from the culprit were found together with the specimen. However, the sizes and spacing of the bite marks are within the range of mesiodistal widths and interdental space lengths of the posterior dentition of MPC-D 102/114. The slightly different sizes are also in line with the varying crown heights of its teeth. Based on these observations, it seems

that another individual *Natovenator* of similar size likely caused the bite marks on MPC-D 102/114 during intraspecific aggression. The absence of wounds on any postcranial elements is interesting, and this may suggest that intraspecific aggression in *Natovenator* primarily involved facial bites like large theropods and crocodylians but in contrast to extant birds, which rarely engage in violent intraspecific combats. It suggests that physical intraspecific aggression, a possible plesiomorphic behavior, could be retained in small-sized dromaeosaurids even with the development of pennaceous feathers.

Funding Sources The Basic Science Research Program through the National Research Foundation of Korea, funded by the Ministry of Education (grant number 2022R111A2060919) to Y.-N.L.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Stomach contents of a juvenile *Tarbosaurus* (Dinosauria: Tyrannosaurinae)

Lee, Yuong-Nam¹, Kim, Taehyun^{3,2}, Lee, Yongjae³, Bevitt, Joseph⁴, Kobayashi, Yoshitsugu⁵, Jacobs, Louis⁶, Barsbold, Rinchen⁷, Zelenitsky, Darla K.⁸, Paulina-Carabajal, Ariana⁹

¹School of Earth and Environmental Sciences, Seoul National University, Seoul, South Korea, Korea (the Republic of), ²Department of Earth Sciences, Yonsei University, Seoul, Korea (the Republic of), ³School of Earth and Space Exploration, Arizona State University, Tempe, Arizona, United States, ⁴Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation, Lucas Heights, New South Wales, Australia, ⁵Hokkaido University Museum, Hokkaido University, Sapporo, Japan, ⁶Roy M. Huffington Department of Earth Sciences, Southern Methodist University, Dallas, Texas, United

States, ⁷Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia, ⁸Department of Geoscience, University of Calgary, Calgary, Alberta, Canada, ⁹Instituto de Investigaciones en Biodiversidad y Medioambiente (INIBIOMA), CONICET-Universidad Nacional del Comahue, San Carlos de Bariloche, Río Negro, Argentina

The internal organs of non-avian dinosaurs are very rarely found. Here, we report a juvenile *Tarbosaurus* specimen (MPC-D 107/18) with an exceptionally well-preserved digestive tract containing stomach and intestine contents. It was found in situ inside the left gastralia as a tube-shaped structure, believed to be the gastrointestinal tract. It is divided into three distinct parts by the composition of contents and shape from front to back: proventriculus, ventriculus, and duodenum. The proventriculus contains remnants of its last meal, including isolated elements of *Avimimus* and fish identified through NCT imaging. The fish vertebrae are identical to *Harenaichthys lui*, abundantly found in the Nemegt Formation. All enameloid fish scales on the broken surface are acid-etched, indicating a stomach residency. The ventriculus is marked by an expanded middle region containing over 2,000 pebbles and rock fragments, surrounded by a thick muscular wall shown by NCT imaging. It appears to be an elongated sack connected with the pylorus at its base, which contains only a few pebbles. The proximal duodenum begins at the pyloric canal, expanding significantly right behind the pylorus. It appears as a bleached whitish aggregation (cololite), probably formed from the neutralization of acidic chyme by pyloric gland secretions. This mass contrasts with the surrounding reddish rock matrix and pebble-filled area in front. It consists of densely packed broken bones probably caused by pyloric pressure slowing the movement of large particles into the duodenum. These bones show a more

advanced stage of digestion than in the proventriculus. XRF analysis revealed a high chlorine concentration in this whitish mass, supporting the identification as fossilized acidic chyme. Bone elements within this mass include *Gallimimus* pedal unguals, thin broken bones (possibly skull elements), caudal vertebrae, and *Herenaichthys* vertebrae and spines. One flat bone exhibits radial cracks likely caused by a tooth puncture. Many unidentified materials, potentially muscle fibers, were also observed. FE-SEM analysis showed periosteal bone loss of *Gallimimus*' toe bones, consistent with digestive corrosion. The presence of small bone fragments and broken fish bones in the duodenum suggests that *Tarbosaurus* could puncture bones, with fragments created during biting and subsequent trituration in the gizzard. This finding provides direct evidence of the diet and digestive processes of *Tarbosaurus*.

Funding Sources National Research Foundation of Korea (NRF 2022R111A2060919, NRF 2019R1A6A1A10073437)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The inland cetaceans and other marine mammals of east Texas

Leidy, Brennen¹, Godwin, William¹, Lewis, Patrick J.²

¹Sam Houston State University, New Braunfels, Texas, United States, ²Biological Sciences, Sam Houston State University, Conroe, Texas, United States

As the shoreline was much further inland than the Gulf Coast is presently, most of east Texas was submerged and inhabited by a variety of marine mammals, including cetaceans and sirenians, from the Eocene through the Miocene. The associated

depositional environment and the fauna within were extensively documented by Dr. H. B. Stenzel, beginning in 1929, as vertebrae were found by a rancher in Burleson County protruding from the lower Claiborne Formation. These vertebrae were initially identified as that of the archaeocete *Zeuglodon*, or *Basilosaurus*, as in modern literature, and in 1934, less than 100 miles to the northeast of this locality, Stenzel found the vertebra of another archaeocete, *Protocetus*, as identified by Dr. R. Kellogg, in Two Mile Creek, Leon County. Both localities were the lower Yegua formation of middle Eocene age. Additionally, Dr. C. Hesse found teeth of the sea-cow *Desmostylus* from the Miocene of Burkeville, Newton County in the 1930s. Stenzel studied and described the fauna through 1941, however, an exhaustive record of these marine mammals was not achieved due to several factors. The taxonomic status of most specimens proved problematic, as with the *Zeuglodon* material from the Burleson County locality. Further analyses exhibited the presence of both cetacean and sirenian vertebrae in association within this single locality, and additionally, the size of the sirenian vertebrae was uncharacteristic of Eocene species, suggesting that this material may be of Miocene age. Positive identification was increasingly difficult due to intense weathering, as with *Protocetus* from the Leon County locality, and the apparent rarity of these fauna was also documented, as historically, further field work at each described locality has not produced new material. As presented, this project is carried out with the intent to consider existing archives and collections, including the Newton County Historical Center and the University of Texas Vertebrate Paleontology Collections, describe relevant specimens, and ideally collect further material. As of May 2024, a large vertebra was located in the Newton County Museum. Documentation indicated the locality as Yellow Bayou, near Burkeville, where *Desmostylus* material was

recovered. Although identified as a cetacean by Stephen F. Austin State University, no further identification has been given.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Unexpected discoveries: Postcranial elements and burrows within the skull of *Stanocephalosaurus amenasensis* (Amphibia, Temnospondyli), from the Lower-Middle Triassic of Algeria

Lemierre, Alfred, Logghe, Antoine, Arbez, Thomas

CR2P, MNHN/Sorbonne Université/CNRS-UMR7207, Juvisy-sur-Orge, France

The mastodonsauroid temnospondyl *Stanocephalosaurus amenasensis* was described almost a decade ago from the Lower-Middle Triassic of Algeria, based on two well-preserved skulls from a mass-death assemblage. The shape of the skulls and their internal features suggested that this taxon spent most of its life underwater. Unfortunately, until now, no postcranial elements were described to support this lifestyle hypothesis. The tomography of one of the previously described skulls allowed for an unexpected discovery with postcranial elements preserved within the cranial cavity. In total, 25 postcranial bones were identified within the skull, representing part of the left hindlimb and posterior region of the vertebral column of another single *Stanocephalosaurus* specimen. The small size of the tibia and fibula suggest that *Stanocephalosaurus amenasensis* indeed had an aquatic paleoecology. Moreover, the presence of fused hemal arches on the posterior caudal intercentra suggests that the tail was lateromedially compressed on its whole length. This would indicate that *S. amenasensis* hunted by ambush, a predation method also supported by its dorsally located orbit and flattened skull. In addition, an

ichnostructure has also been recovered within the skull. This structure resembles crayfish burrows assigned to *Thalassinoides*, suggesting that the site was filled with freshwater after the mass death of *Stanocephalosaurus*.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Comparison of the cephalic lateral line system across tetrapodomorphs from Red Hill, Nevada

Leong, Derrick M., Liu, Juan

Department of Integrative Biology & University of California, Museum of Paleontology, University of California, Berkeley, Berkeley, California, United States

The Red Hill, Nevada locality, Middle Devonian (Givetian) in age, represents a marine, open continental shelf environment yielding a range of sarcopterygian specimens, notably tristichopterid and osteolepid. While most collected materials are fragmentary, computed tomography enables the imaging of bone-enclosed cephalic lateral line, a mechanosensory system enabling fish and some aquatic vertebrates to detect hydrodynamic stimuli in their environment. We seek to identify the characteristics of the lateral line system when the hydrodynamics are consistent across all taxa; therefore, we examined the lateral line system of tetrapodomorph taxa from the same locality, *Tinirau clackae*, *Latvius* sp., and *Osteolepis* sp. from Red Hill, Nevada. These specimens, likely from similarly sized juvenile individuals, preserve with both lateral line canals and tubules. Observations of various canal segments (supraorbital, otic, post-otic) reveal comparable pathways passing through similar skull elements. However, the otic and post-otic canals within the postparietal shield of *Latvius* sp. and *Osteolepis* sp. are slightly more curved than that in *T. clackae*.

Latvius sp. And *Osteolepis* sp., both members of Osteolepidae, share similarly shaped postparietal shields with a narrow supratemporal and broad postparietal region, which may dictate the pathway of the canal. This implies that phylogenetic history may influence canal morphology, due to layout or shape of the associated bony elements. Tubules are minute projections extending off of canals that interface with the environment, directing fluid flow. All three taxa display short, individual primary tubules extending directly from the canal, consistently observed across the otic, mandibular, supraorbital canals. The consistency of the tubule branching pattern across distantly related taxa from the same locality suggests that it may reflect environmental factors. In conclusion, Red Hill, Nevada produced a range of tetrapodomorph taxa that possessed comparable lateral lines, particularly in tubules morphology, to interpret their surrounding environment. We hypothesize that the short and minimally bifurcated tubule pattern of tetrapodomorphs is associated with an open, continental shelf environment. Subsequent work intends to broaden this comparative dataset by incorporating more tetrapodomorph taxa from different localities, allowing us to determine whether the observed trends are consistent across the broader group.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Rethinking the paleontology virtual fieldtrip with AI and metaverse technologies

Levering, David, Wilson, Laura E., Schmelmer, Kilian, Coelho, Pedro, Finnegan, Terence

Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas, United States

Over the past decade, online education opportunities through formal and informal education organizations have exploded in popularity. We saw such offerings truly take off during the COVID19 pandemic. While we are no longer in lockdowns, accessibility to robust, dynamic learning experiences via online pathways is still a hot topic and in high demand. Virtual learning resources broaden accessibility to content, and offers new opportunities for students and educators to connect. Despite this, earth and life science education has remained fraught with physical and financial accessibility challenges. With this project, we have developed a multifaceted approach to addressing these ongoing issues in earth and life science education through a scaffolded immersive interactive virtual-world course, bolstered by an in-world custom-trained AI chat-bot learning assistant.

In this course, students moved through six interactive virtual-world modules built in the metaverse platform GatherTown, with course content focused on climate change in the Arctic from the Cretaceous to modern day. By moving through modern, Late Cretaceous, K-Pg boundary, Eocene, and then back to modern time periods, students take a comprehensive look at the evidence for and study of climate change. Assessment of student response to the course was three-fold: 1) Observations from student conversations about the course content and interface during course assignments; 2) Formal assessment of the course via standard course evaluations and IRB-approved student survey; 3) Student course-content activity tracking via background software. Our findings indicate that students have predominantly positive opinions of the interactive virtual world setting, and more universally positive opinions on the utility of the AI chat-bot learning assistant. Data-capture on the AI chat-bot use indicates it saved over eight hours of instructor time with well over 1,000 student queries submitted,

leaving more time for higher-quality engagement by the instructor. The authors observed excellent student conversational understanding of course academic content at the close of the course via discussion assignments conducted on Blackboard. Our results emphasize the potential of using game-like digital spaces and content-trained AI chatbots to facilitate student learning in a way comparable to a traditional, face-to-face fieldtrip.

Funding Sources \$5,000 USD - Fort Hays State University President's Innovation and Entrepreneurship Grant.
\$3,000 USD - Sternberg Science Camps net revenues from 2023 operations.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Make it a federal case! Comments on making federal fossil criminal cases, with a summary of pre- and post-Paleontology Resource Preservation Act (PRPA) prosecutions

Liggett, Gregory A.¹, Schumacher, Bruce²

¹Bureau of Land Management, Billings, Montana, United States, ²USDS Forest Service, Lakewood, Colorado, United States

Developing federal criminal cases concerning fossil crime is difficult. Crimes must be recognized, suspects identified, and evidence compiled. The vastness of federally managed land makes patrolling for criminal activity hit-and-miss. Many federal parcels are land-locked within private land, and agency officials cannot always get permission to cross private land to visit them.

Identification of a potential crime leads to investigation, which may involve a range of law enforcement tools, including interviews, search warrants, and undercover work. In the United States, after the case is put together,

federal agents present it to U.S. Attorneys for potential prosecution. U.S. Attorneys prefer to take only cases that are most likely to be successfully prosecuted. More recently, with examples of successful prosecution and reports of high market prices for dinosaur fossils, U.S. Attorneys are becoming more comfortable with taking on fossil resource cases for prosecution.

Whether a case is pursued as a felony or a misdemeanor in the federal system depends entirely upon the length of potential prison sentence (one year or less = misdemeanor). As written, PRPA's prison sentences are a maximum of either 2 or 5 years. Thus, PRPA cases can only be pursued as felonies, even if this is an unintended consequence of how the law was written. Due to the lack of a misdemeanor charge, prosecution under PRPA is made more difficult. This is unfortunate, because strengthening penalties was among the reasons PRPA was enacted. Amending PRPA to provide a misdemeanor penalty authority would improve its law enforcement utility.

The history of federal fossil cases goes back to 1974, when charges were brought under the Antiquities Act of 1906, although the case was eventually dismissed. Noteworthy cases include the sale of large theropod dinosaurs, like *Tyrannosaurus rex*, and many lesser-known cases; some of these will be discussed. Penalties for conviction have generally included probation, restitution, fines, and prison time. The more severe penalties have come after passage of PRPA in 2009.

PRPA was first cited in a criminal investigation soon after its passage. The first PRPA conviction was in 2010 in Utah. One recent case resulted in a \$100,000 fine. The most recent conviction involved BLM land in Alaska and resulted in prison time of 33 months. In 2023, 4 people were indicted for stealing and selling \$1 million worth of fossils from BLM land in Utah in the largest PRPA case to date.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Crocodiles of Pierced Rock: a rediscovered mid-late Paleocene fossil site in south-east Saskatchewan, Canada

Lindblad, Kaitlin¹, Bamforth, Emily^{2,1}, Mangano, Maria G.¹

¹Geological Sciences, University of Saskatchewan, Regina, Saskatchewan, Canada, ²Philip J. Currie Dinosaur Museum, Wembley, Alberta, Canada

The Souris River Valley and Short Creek tributary in the south-east corner of Saskatchewan, Canada, host rich fossil assemblages of mammals, fish, and reptiles of mid-late Paleocene age (Upper Ravenscrag Formation, Tiffanian NALMA (Ti4) biochron, ~ 59 Ma), equated to the upper Tongue River (Bullion Creek) Formation of Montana and North Dakota. During the summer of 2023, a noteworthy fossiliferous outcrop located east of the town of Roche Percee and originally collected in 1918 by the National Museum of Canada (now Canadian Museum of Nature) was rediscovered. Over a century later, it still produces fossils of crocodyliforms, champsosaurs, and freshwater molluscs. This site is the focus of an ongoing comprehensive study and excavation to uncover its depositional history, taphonomy, and fossil content. Abundant calcareous marlstone and clay of the area record deposition in lacustrine systems, whereas some of the prominent sandstone outcroppings that form the eponymous 'pierced rocks' of the valley likely represent episodes of lower accommodation with low sinuosity rivers.

The new crocodyliform fossils are of special interest, representing the first major site of these reptiles from the Tiffanian beds of the Ravenscrag Formation thus far. The partial

dorsal osteoderms strikingly resemble those of the long-lived genus *Borealosuchus*, being relatively large and having no keels. A jugal fragment bears an enlarged medial jugal foramen, that is also noted to be present in the mid-late Paleocene species *B. formidibilis*. If verified, this would represent the first documented occurrence of this crocodyliform taxon outside of the Wannagan Creek Quarry in western North Dakota.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Utilizing workflows to prioritize and rehouse unstable fossils for long-term storage

Link, Kale, Cope, Carson R., Landwehr, Alex, Black, Paige, Rivera-Molina, Israel J., Wilson, Laura E.

Geosciences, Fort Hays State University, Williamsburg, Kansas, United States

In 2022, Fort Hays State University's Sternberg Museum of Natural History (FHSM) was awarded a three-year IMLS grant to address the long-term preservation of a Late Miocene mammal collection. These fossils come from an Ogallala Formation locality known as the Minium Quarry. This project builds on paleontology collection improvement initiatives that started in 2016 to institute a relational database and advance digitization and data-sharing efforts by the Sternberg Museum. However, some important aspects of the project are novel and have required new protocols. Specifically, many of the fossils from the Minium Quarry were poorly consolidated, which left them prone to significant (and rapid) degradation over time. This has been accelerated by improper storage of uncured specimens and over-crowding of curated specimens in cabinet drawers.

To address these issues, Year 2 activities of our IMLS grant focused on fossil stabilization. Stabilization efforts include sediment removal, applying consolidants, fabricating cavity mounts, and/or building cradles. To organize our stabilization efforts, we developed a new assessment workflow consisting of two evaluation tools. First, each fossil in the Minium Quarry collection was assessed for whether the fossil was high risk or low risk for permanent damage based on criteria such as breakage, stability, and adequacy of housing. After categorization, fossils were evaluated for whether archival cradles, cavity mounts, or archival boxes were needed for long-term stabilization. Housing criteria included specimen size, stability, and curvature. With these newly developed workflows, we are in a better position to coordinate our team and address stabilization in our collections in the future.

Funding Sources Funding for this project was received from Institute of Museum and Library Services Museums for America grant number MA-251778-OMS-22.

Colbert Prize Session

First 3D reconstruction of the endocranium of the Miocene strepsirrhine primate *Mioeuoticus shipmani* from Kenya

Lis, Adam J.¹, López-Torres, Sergi¹, Anderson, Holly E.¹, Silcox, Mary T.², Lang, Madlen², Zalewski, Jakub¹

¹Department of Biology, University of Warsaw, Gdynia, Poland, ²Department of Anthropology, University of Toronto, Toronto, Ontario, Canada

Mioeuoticus shipmani is an extinct primate of the family Lorisidae, the group that includes modern lorises and pottos. This species comes from the early Miocene of Kenya and has been argued to be a stem lorisid. *Mioeuoticus shipmani* is known only from its

holotype (KNM-RU 2052), represented by a relatively complete partial cranium. We present the first virtual cranial endocast of a fossil lorisid and perform comparative analyses with extant lorisoids (i.e., lorises and galagos). The segmented endocranial space resembles today's Galagidae despite the fossil being ascribed to its sister family, Lorisidae. Such shared features include the relative size and overall shape of the olfactory bulb and the neocortex, as well as an encephalization quotient (0.74-0.82) overlapping with the bottom range of galagids. *Mioeuoticus* differs from its extant Asian relatives of the subfamily Lorisinae, specifically in having a significantly smaller neocortex, and an especially reduced prefrontal cortex. Additionally, the olfactory bulb volume ratio and the encephalization quotient of *Mioeuoticus* do not overlap with the respective ratios in lorises. This suggests that the galagid brain might have retained plesiomorphic features (similar to *Mioeuoticus*), whereas the brain of modern lorisids may have acquired derived endocranial traits. Despite the apparent similarities between the endocasts of the primitive lorisid, *Mioeuoticus*, and galagos, members of Galagidae have relatively larger petrosal lobules than *Mioeuoticus*; the relative size of these structures in *Mioeuoticus* is more consistent with the small petrosal lobules typical of modern lorises. However, *Mioeuoticus* stands out for having even smaller petrosal lobules than extant lorisids, which suggests even less capacity for visual tracking of moving insects. Our study reveals critical aspects of brain evolution in Lorisidae to fill an important gap in their poorly known evolutionary history.

Funding Sources Funded by W. V. Scott Grant to HEA, NSERC CGS to MML, NSERC Discovery Grant to MTS, and National Science Center (Cracow, Poland) grant (no. 2022/45/B/NZ8/03585) to SLT.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Middle and inner ear anatomy of the 32 Myo
canid *Mesocyon* including the oldest
known carnivoran ear ossicles**

Littleton, Aidan¹, Drumheller, Stephanie K.¹,
Boyd, Clint A.²

¹Earth, Environmental, and Planetary
Sciences, University of Tennessee, Knoxville,
Knoxville, Tennessee, United
States, ²Paleontological Resource Protection,
North Dakota Geological Survey, Bismarck,
North Dakota, United States

Mammals have a unique hearing anatomy among vertebrates, possessing three auditory ossicles present in each ear as opposed to the ancestral condition of a single ear ossicle (i.e. stapes). These ear ossicles vary in size and shape, affecting the range of sounds audible to different mammalian groups, so investigations of these elements can provide key insights into the biology of extinct animals. Unfortunately, they are also exceedingly small and delicate, so they are rarely recovered in fossils. An unusually well-preserved specimen of early-diverging canid *Mesocyon temnodon* was recovered from the Oligocene Brule Formation of Stark County, North Dakota, providing the opportunity to study the ear anatomy of early canids. Its skull was subjected to computed tomographic (CT) scanning to reveal details of the teeth (to confirm taxonomic identity), middle ear, inner ear, and brain cavity. Sectioning of these scans in the program Dragonfly revealed the oldest known ear ossicles for any carnivoran in addition to well-preserved semi-circular canals and cochlea. This species has been interpreted as one of the earliest canids to exhibit a primarily carnivorous diet and a cursorial, rather than semi-arboreal, lifestyle. Observations of the ear ossicles reveal broad similarities with modern canids (e.g. wolves) and recently extinct canid species, suggesting a near-

modern range of hearing in this species, and the structure of the semi-circular canals supports prior interpretations of a more cursorial lifestyle. Measurements of the semicircular canals roughly align with those of the genus *Canis* and have a maximum deviation of only ~3mm; the anterior semicircular length 11.17mm, posterior semicircular length is 10.54mm, and lateral semicircular length is 7.68mm. Larger semi-circular radii are thought to be associated with greater capabilities in agility, contrasted to smaller radii of slower-moving species. Additionally, aspect ratios between height and width of the semicircular canals (anterior, 1; posterior, 0.9; lateral, 1.03) are comparable between *Mesocyon* and *Canis*. The length of the cochlear canal is measured at 20.6mm, noticeably longer than those obtained from *Canis*; however, the aspect ratio between the height and width of the cochlea of *Mesocyon* is 0.59, similar to *Canis*. These findings suggest that early canids possessed hearing and locomotor capabilities on par with modern canids as far back as the early Whitneyan North American Land Mammal Age (~32 mya).

Funding Sources This research was funded by the Univ. of TN Department of Earth, Environmental, and Planetary Sciences, the Division of Student Success, and the State of North Dakota.

Technical Session 10: Fishes (Thursday,
October 31, 2024, 1:45 PM)

**Revision of a Paleocene catfish from
Sanshui Basin, South China**

Liu, Juan^{1,2}, Zhang, Jiang-yong³

¹Integrative Biology, University of California,
Berkeley, Berkeley, California, United
States, ²University of California Museum of
Paleontology, University of California,
Berkeley, BERKELEY, California, United
States, ³Institute of Vertebrate Paleontology

and Paleoanthropology, Chinese Academy of Sciences, Beijing, Beijing, China

Paleocene-Eocene catfish from East Asia were previously assigned to the extant family Bagridae (Siluriformes), leading to a long-standing ghost lineage. Furthermore, two nominal species, *Mystus dalangshanensis* and *Mystus spinipectoralis* (Wang et al 1981), from the Paleocene Buxin Formation in Sanshui Basin, south China represent a 30 Ma gap from the estimated mitogenomic divergence time for *Mystus*. These discrepancies suggest either problematic taxonomic assignment, and/or a 'morphology vs. molecules' conflict exacerbated by an incomplete fossil record. Based on our analyses of new materials from recent fieldwork, we propose a substantial revision of Paleocene Sanshui catfish by removing them from the suborder Siluroidei, and by extension, Bagridae, based on key new observations. First, the principal caudal fin rays of Sanshui specimens are 18 (i,8,8,i), which is a basal character absent in extant catfish (i,7,8,i) except Diplomystidae. The Paleogene †Hypsidoridae and †Astephidae also have 17. Second, the coronoid process of the dentary is elevated and prominent. This condition is seen only in †Hypsidoridae. The moderately developed coronoid process is present in diplomystids and some bagrids, but not in the rest of the siluriforms. Third, interdigitation is absent at the suture of ceratohyal and epihyal, a known synapomorphy of Siluroidei. All these characteristics indicate Sanshui catfish belong to a basal lineage of catfish and suggest early morphological diversification hidden by previous taxonomic assignment. These new findings offer clarification critical to untangling puzzling aspects of the evolutionary history of catfish and highlights the importance of systematic review and revision as evidence of divergence times.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

New vertebrate body and trace fossils from the Upper Cretaceous (Campanian) Neslen Formation, Utah, USA

Lively, Joshua R.¹, Toscanini, Marcello²

¹Prehistoric Museum, Utah State University Eastern, Price, Utah, United States, ²Western Slope Paleontological Services, Grand Junction, Colorado, United States

North America's Western Interior preserves numerous penecontemporaneous vertebrate-bearing fossil assemblages from the Campanian stage of the Upper Cretaceous. These have served as a study system for understanding paleobiogeography and evolutionary patterns, providing data supporting some level of provinciality and endemism in certain clades. We present new contributions to the vertebrate body and trace fossil assemblage from the Campanian (~75 Ma) Neslen Formation of east-central Utah. The Neslen Fm represents deposition in fluvial and paralic settings along the Laramidian margin of the Western Interior Seaway. Compared to other Campanian formations, the Neslen Fm has not been rigorously surveyed for its paleontological resources. Thus far, only two vertebrates – the hadrosaur *Rhinorex* and a partial tyrannosaur hindlimb – are published from the formation.

Three field seasons in the Neslen Fm have produced over 150 new cataloged specimens of plants, invertebrates, and vertebrates, along with numerous localities preserving vertebrate tracks. The lower portion of the formation is the most fossiliferous, especially the Palisades Coal Zone and overlying estuarine deposits. Though most of the vertebrate body fossils are isolated elements, many are diagnostic to the generic level. Turtles include *Adocus*, *Basilemys*, c.f. *Neurankylus*, a plastronine (c.f. *Hutchemys*), and two other trionychids. Additionally, we recognized the ichnogenera

Emydhipus and *Chelonipus*, both hypothesized to represent turtle trace makers. At least two morphotypes of crocodyliform teeth were discovered, in addition to large tracks that may be attributable to the group. New dinosaur remains are represented by dromaeosaur and tyrannosaur teeth, and elements from hadrosaurs, ankylosaurs, and ceratopsians. One ceratopsian specimen is a postorbital horn that exhibits a morphology unique amongst known ceratopsians.

Results from body fossils support the presence of components from both the hypothesized northern and southern Campanian biogeographic provinces, indicating either a latitudinal gradient or zone of mixing between two provinces. Plastomenines, including the genus *Hutchemys*, are more common to the south (southern UT and NM). The published tyrannosaur from the formation possesses features that may be similar to northern (MT and AB) tyrannosaurs. Continued work on the Neslen Fm will further elucidate the nature of paleobiogeographic patterns and paleoecology across Laramidia.

Funding Sources Prehistoric Museum
Utah State University

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

FEBio: Free Finite Element Analysis software for biomechanical analysis tested using megatheropods analysis replications and multi-step analysis of the puncture-pull feeding strategy of *Tyrannosaurus rex*

Lopez-Vaca, Alejandro^{1,2}, Johnson-Ransom, Evan D.³, Snively, Eric⁴

¹Department of Natural Sciences, University of California, Merced, Merced, California, United States, ²Department of Mechanical Engineering, University of California, Merced,

Merced, California, United States, ³Department of Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ⁴Department of Anatomy and Cell Biology, Oklahoma State University-College of Osteopathic Medicine at the Cherokee Nation, Tahlequah, Oklahoma, United States

Finite Element Analysis (FEA) is an engineering simulation tool that is used to recreate stresses and strains in objects under specific forces, conditions, and constraints induced by the functions and actions of an object. These capabilities have driven rapid adoption of FEA in paleontology, to test hypotheses of morphological, anatomical, and behavioral functions of structures within organisms at the species and evolutionary level. Despite this, the software cost and perceived complexity of FEA have been barriers to its wider use.

Here we introduce the free, user-friendly, and sophisticated finite element software Finite Elements for Biomechanics (FEBio). FEBio is a finite element code specifically made for 3D biomechanics, and uniquely includes a multitude of customizable biomaterial properties of both hard and soft tissue. Performance of this software is analyzed by replication of past studies of megatheropods *Tyrannosaurus rex* and *Spinosaurus aegyptiacus*, and comparing the results to the original study in its respective software package. FEBio also includes a feature for testing the multi-functional capabilities of organic structures: multi-step analysis. A hypothesis is tested using this method by determining whether the skull of *T. rex* could withstand the muscle forces induced by a puncture-pull feeding strategy, where step one is the biting/puncture action and step two is the pulling action by the neck.

Results of the two megatheropods indicate very comparable results to industry standard FE software (i.e. Strand7 and COMSOL), when set at 20 megapascals. The *Spinosaurus*

models for Strand7 and FEBio consistently show high stress distributions in the nasals, and areas of the crania that serve as muscle attachment sites. The *Tyrannosaurus* models for Strand7 and FEBio consistently show high palatal stress and relatively lower stress distribution than the *Spinosaurus* models.

Funding Sources Learning Aligned Employment Program at the University of California, Merced

Colbert Prize Session

Investigating changes in North American mammal species ranges by ecological group since the Last Glacial Maximum

Loughlin, Nora E.¹, Birlenbach, David M.^{2,1}, Fox, David L.¹

¹Department of Earth and Environmental Sciences, University of Minnesota Twin Cities, Minneapolis, Minnesota, United States, ²Department of Geology, University of Puget Sound, Tacoma, Washington, United States

Since the Last Glacial Maximum, mammal species have undergone significant changes in their geographic ranges in response to warming climates. We compared changes in the size of mammal species ranges across ecological groups in order to examine how ecological traits impact a species' response to climate change. Our data consist of the latitude and longitude locations, and age estimates for approximately 30,000 fossil terrestrial mammal specimens recorded in the Neotoma Paleoecology Database from the U.S. and Canada over the past 40 kyr. We assigned the occurrences into 2 kyr time intervals, and grouped extant species based on three categorical ecological variables: six body size classes based on $\log_{10}(\text{mass in grams})$, eight dietary categories, and seven locomotor modes. For each time interval, we calculated species range sizes (area in

meters²) by constructing a convex hull around species occurrences and removing areas that did not overlap with landmasses. The median range size was recorded for each ecological group, as well as for all species, in each time interval. From 40 to 20 kya, species range sizes are generally consistent across ecological groups. However, between 20 and 14 kya, species range sizes begin to increase from one time interval to the next, roughly coinciding with global warming at the end of the Pleistocene. This trend continues to the present day, but is expressed variably both between and within ecological groups. In particular, the median carnivorous species range size increases at a higher rate than that of other dietary categories. Furthermore, there appears to be a body size threshold in the expansion of ranges, with the median ranges of species less than 1 kg expanding at lower rates than the median rate for all mammals, and median ranges of species larger than 1 kg expanding at much higher rates than all mammals. There is also variation in rate of expansion within ecological groups, indicating complex patterns in species range shifts during a period of global warming. These results have implications for understanding modern North American mammalian biogeography, as well as predicting responses to modern climate change.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Late Triassic (Carnian) lower Popo Agie Formation, part I: faunal notes on the lower carbonate unit

Lovelace, David M.^{1,5}, Woznick, Hawke¹, Hotchner, Anthony², Fitch, Adam J.¹, Miller, Hannah R.⁴, So, Calvin³, Kufner, Aaron M.^{1,5}

¹Geology Museum, UW-Madison, Madison, Wisconsin, United States, ²Department of Geosciences, UW-Madison, Madison, Wisconsin, United States, ³Des Moines, Iowa,

United States, ⁴School of Design, University of Kentucky, Lexington, Kentucky, United States, ⁵Department of Biological Sciences, George Washington University, Washington D.C., District of Columbia, United States

Terrestrial strata of Carnian age (237-227 Ma) are exceedingly rare in North America, limiting our understanding of early Late Triassic ecosystems. An age-depth model constrained by overlying stacked CA-ID-TIMS ages within the ochre unit of the upper Popo Agie Formation (ca. 229 Ma = maximum depositional age for purple/ochre unit contact) and underlying earliest Middle Triassic Alcova Limestone (ca. 248 Ma), is used to predict the depositional age of the base of the Popo Agie (ca. 232-231 Ma) and portions of the Jelm Formation under multiple scenarios (e.g., the presence of hiatal surfaces between the Alcova/Jelm and Jelm/Popo Agie).

Although the Jelm Formation (aka: Crow Mountain Fm; 'unnamed red beds') has historically been considered devoid of body fossils, our fieldwork has yielded a laticopid-rich horizon near the top of the Jelm, and several occurrences of vertebrate traces that include a mammaliaform cf. *Dicynodontipus*, two synapsid-like burrows, numerous *Rhynchosauroides* and a single occurrence of *Atreipus*. Additionally, recent work in the Late Triassic lower Popo Agie Formation of central Wyoming has led to the recognition of a relatively diverse vertebrate assemblage from the lower carbonate unit, the basalmost member of the formation. The lower carbonate unit is characterized by the presence of pedogenic carbonate-clast dominated microconglomerate beds below the vertic paleosols of the overlying purple unit. Together these two units comprise the lower Popo Agie Formation and, relative to the upper Popo Agie Formation, were also historically considered to be depauperate. Physical outcrops of the lower carbonate unit have been walked out from near Thermopolis, WY to exposures south of the Bighorn

Mountains along what is locally known as the Red Wall. Here we present our findings from several productive localities in finer-grained intervals bound by higher-energy microconglomerate beds of the lower carbonate unit along the Red Wall, and near Alcova, WY. Taxa include: Loricata (*Heptasuchus clarki*), Dipnoi, Rhynchosauria (*Beesiiwo coowuse*), Poposauridae, a partial osteoderm with an anterior bar (?aetosaur or ?doswelliid), and a non-sulcimentosaurian silesaurid. The current faunal composition of the lowermost Popo Agie Formation is similar to other mid-late Carnian localities globally demonstrating a more cosmopolitan distribution of these clades into the early Late Triassic than previously recognized.

Funding Sources David B. Jones Foundation, Friends of the Geology Museum, Sherry Lesar Fund for Geological Wonder.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Reproduction of a fossil rhinoceros from 18 mya and origin of litter size in perissodactyls

Lu, Xiaokang¹, Tao, Deng²

¹Henan University of Chinese Medicine, Zhengzhou, Henan, China, ²institute of paleontology and paleoanthropology, Chinese academy of science, Beijing, China

Reproductive strategy is among the most important characteristics of an organism. Here, we report on the reproductive strategy of singleton pregnancy in a fossil rhinoceros, *Plesiaceratherium gracile*, 18 mya from the Shanwang Basin, China. Dental and body development data reveal that after birth, the calf of *P. gracile* was breastfed for 2–3 years; at approximately 5 years of age, when the M2 tooth is slightly worn, the female had already reached sexual maturity and attained a size

close to that of an adult and could give birth to its first calf. Furthermore, given that litter size is phylogenetically conservative and closely correlates with body size, we conclude that the litter size of perissodactyls is determined by singleton pregnancy since the Eocene. In contrast, other reproductive traits are highly variable and have a different pace of evolution. Traits observed in living rhinoceroses have been evolving since at least since 18 mya.

Funding Sources This research was supported by National Natural Science Foundation of China (42172001).

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Managing mammoths and Ice Age collections expansion

Lubbers, Kelly

The Mammoth Site of Hot Springs, SD, Hot Springs, South Dakota, United States

The Mammoth Site of Hot Springs, SD was discovered fifty years ago during construction excavation for a housing development. Today, the Mammoth Site is an in-situ museum housing the remnants of a sinkhole which entrapped over sixty mammoths and other organisms over a period of approximately 125,000 years. Although the core collection of the Mammoth Site includes in-situ specimens and those removed from the sinkhole, the collections have expanded dramatically over the last decade to include material from other Pleistocene localities and a comparative osteology collection. Specimen data was previously recorded through physical catalog cards and digital flat files (i.e. Excel spreadsheets). With collections growth we determined a need for more space and organized data management, including the use of a relational database, or collections management system

(CMS). I compiled information from CMS companies, reached out to collections personnel from a variety of institutions to take heed of their personal experiences with different CMS systems, and gauged these factors against the needs of the Mammoth Site to determine the CMS that would be a best fit. Ultimately, the Mammoth Site selected EMu, a CMS tailored for natural history collections with the capacity to adapt to our rapidly growing collections needs. Factors institutions should consider when selecting or switching to a new CMS include the types of data stored and supported within the CMS, recognizing who, why and how personnel are utilizing and accessing the CMS, technological infrastructure (hardware and storage requirements), costs (upfront, recurring), and growth and flexibility potential for changing collections needs.

Funding Sources This work was funded by The Mammoth Site of Hot Springs, SD.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Conducting learning assessments in an informal education setting to improve pedagogy and learning outcomes

Lukowski, Stephanie M.¹, Greer, Kania², Thaler, Mary²

¹Education Department, New Mexico Museum of Natural History and Science, Albuquerque, New Mexico, United States, ²Institute for Interdisciplinary STEM Education, Georgia Southern University, Statesboro, Georgia, United States

Project Eaglet is an educational program run with the cooperation of the Kiwanis Club of Statesboro, Bulloch County Schools, and Georgia Southern University outreach units. Through this program, every 1st through 5th grade student in Bulloch County has the

opportunity to participate in engaging field trips that are aligned to the Georgia Standards of Excellence science standards for the appropriate grade level.

In 2023, we conducted assessments in order to ascertain whether the program's learning objectives for the 3rd grade fossil program at the Georgia Southern Museum were being met. This assessment consisted of identical pre- and post- field trip forms that consisted of four questions. The first three questions were multiple choice while the fourth prompt asked students to draw or write their answer. After the program had finished, three educators coded the qualitative data and tallied the responses for each question. Results from this assessment will be used to adjust the pedagogy with the hope of obtaining better results in subsequent years.

Overall results from the program assessment were positive. In the pre-assessment for the first question regarding the types of materials that can become a fossil, 69.36% of the total possible correct answers were chosen by the students with 39.79% of the total possible incorrect answers chosen. By the end of the program, 83.12% of the total possible correct answers were chosen and only 27.66% of the total possible incorrect answers. The pre-assessment for the second question, asking students how old fossils are, 26.32% of students chose the correct answer, whereas in the post-assessment, 70.32% of students chose the correct answer.

Part of the goal of our program is to help students understand that the word fossil is not synonymous with the word dinosaur. The third question, asking students to circle the dinosaur silhouettes, included two animals that are dinosaurs and four animals that are often confused with dinosaurs. In the pre-visit assessment, students chose 51.1% of the total possible correct answers and 55.35% of the total possible incorrect answers. During the post- visit assessment, students chose 59.31% of the total possible correct answers

and 32.39% of the total possible incorrect answers. While students still struggled with the concept of birds as dinosaurs in both the pre- and post- assessments, they performed better recognizing that not every extinct animal is a dinosaur after the post-assessment.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Renewed vertebrate fossil collection in the Aycross Formation, Hot Springs Co., WY

Lundeen, Ingrid K.^{2,3}, Kirk, Edward C.^{1,3}, Rodwell, Ben¹

¹Anthropology, Hunter College, CUNY, New York, New York, United States, ²Jackson School Museum of Earth History, University of Texas at Austin, Austin, Texas, United States, ³Department of Anthropology, University of Texas at Austin, Austin, Texas, United States

The Bighorn Basin of northwestern Wyoming is known for its remarkably complete stratigraphic sequence from the Early Eocene, best represented in the Willwood Formation. However, vertebrate fossils representing the Middle Eocene in the Bighorn Basin are more rare. The Aycross Fm. is an early Middle Eocene volcanoclastic sequence of siltstones and mudstones of variable thickness exposed on the southern and western margins of the Bighorn Basin, within the foothills of the Absaroka Range and Owl Creek Mountains. While only sparsely fossiliferous, these Aycross Fm. sites are of considerable interest because they are of younger depositional age than the more often studied Willwood Fm. Previous work in these peripheral, basin-margin sites have reported endemic anaptomorphine primates, suggesting these upland regions may have harbored taxa that decline in diversity in coeval basin-center deposits. Continued collection in the Aycross Fm. then holds the

potential to expand the temporal range of the well-described faunal sequence of the Eocene of the Bighorn Basin into the Middle Eocene and to investigate these regions as possible refugia for anaptomorphine primates. Renewed collection of fossils from the Aycross Fm. has been ongoing since 2018 and has recovered over 300 new identifiable specimens. The vertebrate assemblage of the Aycross Fm. contains multiple taxa that are characteristic of the Bridgerian NALMA, including *Paleosyops*, *Phenacodus*, *Homacodon*, *Orohippus*, *Microsyops*, *Helalestes*, *Notharctus*, and *Sinopa*. The relative molar size of the *Microsyops* and *Notharctus* specimens suggests an early to middle Bridgerian age, corroborating earlier studies of the Aycross Fm. While renewed collection has recovered characteristic Bridgerian omomyid primates like *Omomys* and *Washakius*, to date, only one anaptomorphine (cf. *Gazinius*) has been found, partly as a result of land ownership changes restricting access to a historically productive vertebrate fossil locality. Nevertheless, these findings highlight the potential for continued research in the Aycross Fm. to provide a window into the faunal communities that existed at the southern and western margins of the Bighorn Basin in the Middle Eocene.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Slow-fast continuum of molar eruption relative to replacement and eruption of antemolars In Mesozoic mammaliaforms

Luo, Zhe-Xi¹, Martin, Thomas²

¹Organismal Biology and Anatomy, The University of Chicago, Chicago, Illinois, United States, ²Section Paleontology, Bonn Institute of Organismic Biology, Universität Bonn, Bonn, Germany

Among extant therian species, eruption of molars can shift in timing and in sequence, relatively to the eruption of replacement incisors, canine and premolars in these diphyodont antemolars. Eutherian mammals with relatively fast dental development, would often show a faster molar growth in which some (or all) of the molars erupt earlier than the permanent teeth of some of the diphyodont premolars. An opposite pattern in other placentals with slower molar growth is that the last molars tend to delay their eruption until after the replacement of diphyodont premolars. The latter pattern is also present in most metatherians where the eruption of the ultimate molar occurs after the ultimate premolar replacement. These shifts in timing of the eruption of molars relative to replacement/eruption of premolars, also known as Schultz's Rule, are hypothesized to be related to fast-slow continuum of other life history traits, such as overall growth rates (although there are some exceptions). We offer a new observation that in the slow-fast continuum of dental and jaw growth, the slower and more prolonged molar growth is a plesiomorphic growth pattern of Mesozoic mammaliaforms ranging from the early-divergent morganucodontans and docodontans, to the more crownward clades of spalacotheroidans and dryolestoidans more closely related to eutherians and metatherians. We further identify four diagnostic traits of these slower-growing Mesozoic mammaliaforms: (1) they commonly have more molars (up to nine) than the four or three molars of metatherians, eutherians and their tribosphenidan relatives; (2) the supernumerary molars (m5 or more distal) erupt successively after the replacement is completed in the ultimate premolar locus; (3) successive eruption of posterior molars are in sync with prolonged posterior jaw growth; and (4) the anterior premolars tended to be lost in older individuals of taxa with supernumerary molars, creating a prominent postcanine diastema, which is also common in aging

individuals of cynodonts. Over the Mesozoic mammal phylogeny, the slow-fast continuum is homoplastic, but slower-growing taxa with supernumerary molars are more common among early-divergent mammaliaforms and stem therians, and uncommon in metatherians, eutherians, and their kin that have faster growth, as recently revealed from comparative cementochronology of molar roots among these Mesozoic mammals.

Funding Sources National Science Foundation USA; Deutsche Forschungsgemeinschaft (DFG)

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Teaching an old dog new tricks: The virtual goniometer as a novel tool for 3D molar segmentation and occlusal wear surface angle measurements

Luther, Risa L.¹, O'Neill, Riley C.²

¹Anthropology, University of Minnesota, Minneapolis, Minnesota, United States, ²Mathematics, University of Minnesota, Minneapolis, Minnesota, United States

Advancements in 3D scanning and modeling have revolutionized dental and dietary analyses, yet most studies have been necessarily restricted to whole-crown, largely unworn teeth, which not only limits the sample size, but limits the scope of most studies to a restricted period of the organism's life, growth, and development. Here we propose a novel quantitative method employing a Virtual Goniometer to measure occlusal wear angles, demonstrated on over 130 moderately to heavily worn mandibular second molars representing extant frugivores (*Bunopithecus hooock*, *Hylobates lar*, *Pan paniscus*, *Pan troglodytes*), folivores (*Gorilla gorilla*), and hard-object consumers (*Pongo pygmaeus*).

We utilize the Software for the Analysis and Mapping of Surfaces Hecate package to consistently align and subdivide molars into five patches, coinciding with the five cusps of the lower molars. We segment each patch using the virtual goniometer, which segments the occlusal surface from the side wall (i.e., corresponding buccal, lingual, mesial, distal surfaces) and gives a normal vector corresponding to the plane of best fit for each segment. We then measure three key quantities: the angle between the occlusal surface and side wall, the angle between the occlusal normal and x-y plane, and the angle between the upper occlusal normal and the x-axis to fully capture the orientation of the plane. The angle between the occlusal surface's plane of best fit normal and x-y plane is very similar to the average inclination of the occlusal surface segment (angle between the surface normal and the x-y plane). Preliminary results suggest the inclination measurement from the virtual goniometer is far more robust than the average inclination of points in the occlusal surface, which is more susceptible to variations in local point densities and the surface's parameterization.

Our findings highlight the importance of computer applications in paleontology, demonstrating the virtual goniometer's versatility across paleontological settings. This approach expands beyond its original scope, offering detailed insights into evolutionary traits and dietary behaviors. The virtual goniometer, which has largely been used for strictly archaeological and zooarchaeological inquiries, can be employed more broadly as demonstrated here with the use of primate dentition, in addition to possible applications in the fossil record. Evolution builds off past successes, why shouldn't technological evolution do the same?

Funding Sources National Science Foundation (1846153, 2235734) and The Leakey Foundation

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Partnerships with avocational collectors, landowners, and regional groups catalyze paleontological discovery within the Pittsburgh area

Lyons-Weiler, Zachary J.^{1,2}

¹Section of Vertebrate Paleontology, Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ²Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States

The Carboniferous–Permian deposits of the central Appalachian Basin have long been known to produce fossil vertebrate remains, but modern collection is hampered by numerous logistical challenges regarding property ownership and a paucity of state and federal land, as well as a general paucity of outcrops. Additionally, urbanization coupled with the lack of reliable geographic data from early efforts has led to the loss of invaluable vertebrate localities. Due to the importance of the interval represented by these deposits, new localities are vital for understanding late Pennsylvanian ecosystems of the Appalachian Basin. Concerted efforts by the author with the support of Carnegie Museum of Natural History (CM) to locate historic and novel vertebrate sites have led to an important expansion of our record of such fossils from the region. Collecting efforts have centered on two sites in the Birmingham Shale, but important discoveries have originated from other units as well. Partnership with the Allegheny Land Trust resulted in the discovery of a new Moscovian (307 Ma) locality that has produced the only known vertebrate fossils from the Upper Freeport Coal in Pennsylvania. These include chondrichthyan remains, a cleithrum from an unidentified dipnoan, and a possible tetrapod parasphenoid. This site is critical as it

represents a lateral equivalent of Linton, a diverse cannel coal Lagerstätte in eastern Ohio. Additionally, the first record of the ichnotaxon *Batrachichnus* from the Casselman Formation of Pennsylvania was discovered. This specimen was donated to the CM collection through the efforts of a local collector. The discoveries presented here illustrate two important concepts – the continued potential of the Pittsburgh region to produce fossil vertebrate remains despite urbanization, and the vital importance of avocational collectors, property owners, and conservation organizations that make scientific study of these specimens possible. These relationships will help foster an increased understanding of the geologic heritage of the region, as well as form the basis upon which local vertebrate paleontology programs can be built.

Colbert Prize Session

Large number of unbroken unhatched dinosaur eggs in an Upper Cretaceous layer calls for a new hypothesis for dinosaur extinction from incubation failure

Ma, Merry¹, Zhu, Wei², Ma, Yeming J.^{3,4}

¹College of Art and science, New York University, New York City, New York, United States, ²Department of Applied Math and Statistics, SUNY, Stony Brook, Stony Brook, New York, United States, ³Medical Department, Brookhaven National Laboratory, Upton, New York, United States, ⁴R&D, Johnson and Johnson, Spring House, Pennsylvania, United States

Fossils of unbroken or unhatched dinosaur eggs (FUDE's) used to be extremely rare and notoriously hard to identify. Documented unbroken or unhatched eggs were documented in small numbers (<2~10) for each nest and only a total of <100 FUDE's were recorded through the 1990's. In the 1990's two major paleontological discoveries

in China recovered 3,000 FUDE's in a Middle Cretaceous layer and 20,000 FUDE's in a Late Cretaceous layer in Shiyan and Heyuan respectively. 99% of FUDE's were concentrated in the Late Cretaceous later (~21% of dinosaur existence time). Initially it was assumed that dinosaur population increase led to more eggs being recovered in the Late Cretaceous. But this population increase hypothesis was challenged by recent studies, 1) dinosaur populations declined for tens of MY before K-Pg extinction, 2) dinosaur diversity was declining for tens of MY before K-Pg extinction, and 3) central China shows low biodiversity of dinosaurs for two MY before the K-Pg extinction.

Why did FUDE's spike significantly right before K-Pg extinction? By analyzing the interplay of the extra long incubation time in dinosaurs (2.8-5.8 months), which was determined from growth line counts in dinosaur embryonic teeth, and the late-Cretaceous climate transition to a glacial series in the Paleogene, the authors conclude confidently that a vast incubation failure caused the FUDE spike right before K-Pg extinction. This was caused by shorter summers, with fewer warmer days, which caused large fractions of dinosaur eggs to fail, as evidenced by > 99% of FUDE's that were recovered in the Late Cretaceous right before K-Pg extinction. The longest incubation times for extant birds were recorded for the wandering albatross (75–82 days or 2.73 months), the royal albatross (75–81 days or 2.70 months), and the kiwis (71–84 days or 2.80 months). These times are similar to but shorter than dinosaurs' 2.8-5.8 months incubation periods.

The paleontological findings of > 99% of FUDE's in Late Cretaceous led to the incubation hypothesis that explains not only what caused the extinction of all non-avian dinosaurs, but also why birds, crocodiles, alligators, turtles, and snakes could survive K-Pg extinction.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

The La Brea horse, or how I learned to stop worrying and understand evolutionary stasis

Machado, Helena

Earth Sciences, University of Oregon, Eugene, Oregon, United States

One current concern in evolutionary ecology is understanding how species can exhibit both short-term evolutionary dynamics and long-term stasis, apparently a contradiction. There are several instances of modern taxa suggesting rapid phenotypic evolution among populations while the fossil record often reveals stasis over long periods of time. Understanding the dynamics of evolutionary stasis is, then, crucial to have a better understanding of why extant and extinct taxa might present contradictory evolutionary histories. As stasis seems to be more related to geographic structures than constraints in genetic variation, understanding the differences in evolutionary histories between wide-spread and local species could further our knowledge on the dynamics of stasis. This work, then, aims to broaden the understanding of local population evolutionary dynamics by investigating the La Brea horse. Rancho La Brea is a well-preserved fossil locality, composed of multiple tar pits that represent different depositional episodes corresponding to different time periods, climate fluctuations and environmental changes. Limb bone analyses of the La Brea megafauna have revealed a general stasis, but analysis of skull elements of some taxa refuted the stasis observed in their limb bones. Rancho La Brea was inhabited by a single horse species, *Equus occidentalis*, and previous work indicated stasis in its limb bones. Yet, the conflicting results observed in the analysis of post-cranial and skull elements of other

megafauna raises the question whether *E. occidentalis* skull elements would confirm or contest the apparent horse stasis. Therefore, this work investigates whether the teeth of the La Brea horse remained unchanged, like its limb bones, or varied among the pits. The analysis incorporated 381 molars and premolars, at intermediate wear stage, from 16 pits and consisted of a Multivariate Analysis of Variance, to test whether the variables' means for the pits are the same, a Discriminant Function Analysis, to assess the probability of classifying individuals into a certain pit, and a Cluster Analysis, an exploratory analysis that gathers groups based on numerical similarity. Results revealed that it is not possible to distinguish the horses among pits, indicating that there was no variation and corroborating the stasis observed in its limb bones. *E. occidentalis* appears to show general stasis through the last glacial-interglacial cycle.

Funding Sources NSF Collaborative Research: FuTRES (1759821) and Ranges (2228385); Ewart & Margaret Baldwin Scholarship; and Department of Earth Sciences of University of Oregon.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Using automation tools to streamline field-to-laboratory documentation

Macias, Melissa K., Oberg, Danielle, Shi, Chris, Ollendorf, Amy L.

Paleontology, Applied Earthworks Inc, Fresno, California, United States

Proper documentation of specimens collected during fieldwork can be a time-consuming process. This can be especially daunting within the confines of mitigation paleontology, where time and budget constraints are a common occurrence. These

constraints extend into laboratory analysis and documentation processes, which are highly susceptible to human-induced errors. The data entry is an unnecessary duplication of efforts that also may result in miscommunication between field and laboratory staff. By integrating digital field forms and automation into the documentation process, we can alleviate both the time constraints and human error associated with documenting large, complex projects.

Using two current mitigation projects as test cases, we created and implemented a system of digital inventory tracking using quick response (QR) barcodes and automation services. These projects included the field-collection of hundreds of previously identified paleontological resources and associated sediment samples from geotechnical investigations and construction excavations. To date, the combined projects have resulted in over 1,000 fossil localities and 15,000 pounds of sediment samples. Newly discovered paleontological resources, including microvertebrates and other small fossils, were recovered in the laboratory. Each sample was assigned a unique field collection number, which was encoded into a QR code. Each sample was tracked closely through the entire field-to-laboratory process of collection, screen washing, transportation, and laboratory processing.

By implementing this new system, we significantly decreased the amount of time associated with documenting progress updates for the samples. For example, transcribing sediment samples into a spreadsheet by hand during a previous phase of the monitoring project took hours, whereas we were able to document a field-to-lab transfer of 120 samples in less than 15 minutes. Decreases in recordkeeping time of up to 90% are allowing staff to focus on completing their assigned tasks in the field and in the laboratory. In addition, project managers and supervisors are able to track

and share progress updates quickly in real time. The automation of our field-to-laboratory documentation process improves end-user accuracy in the laboratory and office. The improved process efficiency results in timely completion of project tasks within budget, while allowing paleontologists to focus on science rather than logistics.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Reptile taphonomy: decay, disarticulation,
and paleontological implications**

Maddox, Hannah M., Singleton, Owen J.,
Drumheller, Stephanie K.

Earth, Environmental, and Planetary
Sciences, University of Tennessee, Knoxville,
Tennessee, United States

The study of decomposition and its effects on remains and their immediate surroundings is imperative to our understanding of burial history, post-mortem intervals, and ecology in both the modern and fossil record. However, taphonomic studies historically have focused on mammal decomposition, due in part to these foundational studies being performed in the contexts of forensic anthropology, zooarchaeology, and paleoanthropology. The results of these studies are often uncritically applied to non-mammalian subjects. Recent research on dinosaurian “mummies” has highlighted the contradictory nature of previous taphonomic explanations for their preservation, raising questions as to how the innate biological differences between mammals and reptiles affect decomposition.

Here we present a decomposition study of Argentine tegus (*Salvator merianae*), structured to replicate several of the foundational studies on mammalian taphonomy to facilitate direct comparison between these datasets. Thirty specimens were placed in an open grid container in a

wooded clearing in May 2023. Observations were made regularly to track decomposition stages, faunal succession, disarticulation, and weathering.

After a year tracking these patterns, all specimens retain significant amounts of skin, ranging from isolated strips to the entire body covering. This contradicts previous assertions that skin retention in fossils must rely on exceedingly rapid burial. The prolonged presence of skin has also kept most skeletons whole and articulated well into a year after placement, however insect activity in the early stages allowed the unfused skull bones in many specimens to disarticulate from the rest of the carcass, departing significantly from the mammalian model of disarticulation. In others, skin adhesion to the cranial bones have kept these elements largely articulated into the dry stage. The observed variation is affected by specimen size, weather conditions during exposure, and the extent of insect activity targeting bodily openings in the early stages of decomposition. The extensive retention and sometimes adhesion of skin to the underlying bones in the postcrania has also revealed one potential explanation for the iconic “death pose” seen in many dinosaurian taxa. Taken together, these diverse results demonstrate the importance of considering clade-level anatomical differences when performing and applying actualistic data to paleontological datasets.

Funding Sources This research was funded by the University of Tennessee Department of Earth, Environmental and Planetary Sciences.

Regular Poster Session 3 (Friday, November
1, 2024, 4:30 - 6:30 PM)

**Pathologic and taphonomic history of the
largest known specimen of *Allosaurus
jimmadseni* from the Upper Jurassic
Morrison Formation of Wyoming**

Maddox, Lily A.¹, Loewen, Mark^{1,2}

¹Geology and Geophysics, University of Utah, Sandy, Utah, United States, ²Natural History Museum of Utah, Salt Lake City, Utah, United States

An exceptionally preserved specimen of *Allosaurus jimmadsoni* was recovered from the lower portion of the Morrison Formation in the Big Horn Basin of Wyoming just south of the Montana border. Known as EMK 0011, it was preserved as an articulated skeleton and represents the largest individual of the species currently known. The skull is 90 cm long, and each element in the skeleton, save for the ilia, is longer than any other specimen belonging to the species, including MOR 693 and SMA 0005.

The skeleton was preserved lying on its left side in the curled neck and tail position common in theropod dinosaurs. The skull was preserved vertically, resting on its chin, which resulted in some crushing of the skull. The furcula, most of the coracoids, the right hand, and the tip of the tail were presumably lost to erosion prior to discovery. Dorsal vertebrae D2 and D3, caudal vertebrae Ca6-10, parts of the left hand, and right pedal ungual III were lost during excavation, along with the nasals, which were damaged during excavation. Both premaxillae and the left lacrimal were slightly displaced from the articulated skull, suggesting some minor decomposition of the soft tissues on the skull prior to burial. Skin impressions are preserved in multiple locations on the body, including the skull, neck, shoulder, body, and leg areas, confirming the presence of soft tissues holding the articulated skeleton together.

Examination of each element reveals multiple injuries prior to the death of the animal. The right leg includes modified bone pathologies to the proximal and distal tibia and fibula, the astragalus, calcaneum, metatarsals, and phalanges, suggesting traumatic conditions

such as mechanical injuries, ligament tears, and locomotor injuries that healed poorly. The worst of the injuries is undoubtedly in the skull; the right maxilla reveals multiple, likely infectious, pathologies on the lateral and medial surfaces consistent with facial abscesses that had spread into pneumatic spaces within the skull, possibly due to traumatic injury from the teeth to the palate of the animal. Further description of these pathologies will include the classification of the injuries and likely cause: these categories will be traumatic, infectious, and idiopathic. EMK represents the largest specimen of *Allosaurus jimmadsoni* with a fascinating life history and exceptional preservation consistent with rapid burial soon after death and prior to the decomposition of soft tissues.

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Investigating our roots: Assessing the biomechanical significance of diverse tooth root morphologies in Mesozoic mammals using 3D FEA

Magallanes, Isaac^{1,2}, Luo, Zhe-Xi³, Martin, Thomas⁴

¹Committee on Evolutionary Biology, University of Chicago Division of the Biological Sciences, Chicago, Illinois, United States, ²The Field Museum of Natural History, Chicago, Illinois, United States, ³Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ⁴Section Paleontology, Bonn Institute of Organismic Biology, Universität Bonn, Bonn, Germany

In the Mesozoic, the postcanine dentition of mammals underwent a transformation from their synapsid ancestors. Mammals and their mammaliaform relatives evolved divided double roots in their postcanines, a condition that is ubiquitous across the entire clade. By

contrast, most non-mammaliaform cynodonts had a plesiomorphic root structure where the postcanines either had a single or partially divided tooth root. In mammals, tooth roots serve mechanical functions by resisting the loading forces placed on the tooth crown during mastication. They also relay sensory information via dense nerve bundles in the periodontal ligaments that anchor the roots to the jaw. It has been hypothesized that a fully divided double root system conferred a mechanical advantage over the undivided root system by reducing stress at the crown-root junction. However, the mechanical difference between the fully divided, symmetrical roots in the molar teeth of mammals and the undivided roots in the postcanines of cynodonts is yet to be fully characterized. Furthermore, it is yet to be tested if differences in shape and size between the two divided roots convey any mechanical advantages to the molars in mammals. Here, we examine the influence of tooth root shape on biomechanical function in a modern mammal group (opossums) and the Jurassic-Cretaceous dryolestoids, a diverse stem lineage of crown therians. While all dryolestoids have a conserved molar crown morphology, their lower molar roots show a shape and size disparity between stemward dryolestoids and more derived dryolestids. The less derived taxa have more symmetrical, equally sized double roots in their lower molars, while the more derived taxa have an asymmetrical shape in which the anterior root is enlarged, spatulate in shape, and envelopes a shorter and thinner cylindrical posterior root. With this comparative framework, we apply 3D Finite Element Analysis (FEA) to assess the influence of tooth root shape on biomechanical function. We aim to test if placement of the enlarged anterior root below the principal trigonid cusps provides greater stability during mastication. We characterize patterns of stress and strain on the tooth roots and surrounding tissues under different

loading regimes. We also discuss the diversity of tooth root morphologies of the early mammal fossils and their functional relationship to the diversity of the tooth crowns.

Funding Sources Field Museum Brown Graduate Fellowship

University of Chicago Hinds Fund

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A collections-based survey of the distribution and occurrence rates of *Microsyops* sp. dental caries in Wyoming

Malmberg, Kate O., Worrell, Whitney E., Vietti, Laura A.

Geology & Geophysics, University of Wyoming, Laramie, Wyoming, United States

Dental caries, or cavities, are among the most common health issues for people today. However, they also affected the extinct plesiadapiform primate, *Microsyops* sp., of North America. *Microsyops* lived in North America during the Eocene (56-34 million years ago) and are thought to have been a frugivore. Due in part to a diet of fruit, which is high in natural sugars, *Microsyops* molars with dental caries can be found in every formation in Wyoming where *Microsyops* occurs, making this an important example of the distribution of this pathology in the fossil record. We conducted a collections-based survey of *Microsyops* tooth fossils including upper and lower molars (M1, M2, and M3), housed in the University of Wyoming Geological Museum from throughout the state of Wyoming (n=334). Specimens include teeth from the Green River, Wind River, Bridger, Wasatch, Aycross, Wapiti, Indian Meadows, and Uta Formations. We used image focal stacking on a Keyence microscope to take high resolution images and generate 3D models of the teeth from

occlusal, buccal, and lingual views. These high-resolution images allowed us to measure the maximum and minimum diameters of dental caries, and depth was measured utilizing Keyence software 3D measuring tools. Of all specimens examined in the University of Wyoming collection, 7.2% specimen had dental caries, with minimum dental caries depth of 170 μm to maximum depth of 610 μm and an average of 408 μm . There is a distribution bias that shows 72% of dental caries are found in the upper molar. The largest sample size, the Green River Formation (n=125), shows a dental caries occurrence rate of 8.8% and depth ranging from 170 μm to 520 μm with an average of 408 μm . In the Green River Formation, 82% of dental caries are in the upper molar which follows the statewide trend. Our study builds on previous studies of dental pathologies by expanding the geographic and temporal range of the prevalence of pathologies in Eocene primate dental fossils. This study aims to provide further insight into Eocene mammal diet and health in North America.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

A new lysorophian from the Kinney Brick Quarry (Atrasado Formation, Upper Carboniferous, New Mexico) reveals new details on body size and body-elongation patterns in molgophid recumbirostrans

Mann, Arjan², Sues, Hans-Dieter¹, So, Calvin¹, Pardo, Jason²

¹Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States, ²Paleobiology, Smithsonian, National Museum of Natural History, Washington, District of Columbia, United States

Lysorophians or molgophids are a group of superficially snake-like early tetrapods with a fossil record spanning the Permo-

Carboniferous, with the earliest members of this group known from the Mazon Creek Lagerstätte, Illinois (309-307 Ma). Recent phylogenetic analyses show that lysorophians belong to Recumbirostra, which together with their sister group Brachystelechidae form a clade of highly fossorial recumbirostrans, Chthonosauria. In particular, the application of microCT-scanning data to understanding the structure of the lysorophian neurocranium, combined with studies on new taxa (e.g., *Infernovenator*, *Nagini*), has both clarified the position of molgophids within Recumbirostra and revealed greater ecological diversity within this group. Fossorial adaptations among lysorophians are perhaps the most extreme of any Paleozoic tetrapod group, and include: a robust skull with a hyperossified braincase, body elongation, and limb reduction, with the most recently described molgophid, *Nagini mazonensis*, completely lacking forelimbs and the pectoral girdle. Recumbirostrans are typically considered a small-bodied diversification, with many of these adaptations tied to miniaturization as well as fossoriality.

Here we report a new large molgophid recumbirostran from the Pennsylvanian Astrasado Formation of the Kinney Brick Quarry of central New Mexico. It is known from a single articulated individual, approximately 74 cm in length (USNM PAL 706594). The new specimen bears a unique 73 presacral vertebrae, and differs from *Infernovenator* but shares with *Nagini* and *Brachydectes* a rounded snout, a small lacrimal, and the absence of a prefrontal. MicroCT scans of USNM PAL 706594, allows for the first time a detailed study of rib morphological variation along the axial column as well as reveals the presence of well-preserved fore- and hindlimbs including well-developed tarsal elements with an amniote-like astragalus and calcaneum, previously only observed in a referred juvenile specimen of *Nagini*. The forelimbs and

pectoral apparatus are both present, unlike in *Nagini*, but the forelimb overall is diminutive in comparison to the well-developed hindlimb, implying a complex interplay of limb-reduction and limb loss present among molgophids. The new taxon also provides novel data on body size evolution within Recumbirostra, showing Late Carboniferous recumbirostrans rivaled other coeval early tetrapod groups in body size.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Age-segregated assemblage of a new species of oviraptorid (Theropoda: Oviraptoridae) from the Late Cretaceous of southern Mongolia

Maranga, Denise C. A.^{1,2}, Funston, Gregory F.², Jargalsaikhan, Myagmarsuren³, Currie, Philip J.⁴

¹Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada, ²Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada, ³Baigaliin Tuukhiin Musei (Natural History Museum), Ministry of Culture, Ulaanbataar, Mongolia, ⁴Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada

The Gobi Desert of Mongolia and China is home to a diverse and exceptional assortment of dinosaur fossils; unfortunately, this wealth of fossil material has fallen victim to increased rates of poaching in the past decades. In recent years, there have been efforts to find and return poached fossils to their rightful place of origin. One such repatriated specimen is a slab of four articulated juvenile oviraptorids—a clade of small-bodied herbivorous theropod dinosaurs—from the Late Cretaceous beds of southern Mongolia.

While locality data was not collected by the poachers, examination of the sediment from the slab suggests the specimen was most likely collected from the Baruungoyot or Nemegt Formations exposed in the Nemegt Basin. The assemblage consists of at least four well-preserved individuals in death poses arranged in close proximity. The specimens display multiple diagnostic characters assigned to Oviraptoridae; however, some unusual anatomical features are present and are unique among all known oviraptorids and oviraptorosaurs. One of these notable features is a spatulate ischium; the distal edge is truncated into a blunt, paddle-like shape and is present in all individuals in the assemblage. This ischial morphology has not been observed in any other known oviraptorosaurs to date, which suggests that these specimens represent a new taxon.

Although the poached nature of the specimen means that its sedimentological and taphonomic context cannot be understood in full, some aspects of the skeletons and their preservation give insight into the nature of the assemblage. The skeletons are well-articulated, indicating that their proximity to each other is likely the result of congregation at the time of death rather than artificial aggregation through taphonomic transport. Additionally, the similar size and body mass estimates of the individuals, as well as incomplete fusion of the neural arches and sacra, suggest that these specimens represent an age-segregated juvenile assemblage. Despite the juvenile status of the material, inclusion of the new taxon in a popular phylogenetic matrix of oviraptorosaurs allies it with late-branching heyuannines like *Oksoko avarsan*. This new specimen is thus evidence of a singular mass mortality event and contributes to a growing body of evidence towards the presence of gregarious behaviour found throughout Oviraptorosauria, and especially highlights

the frequency of age-segregated assemblages in Heyuanninae.

Funding Sources Dinosaur Research Institute Grant (DCAM), NSERC (GFF), Vanier-Banting Commission (GFF), NSERC Discovery Grant (PJC).

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Reconstructing Late Pliocene and Pleistocene paleoenvironments using taphonomy

Marano, Katelyn¹, Haveles, Andrew W.¹, Fox, David L.²

¹Plant and Earth Science and Biology, University of Wisconsin - River Falls, River Falls, Wisconsin, United States, ²Department of Earth and Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States

The Meade Basin in Southwestern Kansas has a well-documented, five-million-year record of mammalian diversity and paleoenvironmental change. This record resulted from a culmination of taxonomic presence and absence data with consideration of depositional environments. However, there has not been a quantitative assessment of potential taphonomic biases among Meade Basin faunas. Here, we compared taphonomic biases among three Meade Basin vertebrate faunas to assess whether differences in vertebrate diversity could be the result of differing depositional histories. We quantified microfossil size distributions that can be used to identify channel hosted, lacustrine, and floodplain environments. Microfossil size distributions for each fauna were generated using multiple 1,000-gram samples sorted into four clast size bins: 0.5-1mm, 1-2mm, 2-4mm, and >4mm. After sorting the fossil material, a total count and weight was taken of each sample,

and bones were classified based on discernable type (long bone, teeth, bone pebbles, and unknowns). The three localities- Ripley (N=735, total fossil weight (tfw) = 0.68g), Borchers (N=9,146, tfw = 14.5g), and Cudahy (N=125, tfw= 0.3g)- did not have distributions associated with a channel hosted environment. The fossil material likely underwent minimal particle size sorting, leading to the conclusion that these depositional environments were not channel-hosted and did not differ in depositional environments. Thus, using the knowledge that all three localities are from similar depositional environments, taxonomic and diversity comparisons can be made in greater confidence.

Funding Sources NSF Award Number: 1338313; Undergraduate Research, Scholarly and Creative Activity - University of Wisconsin - River Falls

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

The Messel salamander, ?*Chelotriton robustus*

Marjanović, David¹, Auste, Selina N.², Witzmann, Florian¹, Fröbisch, Nadia B.^{1,3}

¹Museum für Naturkunde – Leibniz-Institut für Evolutions- und Biodiversitätsforschung, Berlin, Germany, ²Zentrum für Epidemiologie und Gesundheitsforschung Berlin, Berlin, Germany, ³Humboldt-Universität zu Berlin, Berlin, Germany

Amid thousands of extremely well preserved birds, mammals, crocodyliforms, actinopterygians, insects and plant remains, the early middle Eocene site of Messel near Darmstadt and Frankfurt in western Germany has so far yielded about 200 specimens referable to three or four frog species, but only a single specimen of a salamander: the holotype and only known specimen of the

pleurodelin salamandrid *Chelotriton robustus* Westphal, 1980. Unfortunately, it was split roughly in the sagittal plane; because Messel shale contains no less than 40% water, the two slices of the fossil had to be transferred to two artificial-resin plates that make many details difficult to see. This may explain why this practically complete peramorphic skeleton was never sufficiently described or illustrated for a phylogenetic analysis, even though it shows a number of highly unusual features (some practically unique among salamanders, e.g., honeycombed sculpture on the skull). We present the first μ CT scan of the specimen and compare it to our μ CT scan of a specimen of the extant pleurodeline *Tylotriton* (the first to include the entire skeleton of any *Tylotriton* species). The lack of a hyobranchial skeleton (unlike all other known *Chelotriton* skulls), the fully ossified tarsus and largely ossified carpus of this fairly small salamander, its long, robust limbs and its short trunk (shorter than previously interpreted) argue for a terrestrial animal that did not live in the Messel lake or on its shore, explaining the extreme rarity of the taxon in the lake sediment. A revised and expanded phylogenetic analysis confirms the specimen as a pleurodelin newt, but casts doubt on its referral to the Oligocene through Pliocene *Chelotriton*.

Funding Sources DFG Emmy Noether grant FR2647/5-1 to NBF.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The hidden diversity of monodominant macrofossils bonebeds: a case study in allokokotosaurian archosauromorphs from the Upper Triassic Chinle Formation

Marsh, Adam¹, Sidor, Christian A.^{2,3}, Armour Smith, Elliott^{2,3}

¹Petrified Forest National Park, Holbrook, Arizona, United States, ²The University of

Washington, Seattle, Washington, United States, ³Burke Museum of Natural History and Culture, Seattle, Washington, United States

Monodominant macrofossil bonebeds (MMBs) are important components of the fossil record because they provide non-time averaged data on variation within the taxon of the highest abundance in the locality, including ontogeny, pathology, and individual variation. MMBs are known for temnospondyl amphibians, allokokotosaurian archosauromorphs, and coelophysid dinosaurs in North America, aetosaurs and sauropodomorphs in Europe, and phytosaurs and rhynchosaurs in India. However, because MMBs typically yield a high number of specimens and often display better preservation than more typical fossil localities, these sites provide important information about members of their respective vertebrate assemblages that are preserved in lower abundance elsewhere.

Here we describe an allokokotosaur assemblage known from a shuvosaurid pseudosuchian MMB in the Sonsela Member of the Chinle Formation at Petrified Forest National Park. More than 2,565 catalogued specimens have been collected from PFV 410 (the Kaye Quarry) over 9 years; 33% of these represent a new taxon of shuvosaurid and only 6.7% represent allokokotosaurs. Indeterminate allokokotosaur elements include a femur and tibia, trilophosaurid elements include a postorbital, cervical vertebrae, calcaneum, metatarsal V, and a tooth and fragmentary maxilla referable to *Trilophosaurus phasmalophos*, and malerisaurine elements include a premaxilla, maxilla, prefrontal, quadrate, humerus, proximal end of an ulna, astragalus, and ungual. PFV 410 includes the first unambiguous Revueltian (i.e., youngest) malerisaurine and only the third occurrence of both azendohsaurid and malerisaurine allokokotosaurs. The Upper Triassic of the American Southwest preserves a high diversity and abundance of allokokotosaurs

from sites spanning the Otischalkian through the Revueltian teilzones. Fourteen of these sites preserve only trilophosaurids (two of which are trilophosaurid MMBs), five preserve only malerisaurines (two of which are malerisaurine MMBs), and three preserve both lineages. Continued research on fossils from PFV 410 will shed light on lesser-known members of this early Revueltian terrestrial vertebrate assemblage and any biological transition that may have occurred from the Adamanian to the Revueltian beyond the phytosaur taxa on which the biozones are based.

Funding Sources Funding for this work was provided by the Burke Museum of Natural History and Culture and by Petrified Forest National Park.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

An unusual ungual from the Hell Creek Formation, Montana: is the enigmatic theropod *Richardoestesia* a unenlagiine (Theropoda: Dromaeosauridae)?

Martínez-Ruiz, Gabriel A.¹, Fowler, Denver²

¹Geology, University of Puerto Rico at Mayagüez, Arecibo, Puerto Rico, United States, ²Badlands Dinosaur Museum, Dickinson, North Dakota, United States

Unenlagiines are a clade of aberrant dromaeosaurids that thus far have been definitively reported from South America (Argentina and Brazil) and Madagascar. Unenlagiines were small-to-medium predators, possibly piscivorous, with small teeth that lacked denticles, a subarctometatarsalian metatarsus, and a sickle-shaped pedal D-II ungual. Here we describe the unusual unguals BDM 009 and BDM 010, from the Hell Creek Formation of Montana, and compare them with unguals from Alvarezsauridae, Eudromaeosauria,

Halszkaraptorinae, Ornithomimosauria, Oviraptorosauria, Tyrannosauridae, Unenlagiinae, Pterosauria, Choristodera, Crocodylomorpha, Testudinata, and Varanoidea. Most notably, pedal ungual BDM 009 is unusual in being high-sided and very laterally compressed, with a strongly keeled dorsal margin and flat to weakly concave ventral margin giving a triangular cross section, small bumps or wrinkles adjacent to the lateral groove, and a weak flexor tubercle. These unusual characteristics are unlike most unguals to which we could compare them but best match the morphology of unenlagiines, notably *Buitreraptor*. A unenlagiine-affiliated identity is consistent with the recent report of the first North American unenlagiine remains: a metatarsal from the Hell Creek Formation of North Dakota. This recent recognition of unenlagiines in the Hell Creek is perhaps unanticipated since abundant theropod teeth are known from the unit and it might be expected that unserrated unenlagiine teeth would have been recorded already. However, we suggest that the numerous specimens of the enigmatic theropod *Richardoestesia* (mostly a tooth taxon, with the exception of an isolated pair of dentaries) that have been discovered across North America (and possibly Asia) may represent the teeth of a basal group of unenlagiines which still bore denticles (the basal character trait for Dromaeosauridae). This suggests a more complex paleobiogeographical history for the Unenlagiinae than previously thought. Further research should focus on searching for more unenlagiine fossils in North American paleontological collections, and conducting targeted fieldwork in Cretaceous geological units.

Funding Sources There are no funding sources for this work.

Regular Poster Session 3 (Friday, November
1, 2024, 4:30 - 6:30 PM)

Assessing the hydro- and thermodynamic capabilities of long-necked plesiosaurs using computational fluid dynamics

Marx, Miguel¹, Szász, Robert-Zoltán², Eriksson, Mats E.¹, Kear, Benjamin³, Sachs, Sven⁴, Lindgren, Johan¹

¹Department of Geology, Lund University, Lund, Sweden, ²Division of Fluid Mechanics, Lund University, Lund, Sweden, ³The Museum of Evolution, Uppsala University, Uppsala, Sweden, ⁴Geowissenschaften, Naturkunde-Museum Bielefeld, Bielefeld, Germany

Reconstructing the appearance of ancient organisms is a major focal point of paleontological research. Typically, our ideas for life-like reconstructions derive from exquisitely preserved specimens with soft tissues. However, many animals are not commonly preserved with fossilized soft parts and among these are the plesiosaurs. These marine reptiles have a fossil record that extends over more than 130 million years during the Mesozoic Era, and their remains have been found in deposits representing both warm, equatorial waters and cold, high-latitude environments. Reconstructions of plesiosaurs are often characterized by a narrow, snake-like neck attached to sea turtle-like body. However, this design is at odds with the otherwise prevalent spindle- to torpedo-shaped bauplan of marine animals.

Given the presence of plesiosaurs in cold-water environments, it is reasonable to assume that these secondarily aquatic reptiles utilized blubber for insulation, in similarity with modern-day whales and adult individuals of the leatherback turtle (*Dermochelys coriacea*). Blubber is also beneficial in enhancing streamlining, which reduces drag. To test this alternative scenario, a traditional long-necked form was 3D generated along with a blubber-lined geometry to assess their hydro- and thermodynamic capabilities using computational fluid dynamics. A model that

is both hydrodynamic and thermodynamically efficient is here hypothesized as the most likely candidate for the actual appearance of a plesiosaur in life. Computational fluid dynamics is a burgeoning experimental approach in paleontology that holds great potential as an avenue to assess likelihood scenarios for reconstructions of the appearance and adaptations of extinct animals.

Funding Sources Swedish Research Council grant (#2020-03542) to J.L., (#2019-03516) to M.E.E, and (#2020-3423) to B.P.K.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

New chondrichthyans from the Early Permian Phosphoria Formation from Grand Tetons National Park, Wyoming, U.S.A.

Mateo, Madison¹, Hodnet, John-Paul M.², Bovis, Max², Mateo, Rodrigo³, Timko, Samuel⁴, Santucci, Vincent⁵

¹Department of Atmospheric, Oceanic & Earth Sciences, George Mason University, Fairfax, Virginia, United States, ²Natural and Historical Resources Division Maryland National Capitol Parks and Planning Commission, Dinosaur Park, Upper Marlboro, Maryland, United States, ³Uniformed Services University of Health Sciences, Bethesda, Maryland, United States, ⁴Grand Tetons National Park, National Park Service, Grand Tetons National Park, Wyoming, United States, ⁵Paleontology Program, National Park Service, Washington, District of Columbia, United States

United States Geological Survey (USGS) work in the northwest corner of Grand Tetons National Park (GRTE), in western Wyoming in the early 1950's had identified a rich fossil fish assemblage from the Early Permian Phosphoria Formation. This initial survey recovered fish fossil samples that included

the edestoid *Sinohelicoprion*, small holocephalans, ctenacanthiforms, hybodontiforms and large platysomid actinopterygians from an apparently fossil rich phosphatic limestone ridge. Unfortunately, the exact locality for this site was apparently lost and the fossil assemblage, excluding the *Sinohelicoprion*, has not been reviewed since the early 1970's.

A recent expedition in 2022 was successful in relocating the original USGS Phosphoria Formation survey site in GRTE. The 325-meter long phosphatic limestone ridge is rich with vertebrate material and new discoveries included the presence of a large ctenacanthiform shark, possibly representing *Kaibabvenator*, the ctenacanth *Glikmanius occidentalis*, an orodontiform, a *Fadenia*-like durophagus eugenodont, a large median tooth plate of the holocephalan *Deltodus*, and a new large *Psephodus*-like holocephalan.

Reviewing the previous USGS collections and the new samples collected in 2022, adds new important biogeographical information for Early Permian chondrichthyans found along the ancient western coastline that extended from Mexico to Canada. Many of the new taxonomic records from the Phosphoria Formation at GRTE, such as the large *Kaibabvenator*-like ctenacanth, the ctenacanth *Glikmanius occidentalis*, and the holocephalan *Deltodus*, share ties with the Kaibab Formation in northern Arizona, including Grand Canyon National Park, Arizona. Our data suggest that some Early Permian chondrichthyan taxa had extensive distributions along this western coastline (such as *Glikmanius occidentalis*), while other species may have been regionally endemic (eugenodontiforms).

Funding Sources n/a

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Coprolite happens: analysis of specimens from Egg Mountain in the Cretaceous Two Medicine Formation of Montana

Matteson, Ian M.¹, Varricchio, David J.¹, Chin, Karen²

¹Earth Science, Montana State University, Bozeman, Montana, United States, ²GEOLOGICAL SCIENCES, CU MUSEUM OF NATURAL HISTORY, Boulder, Colorado, United States

Egg Mountain, a fossiliferous site within the Campanian Two Medicine Formation of Montana produced the first intact dinosaur eggs and egg clutches in North America of the ootaxa *Prismatoolithus* and *Continuoolithus*. Several dinosaurs have been found at this location including several *Orodromeus makelai*, as well as *Troodon*. The site has recently produced the fossils of an articulated lizard and a semi-fossorial mammal, as well as traces of burrowing soil invertebrates, and some mammal-bearing regurgitates, potentially assignable to *Troodon*. Some recent specimens (MOR 10878-9 and MOR 10878-4) collected from Egg Mountain are dark brown, globular masses on a siltstone matrix, hypothesized to be coprolites.

MOR 10878-9 is a 67 x 48 x 24 mm sample that's semi-triangular in shape with a large dark mass roughly covering one side. The two pieces of MOR 10878-4 include block (A) formed by the fusion of two small semi-ovular chunks that are 21 x 14 x 13 mm in size and a long semi-ovoid (B) that is 37 x 22 x 21 mm. Both A and B have dark masses marking one side of the samples.

CT scans from these samples all show a distinct difference between the dark, relatively homogeneous, masses and the surrounding matrix. Elemental composition via portable X-ray fluorescence (pXRF) of MOR 10878-9 shows distinct elemental variation between the mass and the matrix. Higher amounts of phosphorous (66,856 ppm)

difference) and calcium (173,145 ppm difference) were found in the mass than in the surrounding matrix. This could imply dissolved tissues, such as bone, within the sample, consistent with a carnivore origin. The size, shape, and initial compositional results suggest these specimens may represent the products of a small carnivore, possibly a small theropod. Continued studies using synchrotron scans and elemental mapping of thin sections will help to clarify the potential trace maker.

Funding Sources Funding for collecting these specimens in 2010 was under an NSF grant.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Rediscovering the lost tracks: Using modern photogrammetry to map the past at Dinosaur Ridge, Colorado

Matthews, Neffra A.¹, Breithaupt, Brent H.², Murphey, Paul C.³

¹Prehistoric Impressions, Denver, Colorado, United States, ²Wyoming State Office, Bureau of Land Management, Cheyenne, Wyoming, United States, ³Department of Paleontology, San Diego Natural History Museum, San Diego, California, United States

The type area of the Jurassic Morrison Formation west of Denver Colorado is located at what we now know as Dinosaur Ridge. Although the first report of dinosaur remains at Dinosaur Ridge was published in 1877, it was not until 1938 that dinosaur footprints were discovered. Since then, a wealth of paleontological discoveries made at this and other nearby localities have resulted in the Dinosaur Ridge area becoming one of the most scientifically significant and well-visited paleontological destinations in North America. Unearthed in 1937, the first tracks from Dinosaur Ridge apparently went

unnoticed by workers during construction of the road to Red Rocks Amphitheatre. However, the following year, they were discovered by Harvey Markman (Geology Curator of the City Park Museum in Denver) on the roadcut which exposed strata near the top of the Lower Cretaceous South Platte Formation of the Dakota Group. Markman briefly described these tracks. His simple schematic diagram depicts two trackways, one with large (48 cm) and one with small (25 cm) footprints of bipedal dinosaurs, which he labeled Alameda Trackways No. 1 and No. 2, respectively. At least two types of bipedal dinosaurs at the “Alameda Trackways,” an ornithomimid and a theropod (coelurosaur), were noted. Markman took photographs and made plaster casts, and applied a preservative to Trackway No. 1. Unfortunately, in 1945, Markman reported that both trackways had been “about destroyed” by weathering, leading others to refer to these footprints as the “Lost Tracks.” Subsequent studies of this area noted that based on museum archival photographs, these trackways were preserved in stratigraphically higher beds and to the north of the main track-bearing surface at Dinosaur Ridge. However, recent work comparing these historic photographs with others of Dinosaur Ridge, found that Markman’s tracks were in fact located immediately to the south and adjacent to the Dinosaur Ridge Main Tracksite in the South Platte Formation and not in the Mowry Shale, a marine unit, just above the contact with the underlying South Platte Formation, as suggested by some. The application of photogrammetric techniques to historic photographs provided the initial clues that led to the rediscovery of the locations of these historic trackways and at least four remaining tracks. The methodology also demonstrates that mapping is perhaps more essential to the field of vertebrate ichnology than to any other subdiscipline of paleontology.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Change in student perception of science as a practice: an initial study from the Sternberg Museum of Natural History Paleontology Academy: Kansas summer program

Matzen, Benjamin L.^{1,2}, Levering, David², da Silva, Noah², Smith, Amelia²

¹Science Department, Oxbridge Academy, West Palm Beach, Florida, United States, ²Sternberg Museum of Natural History, Fort Hays State University, Hays, Kansas, United States

This study aimed to assess changes in high school-age student perception of science both prior to and post participation in the Paleontology Academy: Kansas (PAK) program at the Sternberg Museum of Natural History at Fort Hays State University. Understanding how students perceive and engage in the scientific process is crucial to effective science education. Perception of science and scientific work, as well as how one perceives the process of learning about science, spans a broad spectrum in society, even among those who consider themselves scientifically literate. The PAK experience is an indoor lab, classroom and museum-based program focused on topics in academic vertebrate paleontology. The program is divided into two units, each focused on different topics, while maintaining common themes of vertebrate paleontology as a focus of scientific inquiry. Each unit is led by a different expert lead instructor, while the team of teaching assistants remains the same through both weeks. Pre- and post-participation evaluations were administered to students regarding multiple facets of the scientific process, including hypotheses formation, data collection, analysis, and interpretation, as well as how students perceive said processes. Formative

assessments regarding student perception were also recorded qualitatively over the course of the PAK program.

Initial assessments found that students had a moderate perception of their own knowledge of scientific research as a concept, and a low confidence in their knowledge of the process required to publish a scientific paper. Providing the same assessment questions at the conclusion of the program, we found that students' confidence in their own knowledge of paleontological science increased. We found that students made greater gains, however, in their conceptual confidence in understanding how scientific research is conducted and shared by professional researchers. Students also expressed appreciation for the role of data collection methods and variable structuring in the course of "publishing" their respective studies. By using project-based learning strategies combined with conceptual scaffolding approaches at PAK, we were able to improve student appreciation for science as a dynamic process, as well as the diligence necessary to create and share new scientific knowledge.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

A biogeographic assessment of Columbian and woolly mammoths from the central Great Plains Region, U.S.A., using newly acquired fossil molars

McCloskey, Jacob¹, Secord, Ross^{1,2}

¹Earth and Atmospheric Sciences, University of Nebraska Lincoln, Lincoln, Nebraska, United States, ²Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska, United States

The geographic distribution of mammoth species and knowledge of their habitats is important for understanding mammoth

ecology in late Pleistocene ecosystems. Here we use isolated molars from the University of Nebraska State Museum to distinguish species of Columbian (*Mammuthus columbi*) and woolly (*Mammuthus primigenius*) mammoths. From these identifications, we infer the distribution of these species in Nebraska, southwestern Iowa, and northwestern Missouri.

We identified 54 molars, 24 from Nebraska and 29 from Iowa and Missouri. Teeth from the latter area are part of the recently donated David Easterla Collection. We use two widely used molar characters for identifications: lamellar frequency (LF), measured as the number of plates per decimeter, and the thickness of exposed enamel ridges (ET). Woolly mammoths generally have relatively thin enamel (ET=1.0–2.0 mm) and high lamellar frequency counts (LF=7–12). Conversely, Columbian mammoths typically have thick enamel plates (ET=1.5–3.0 mm) and low lamellar frequency counts (LF=5–9). We measured length, width, LF, average ET, and maximum and minimum ET (± 1 standard deviation from the mean). Potential effects of tooth wear on ET measurements were taken into account by estimating wear stages in our specimens based on those of the African elephant (*Loxodonta africana*). We used Spearman's rank correlation (SRC) to determine the relationship between wear stages, and ET to test if tooth attrition posed a significant impact on the thickness of exposed enamel ridges. We then ran two multivariate tests, a non-metric multidimensional scaling (NDMS) model and a linear discriminant analysis (LDA), comparing our dental measurements with those from teeth of known species affinity in order to identify each tooth as belonging to either a woolly or Columbian mammoth.

The SRC test yielded a weak ($r_s=0.20$), insignificant ($p=0.15$) correlation between wear stages and ET, suggesting that wear poses a negligible effect on our taxonomic

assessment. The NDMS and LDA tests indicate that mammoths in Iowa and Missouri were primarily woolly mammoths (24 of the 29 teeth), and those from Nebraska were predominantly Columbian (17 of 24). The observed difference in species distributions may be related to the extension of the Laurentide ice sheet in north-central Iowa during the late Pleistocene, providing more suitable habitat for the steppe-adapted woolly mammoth east of the present-day Missouri River.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Osteohistology and bone microstructure of the phytosaur jaw

McCloskey, Lina, Goldsmith, Erika R., Stocker, Michelle R.

Geoscience, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, United States

Extant and extinct organisms exhibit diverse snout shapes and tooth characteristics, which may be associated with developmental, evolutionary, or functional differences. Osteohistological (i.e., bone microstructural) analyses have been implemented to investigate jaw bone growth, and tooth implantation, attachment, and replacement patterns across long-snouted (=longirostrine) reptiles such as dinosaurs, marine reptiles, and crocodylians. However, the jaw bone histology of many other extinct taxa has yet to be studied. For example, phytosaurs (large, semiaquatic reptiles known from the Middle and Late Triassic) possess elongate jaw elements in a longirostrine snout that externally resembles the rostra of extant crocodylians, yet it is unknown how the internal microstructure compares to that of extant crocodylians or other long-snouted organisms. To investigate the internal microstructure of the phytosaur

rostrum, we conducted a novel osteohistological study of a phytosaur dentary from the Dockum Group, TX. The specimen preserves at least 21 ovular alveoli that are widely-spaced (average spacing = 3.82 mm), spacing that is commonly observed in skeletally immature phytosaurs (e.g., '*Redondasaurus*', NMMNH P-44920). In contrast, *Leptosuchus crosbiensis* (UMMP 7552) from a nearby locality in the Dockum Group, preserves circular alveoli. We estimate the orbito-dorsal cranium length (ODCL) of our specimen between 114.82 to 141.25 mm, which may suggest skeletal immaturity[MS1] [EG2] . Based on other specimens collected from this general locality this dentary may be identifiable as *Leptosuchus*, a phytosaur clade known from the Adamanian of Texas. To preserve the internal and external morphology, we first microCT and 3D surface scanned this specimen. We serial sectioned two fragments of the dentary in transverse and coronal planes to assess how bone tissues may change across its length. MicroCT data reveal a replacement tooth in an anterior portion of the mandible just distal to the anterior tip of the snout. Coronal thin sections reveal that the long axis of tooth roots are oriented ventrolingually to dorsolabially, which may suggest a lingual-labial tooth replacement pattern similar to that seen in living crocodylians. This study is the first to use a histological approach to describe mandibular microstructure and alveolus characteristics in phytosaurs and adds to valuable data on the diversity of tissue microstructure that is present in long-snouted organisms.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Reevaluating species level variation in 2-Dimensional morphometric analysis of the first molars of cricetid rodents

McCraw, Caisa, Flores, Deanna, Hopkins, Samantha

University of Oregon, Eugene, Oregon, United States

The majority of the rodent fossil record comes from isolated teeth, which can present challenges for taxonomic identifications. The family Cricetidae are commonly identified by the occlusal morphology of the first lower molar; however, identification using this metric has presented problems because of gradual changes in tooth morphology with wear. This has led to problems understanding the relationship of early cricetid rodents, particularly within the genus *Leidymys*. Preliminary work using geometric morphometrics to solve this difficulty considered the fossil genera *Copemys* and *Leidymys*. This study showed that the method correctly identified roughly 70% of the *Copemys* sample but was less successful with specimens of *Leidymys* as only ~30% were identified correctly. Early fossil cricetids, such as *Copemys* and *Leidymys*, are ecologically and biogeographically important, but understanding their morphological variation may be easier with a better understanding of variability in extant cricetids. We test methods of quantifying this variation using Elliptical Fourier Analysis (EFA) of molar outlines in species from modern cricetids, such as *Reithrodontomys* and *Perognathus*. Tooth outlines from photographs of a sample of several species were digitized using 64 equally spaced semi-landmarks. Coordinates from each tooth were analyzed with EFA, which describes the shape as a sum of harmonics of decreasing wavelength, yielding four Fourier Coefficients (FCs) per each harmonic. Principal component analysis of the resulting FCs yielded a rich dataset to describe tooth shape. The first five principal components (PCs) account for approximately 90% of the variation found within the outlines. Using the first five PCs, linear discriminant analysis showed that approximately 70% of

specimens can be correctly assigned to species by using lower first molar occlusal outlines and centroid size. The species *Reithrodontomys megalotis* exhibits the same wide spread variation as found in the entirety of the fossil genus *Leidymys* found in the John Day, suggested by past authors to be an assemblage of three species. This finding suggests that the variability in fossil cricetids may be consistent with generally high levels of variation found in many species of extant muroids and may not indicate cryptic species as previously suggested.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

First occurrence of the amiid fish *Melvius* from the Late Cretaceous Almond Formation of southern Wyoming: stratigraphic and taxonomic implications

McDiarmid, Fisher⁶, Warner-Cowgill, Ethan⁴, Storrs, Glenn W.¹, Lamanna, Matthew², Hawkins, Quinnlan⁷, Affolter, Matthew³, Ashurst-Mcgee, Logan⁸, Rayburn, Kenneth C.⁹, Kosowatz, Luke⁵, Anduza, Danny¹⁰

¹Unaffiliated, Athens, Ohio, United States, ²Utah Geological Survey, Salt Lake City, Utah, United States, ³Cincinnati Museum Center, Cincinnati, Ohio, United States, ⁴Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ⁵Unaffiliated, Buffalo, New York, United States, ⁶Salt Lake Community College, Salt Lake City, Utah, United States, ⁷Unaffiliated, Salt Lake City, Utah, United States, ⁸Unaffiliated, Denver, Colorado, United States, ⁹Chronicle Heritage, Phoenix, Arizona, United States, ¹⁰Unaffiliated, Oakland, California, United States

The vertebrate paleofauna of the Cretaceous (Campanian–Maastrichtian) Almond Formation of southwest Wyoming is poorly known. Recent work (2021–present) has

recovered dinosaurs (Hadrosauridae, Ceratopsidae, and Ankylosauria), crocodylomorphs, turtles, and freshwater fishes from the formation, filling a crucial geographic gap between well known terrestrial Campanian deposits to the north (Montana, Alberta) and south (Utah, New Mexico), as well as a temporal gap between older Campanian (e.g. Judith River Formation) and younger latest Maastrichtian deposits (e.g. Lance Formation). Among these discoveries are specimens of the amiid *Melvius*, a taxon known from numerous terrestrial Cretaceous deposits of western North America. Two species are recognized, *M. thomasi* from the Maastrichtian Lance and Hell Creek formations (Wyoming, Montana, North Dakota, South Dakota), and *M. chauliodous* from the Campanian Fruitland/Kirtland formations of New Mexico. Amiids are represented in the Almond by teeth, a maxilla, and an associated skeleton. The associated skeleton is assigned to *Melvius* by the presence of anterior abdominal centra that are wider than tall, ventrolateral concavities on central trunk centra and a teardrop-shaped postinfraorbital. Cranial bones include elements previously unreported or incompletely preserved for *Melvius* (e.g. preoperculum), thus providing novel information on the morphology of this taxon. This specimen pertains to a large-bodied individual, with one trunk centrum measuring 5.6 cm in transverse width. The sole character (reduced sculpturing on the postinfraorbital) purported to distinguish *M. chauliodous* from *M. thomasi* is found to be intraspecifically variable. However, the holotype and referred specimens of the Campanian *M. chauliodous* are significantly larger (>2x) than specimens of the Maastrichtian *M. thomasi*, indicating that *M. chauliodous* can be diagnosed in part by its great size. The presence of *M. chauliodous* in Wyoming represents a major northward range extension, indicating that this species spanned a major latitudinal gradient. *M. chauliodous* has been proposed

to represent an index taxon of the Kirtlandian North American Land Vertebrate Age (~75–72.8 Ma). An age of ~73.4–71.0 Ma for the Almond has been constrained using ammonites. The lower end of this range falls within the proposed range of the Kirtlandian, lending tentative support for the hypothesis that *M. chauliodous* is an index taxon of this North American Land Vertebrate Age.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

In the fluke sweeps of giants: Ichthyosaurs in the Cedar Mountains of Nevada, USA fill gaps in the Norian ichthyosaur record

McGaughey, Gary A.¹, Kelley, Neil³, Noble, Paula⁴, Peacock, Brandon R.^{2,1}

¹Biological Sciences, Idaho State University, Pocatello, Idaho, United States, ²Vanderbilt University, Nashville, Tennessee, United States, ³University of Nevada, Reno, Reno, Nevada, United States, ⁴Idaho Museum of Natural History, Pocatello, Idaho, United States

The Late Triassic was a time of pronounced biotic change culminating in one of the ‘Big Five’ mass extinction events which marks the Triassic-Jurassic boundary. One aspect of this transition is the replacement of typical Triassic ichthyosaurs—including the gigantic shastasaurid ichthyosaurs, the largest marine reptiles of all time—with the parvipelvian groups which persisted into the Jurassic. However, a spotty fossil record has hampered our understanding of the timing and nature of this replacement. Recent discoveries from both the Tethyan realm, where *Ichthyotitan severnensis* became the first named Rhaetian ichthyosaur, and the Panthalassic margin of North America, where *in situ* giant shastasaurid remains have been found within 1.7 m of the Triassic-Jurassic Boundary, hold promise to increase our understanding of ichthyosaurs in the Late Triassic. Still,

significant stratigraphic gaps remain, including a ~10 Ma gap between the upper Carnian-lower Norian Hosselkus and Luning formations and the middle-to-upper Norian Pardonet Formation.

The Carnian section of the Luning Formation is best known from Nevada’s Berlin-Ichthyosaur State Park (BISP), where the large concentrations of ichthyosaur material occurs in the *K. schucherti* and *K. macrolobatus* ammonoid zones. Additional abundant ichthyosaur remains occur into the basal Norian *S. kerri* zone in the Pilot Mountains, but facies changes in the middle and upper member of the Luning Formation correspond with a loss of ichthyosaur material. The Luning Formation in the Cedar Mountains shows promise to help fill in some of the thinner spots in the early Norian record above the *S. kerri* zone, due to a different stratigraphy than that of BISP in the Shoshone Mountains and in the Pilot mountains. Multiple University of California Museum of Paleontology (UCMP) localities from the 1960s produced large ichthyosaur ribs, vertebrae, and limb elements. We successfully relocated these localities based on field notes from the initial expeditions and located additional large ichthyosaur elements that confirm occurrence in the middle Norian *J. magnus* zone. These rediscovered and new localities in the upper members of the Luning Formation in the Cedar Mountains, demonstrate the persistence of these giant marine reptiles throughout the Late Triassic and provide an opportunity to clarify shastasaurid relationships and potentially answer questions on body size evolution and tooth reduction within the group.

Funding Sources Funding for this project provided by student research grants from the Paleontological Society and the Nevada Petroleum and Geothermal Society.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**A novel method for estimating
paleoecological modifications of
vertebrate bone surfaces in the fossil
record**

McHugh, Julia¹, Drumheller, Stephanie K.²,
Nestler, Jennifer³

¹Museums of Western Colorado, Fruita,
Colorado, United States, ²University of
Tennessee, Knoxville, Tennessee,
United States, ³National Park Service,
Washington, District of Columbia, United
States

Many factors influence field collection protocols, from research goals to site lithology, logistics, etc. Among these, disparate researcher priorities can have a significant impact on the resulting fossil collection from a site in terms of species richness, size distribution, specimen completeness and condition, and even aesthetic value. Paleoecological data, in the form of taphonomically-modified bone surfaces (e.g., abrasion, feeding traces, etc.), can be particularly susceptible to biased sampling practices. The traditional method of reporting modified bones as per-specimen percentages across an assemblage often fails to capture details in specimen data, such as the location of bone modifications on individual specimens, the relative completeness of modified elements, or the marks' abundance. Here, we statistically compare the traditional, per-specimen percentage method against frequencies calculated from estimated surface areas of preserved cortical bone. To test the utility of this method, we evaluated paleoecological data from within a single locality in the Morrison Formation (Mygatt-Moore Quarry) using subsampled data from different collection regimes. Frequencies of specimens with modified bone surfaces were calculated in each collection cohort using the

traditional, per-specimen method. To estimate modified surface areas, we overlaid sets of specimen photos with a digital grid to create a virtual set of equal-sized fragments from which the frequencies were calculated. Results show the per-specimen frequencies were highly disparate among the intra-locality datasets, while frequencies calculated from the grid data were more consistent among the subsamples, supporting the digital fragmentation method as a more robust method to resist the effects of sampling bias. To further test the new method, we applied digital fragmentation to a second Morrison bonebed deposit (Bone Cabin Quarry). Frequency results were broadly equivalent between the two localities, making meaningful comparisons possible. Similarities in insect damage patterns suggest roughly equal exposure times prior to burial while differences in vertebrate bite mark frequencies indicated varying degrees of predation and scavenging between the localities. These types of inter-site comparisons are far more robust and biologically meaningful using the digital fragmentation method. We propose that this should be the preferred method for reporting bone surface modifications in future surveys.

Funding Sources Funding for this project was provided by the David B. Jones Foundation.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**30 years of insights from hands-on
dinosaur digs and informal paleontology
education at the Museums of Western
Colorado**

McHugh, Julia^{1,2}

¹Museums of Western Colorado, Fruita,
Colorado, United States, ²Colorado Mesa
University, Grand Junction, Colorado, United
States

Since the 1990s the Museums of Western Colorado has run an incredibly successful public dinosaur dig program. The MWC's program provides informal educational opportunities to volunteers, students, non-profit organizations, tourists, and families with children as young as five years of age and grandparents as old as 90. With approximately 30 years of informal, hands-on educational programming experience to draw upon, we were able to fine tune many essential logistical and educational tools and processes to ensure maximum engagement and enjoyment in our programming. We also identified many common pitfalls that can easily be avoided by other programs by employing a three step model: Planning, Awareness & Contingency (PAC). Field work involves a myriad of challenges for seasoned professionals as well as for informal educators and the general public, including logistics, safety, site security, and more. This presentation will highlight successes and challenges faced while teaching paleontology on the landscape. Presentation objectives include: 1) an overview of lessons learned and best practices in logistics and safety, 2) tips for building meaningful and mutually beneficial partnerships with other education-based and stewardship-based organizations, 3) pedagogy tips for engaging multi-generational and multi-background individuals together in an informal, outdoor setting, 4) insights into inclusivity and engagement with neurodiversity and physical disabilities outdoors, 5) the importance of collecting evaluative data on participants and programming, 6) integrating scientific and education goals holistically, and 7) tools for long-term program sustainability.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The evolution of aquatic adaptations in metriorhynchoid skulls (Crocodylomorpha, Thalattosuchia)

McKeown, Matthew¹, Young, Mark², Brusatte, Stephen², Wilberg, Eric¹

¹Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ²School of GeoSciences, University of Edinburgh, Edinburgh, United Kingdom

Metriorhynchoid thalattosuchians have a long evolutionary history, extending from the Early Jurassic to the Early Cretaceous. Within Metriorhynchoidea there is a dramatic shift in anatomy, coinciding the transition from a semiaquatic lifestyle (similar to living crocodylians) to a fully aquatic existence. These fully aquatic metriorhynchoids are members of the subclade Metriorhynchidae, and gave evolved an array of aquatic adaptations, such as the lateralization of the orbit, enlarged salt glands, paddle-like limbs and a hypoceral tail. Alas, the shift in lifestyle within Metriorhynchoidea is masked by an incomplete fossil record of transitional species. To help elucidate this transition, we CT scanned the holotypes of two Middle Jurassic non-metriorhynchid metriorhynchoids; *Eoneustes gaudryi* and *Zoneait nargorum*. *Eoneustes* and *Zoneait* are successive sister taxa to Metriorhynchidae and show the transition to a more metriorhynchid-like skull. Using the CT scans both specimens were segmented on a bone-by-bone basis, as well as their internal cavities. *Eoneustes* and *Zoneait* share several internal anatomical traits with Metriorhynchidae, including the dorsolateral expansions of the posterior nasal cavity, which form concave impressions on the internal surfaces of the lacrimal and prefrontal bones (a proposed osteological correlate for the nasal salt glands). While partially preserved in *Zoneait*, these impressions suggest enlarged salt glands like those seen in Metriorhynchidae. The antorbital cavity of *Zoneait* is broad, expanding laterally more than dorsoventrally, and is demarcated from the nasal cavity by a thin septum. The lateral border of the ventral process of the frontal is also preserved, with

a narrower morphology than seen in *Eoneustes*, potentially suggesting the salt glands were larger. The enlarged salt glands would have facilitated the consumption of osmoconforming prey (such as cephalopods) as well as allowing *Zoneait* to drink water in saline ecosystems. The prefrontals of *Zoneait* overhang the orbits to a greater extent than seen in *Eoneustes*, approaching the condition seen in Metriorhynchidae. The development of enlarged salt glands and lateralized orbits allowed these non-metriorhynchid metriorhynchids to act as effective aquatic hunters, further refined with successive anatomical adaptations as they became fully pelagic predators throughout the Jurassic.

Colbert Prize Session

Exemplary excretions: an examination of a Late Triassic coprolite and possible evidence of cannibalism in parasuchid phytosaurs

McKinney, Isaiah T.¹, Marsh, Adam², Kligman, Ben T.³

¹Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ²Resource Management and Science, Petrified Forest National Park, Petrified Forest, Arizona, United States, ³Paleobiology, Smithsonian, Washington, D.C., District of Columbia, United States

Examples of trophic interactions are rare in the vertebrate fossil record, and such fossils are incredibly important when it comes to reconstructing vertebrate paleoecologies. Here, we report a specimen that offers new evidence towards understanding the little-known ecological interactions of Late Triassic continental vertebrates. This specimen is a remarkable coprolite from the PFV 396 bonebed in the upper Blue Mesa Member (Late Triassic: Norian) of the Chinle Formation at Petrified Forest National Park, Arizona, U.S.A., containing a fragmentary

piece of a left dentary belonging to a small-bodied parasuchid phytosaur. Through comparison to a dataset of more complete phytosaur skull specimens from the Chinle Formation, we estimate that the skull length of this predated-phytosaur was between 461–623 mm. Despite the lack of body fossils for the potential predator/coprolite-maker, we used a mathematical formula from a study on extant crocodilian fecal dimensions, resulting in an estimated length for the phytosaur-eating carnivore of approximately 1.3 meters. Based on the known vertebrates from the PFV 396 vertebrate assemblage in this size class and the taphonomy and the weathered condition of the excretion, we hypothesize that the producer was likely semiaquatic in its life mode instead of terrestrial. This would therefore suggest that the predator was either a large-bodied metoposaurid temnospondyl or a phytosaur, and in life, it may have cannibalized or scavenged this smaller-bodied phytosaur. This is significant because phytosaurs are considered to be one of the apex predators of the Late Triassic in Laurasia, and yet this fossil shows that smaller, younger individuals were susceptible to predation themselves. This specimen serves as an example of either amphibian-on-archosaur predation or intrataxon cannibalism among parasuchid phytosaurs, of which there exists plenty of cases in phytosaur-convergent neosuchians (but this would be a novel ecological interaction in phytosaurs). Given how rare evidence of vertebrate predation is in the fossil record, these types of specimens and studies are paramount to forming stronger hypotheses around Late Triassic paleoecologies, food webs, and trophic interactions and understanding the ecologies of certain organisms within these ecosystems at different ontogenetic stages in their lives.

Funding Sources NSF EAR 1943286.

Petrified Forest National Park

PEFO Museum Association

USA NPS (PMIS 209814)

Virginia Tech Department of Geosciences

NMNH, Smithsonian Institution

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

New fossils and biostratigraphic implications from Miocene sites on the Uyoma Peninsula, Kenya

McNulty, Kieran P.^{2,1}, Hall, Abigail S.¹,
Lehmann, Thomas⁴, Muteti, Samuel^{3,1}

¹Ecology, Evolution & Behavior, University of Minnesota, St. Paul, Minnesota, United States, ²Anthropology, University of Minnesota, Minneapolis, Minnesota, United States, ³Palaeomammalogy, Senckenberg Gesellschaft für Naturforschung, Frankfurt, Germany, ⁴Palaeontology, National Museums of Kenya, Nairobi, Kenya

The Uyoma Peninsula, Siaya County, Kenya, has more than a dozen Miocene fossil localities that are generally thought to be associated with the Kisingiri volcanic edifice. Both lithological and biostratigraphic correlations with nearby Early Miocene deposits on Rusinga Island have tentatively suggested that most Uyoma localities are equivalent to Rusinga's Hiwegi and Kulu Formations. One Uyoma locality, Chianda, has instead been favorably compared to the Gumba Red Beds on Rusinga and to similar sediments at the fossil locality Karungu. Despite more than a thousand fossils from the Uyoma Peninsula, however, little paleontological research has been conducted there.

Here we report new discoveries from Uyoma and revised assessments of some earlier collections. Our results suggest that Miocene deposits on Uyoma likely span a greater time period than previously believed. The discovery of four *Bathyergoides* skulls at the

Magare locality suggest that at least some of the geological sequence is older than any strata from Rusinga Island, and may instead be contemporaneous with the oldest fossils from Mfangano Island and, more broadly, with assemblages from Songhor, Koru, and Napak. If so, a new primate mandible from Magare attributed to *Nyanzapithecus* would extend the age of that genus. On the other hand, the only historically collected primate fossil from Uyoma, a canine tooth from Chianda, bears striking resemblance to Middle Miocene hominoid canines, particularly in its distolingual features. This suggests that Chianda, a highly fossiliferous but poorly studied locality known primarily for aquatic taxa, may be younger than any other Kisingiri site.

Funding Sources Funding for this project came from National Science Foundation grants to KPM (BSE #1241807) and ASH (BSE #2142037), and from a Leakey Foundation grant to ASH.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Comparisons between the hindlimb morphology of early cetaceans and modern semiaquatic mammals

Medeiros, Edward, Uhen, Mark D.

Atmospheric, Oceanic, and Earth Sciences, George Mason University, Fairfax, Virginia, United States

Early archaeocete cetaceans possess physiological traits that imply a semiaquatic lifestyle. Modern pinnipeds and *Enhydra* are semiaquatic, living much of their lives in marine environments but still retaining the capability of terrestrial locomotion. As such these groups have been proposed as analogs for the terrestrial capabilities of early archaeocetes. A potential criticism of these analogies arises with regard to the disparate

evolutionary relationships of the groups as Pinnipeds and *Enhydra* descend from terrestrial carnivoran ancestral stock while cetaceans descend from terrestrial artiodactyls. Given the substantial differences that exist in both terrestrial and aquatic locomotion between groups of pinnipeds and certainly between pinnipeds and *Enhydra* it follows that differences between these groups and cetaceans may be correspondingly large. The purpose of this study is to examine the validity of established analogies for archaeocete locomotion. By comparing the proportions of segments of the hindlimbs in groups including: pakicetids, ambulocetids, protocetids, remingtonocetids, otariids, phocids, *Enhydra*, and terrestrial artiodactyls we can begin to assess morphological similarities and disparities as they relate to gait. For example, the method shows the proportion of total femur length to total tibia length in an archaeocete such as *Maiacetus* compared to the same proportion in *Enhydra*. As basilosaurid archaeocetes are considered to have had an obligate aquatic lifestyle they were excluded from this analysis. Results show that archaeocete hindlimb proportions exhibit significant variance and that the groups do not all cluster together. Given the paraphyletic nature of the group and the variety of archaeocete forms, this result is unsurprising. In general, the limb proportions in sampled archaeocetes do not display consistent or significant overlap with other secondarily aquatic tetrapods though are closer to *Enhydra* than to pinnipeds. Otariids and phocids each plot into a distinctive cluster with those clusters plotting closer to one another than either one does to other groups. While these data imply that archaeocete limb proportions were generally more similar to those of *Enhydra* than to pinnipeds they also suggest that the use of such limb proportions in gait reconstruction in archaeocetes is limited. The addition of more taxa with known gaits to this matrix will serve to strengthen interpretations.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Angular movement during the stance phase of walking in plantigrade, digitigrade, and unguligrade terrestrial mammals: developing an in vivo database for morphofunctional inferences

Medina-González, Paul

Kinesiología, Universidad Católica del Maule, Talca, Región del Maule, Chile

The development of morphofunctional inferences in paleontology is based on ex vivo morphological information obtained from the anatomy of current animals. Although the approach to functional indices stands out within this framework, they do not consider in vivo movement in their structuring, which presents a kinematic synergy in current mammals. In this regard, what is the angular amplitude used by the limbs during the support of terrestrial mammals, and how does it differ between different postures?

The objective was to know the angular excursion during the touchdown (TD), midstance (MS), and toe off (TO) support phases of terrestrial mammals with different limb postures.

187 species belonging to 15 orders of plantigrade (forelimb, n = 37; hindlimb, n = 49), digitigrade (forelimb, n = 45; hindlimb, n = 54), and unguligrade (forelimb, n = 42; hindlimb, n = 60) terrestrial mammals were evaluated during the support phase of the gait cycle. Joint amplitude (degrees) was recorded for the TD, MS, and TO phases. The functional space was determined for the forelimb (i.e., shoulder, elbow, and wrist) and hindlimb joints (i.e., hip, knee, and ankle) through the range of motion (ROM) obtained between the minimum and maximum values of the walking support according to posture.

The analysis was developed by capturing video frames available on the web and data from kinematics studies.

For plantigrades, the ROM (min to max) was shoulder: 68° (15-83°), elbow: 65° (5-70°), wrist: 120° (5-125°), hip: 102° (8-110°), knee: 75° (10-85°), and ankle: 70° (5-75°). For digitigrades, the ROM was shoulder: 91° (0-91°), elbow: 68° (0-68°), wrist: 125° (0-125°), hip: 102° (0-102°), knee: 79° (4-83°), and ankle: 76° (10-86°). For unguligrades, the ROM was shoulder: 98° (5-103°), elbow: 76° (2-78°), wrist: 47° (3-50°), hip: 60° (0-60°), knee: 43° (7-50°), and ankle: 48° (5-53°).

The angular change during the walk stance phase presents a different joint utilization profile depending on the type of posture. This “in vivo” database is an excellent opportunity to start constructing morphofunctional spaces for inferences in the paleobiology of Eocene and Miocene Notoungulates.

Funding Sources Funding for this work was received from Agencia Nacional de Investigación de Chile (ANID). Proyecto FONDECYT de iniciación en investigación N°11231111.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Influence of anatomical layers on the range of motion in rabbit (*Oryctolagus cuniculus*) and pudú (*Pudu puda*): building an ex vivo database for morphofunctional inferences

Medina-González, Paul¹, Bernal-Fernández, Valentina^{2,4}, Arancibia-Müller, Rodrigo³, Aburto-Valdevenito, Pedro⁴, Gómez-Jaramillo, Marcelo⁴

¹Kinesiología, Universidad Católica del Maule, Talca, Región del Maule, Chile, ²Escuela de Graduados, Universidad Austral de Chile, Valdivia, Provincia de los Ríos, Chile, ³Instituto de Farmacología y Morfofisiología, Facultad de Ciencias

Veterinarias, Universidad Austral de Chile, Valdivia, Región de los Ríos, Chile, ⁴Escuela de Medicina Veterinaria, Universidad Austral de Chile, Valdivia, Región de los Ríos, Chile

One of the primary challenges in developing morphofunctional inferences is the limited information on soft tissues in the fossil record, which complicates the determination of indicators such as the range of motion (ROM) of joints. Mammals exhibit a wide variety of postures, ranging from plantigrade (e.g., lagomorphs) to unguligrade (e.g., artiodactyls). These postures are dynamic and influence the biological capabilities. Due to their bioecology and transitional limb postures, rabbits and pudus are small mammal species that can be useful for interpreting the paleobiology of extinct small mammals that lack modern homologs (e.g., Typotheria and Hegetotheria).

Our objective was to determine the influence of anatomical layers on the ex vivo ROM in the limbs of pudu (*P. puda*) and rabbit (*O. cuniculus*). The right forelimbs and hindlimbs were dissected (donations from the Laboratorio de Anatomía Veterinaria, Universidad Austral de Chile). Three evaluators measured the maximum ROM (flexion to extension in degrees) in the forelimb (shoulder, elbow, wrist) and hindlimb (hip, knee, ankle) under four conditions of anatomical layer integrity: 1) tegumentary + muscular (m) + articular (a) + osseous (o), 2) m+a+o, 3) a+o, and 4) o. The inter-rater reliability of the measurement protocol was assessed using the intraclass correlation coefficient (ICC3,1; ICC 95%CI). The percentage change in ROM for each anatomical condition was analyzed using Friedman's ANOVA with Dunn's post hoc test.

The measurement protocol demonstrated excellent reliability, with an ICC of 0.998 (95%CI: 0.997-0.998). In both species, the ROM increased significantly in the forelimb (ranging from +6% to +379%; $p < .001$) and hindlimb (ranging from +17% to +480%; p

<.001). In the forelimb, the rabbit showed a higher rate of change in the wrist (+379% vs. +51%) and pudu in the shoulder (+197% vs. +79%), while the change in the elbow was similar (+140% in rabbit vs. +164% in pudu). In the hindlimb, the highest rate of change was observed in the pudu for the hip (+480% vs. +100%), knee (+129% vs. +86%), and ankle (+196% vs. +66%).

Dissecting the anatomical layers in the limbs of the rabbit and pudu consistently resulted in an increase in ROM. The magnitude of this change varied according to the type of posture and the joint being evaluated. This reliable protocol is intended to be applied to establish correction factors in the development of paleobiological inferences.

Funding Sources Funding for this work was received from Agencia Nacional de Investigación – ANID, Chile. Proyecto FONDECYT de iniciación en investigación folio N°11231111.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Preliminary report of tridactyl track morphotypes in the Brushy Basin Member of the Jurassic Morrison Formation, Curecanti National Recreation Area, Colorado

Mehew, Spenser¹, King, Michael R.², Foster, John R.³, Mims, Alison⁴, Frost, Forest⁵, Tweet, Justin⁶, Santucci, Vincent⁷

¹Department of Geographic and Environmental Studies, University of Colorado at Colorado Springs, Colorado Springs, Colorado, United States, ²Natural and Environmental Sciences, Western Colorado University, Gunnison, Colorado, United States, ³Utah Field House of Natural History State Park Museum, Vernal, Utah, United States, ⁴Pacific Northwest Region, U.S. Forest Service, Elgin, Oregon, United

States, ⁵Curecanti National Recreation Area, National Park Service, Montrose, Colorado, United States, ⁶National Park Service, Cottage Grove, Minnesota, United States, ⁷National Park Service, Washington, District of Columbia, United States

Three morphotypes of vertebrate trace fossils can be defined in the Kimmeridgian–Tithonian Brushy Basin Member of Curecanti National Recreation Area (CURE) in southwest Colorado. All three morphotypes are preserved along surfaces in disparate, thin, very fine–fine grained sandstone beds with rippled or massive textures due to invertebrate burrows and rooting. Morphotypes 1 and 2 are preserved as convex hyporeliefs (natural casts) along the bases of two of these overbank deposits, whereas Morphotype 2 and 3 are preserved as concave epireliefs (natural moulds) along one disassociated sandstone upper surface. Thirty-six tridactyl tracks of Morphotype 1 are present in CURE as displaced, mesaxonic natural casts that are almost twice as long as wide (average length of 41.2 cm, width of 26.9 cm, and length/width ratios of 1.54). The triangular shape and length/width ratio values suggest these tracks are attributable to *Deltapodus brodricki* (stegosaurian producer). Morphotype 2 consists of one natural mould (associated with Morphotype 3 tracks) and three tracks as natural casts along the base of a separate displaced sandstone block. Morphotype 2 has a large II–IV digit divarication measure (around 105°), similar measures of footprint length to width, and closely equivalent II–IV digit lengths and interdigital (II–III, II–IV) divarication angles. Some specimens of Morphotype 2 exhibit impressions of the distal metatarsals. These features are consistent with descriptions of *Anomoepus* (small ornithischian). Morphotype 3 is represented by more gracile shallowly emplaced natural moulds with narrow II–IV digit divarication angles (61.5–64°), larger length/width ratios, and small anterior triangle measures due to an elongate

digit III. Morphotype 3 is a *Grallator*-like track (small theropod). The identification of these tracks adds to the scant record of stegosaur tracks and suggests the presence of small theropods and ornithischians within the area. Identification of these morphotypes provides comparable examples to build towards establishing norms and variants of regular kinetic motion or taphonomic controls. Additionally, the identification of these vertebrate trace fossils provides avenues for public education about natural history within Curecanti National Recreation Area, as well as help establish plans for paleontological resource management.

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Dental complexity disparity of Late Triassic reptiles resembles extant Sauria

Melstrom, Keegan M.^{1,2}, Kligman, Ben T.^{3,4}, Marsh, Adam⁴, Nesbitt, Sterling J.⁵, Stocker, Michelle R.⁵, Irmis, Randall^{6,7}

¹Biology, University of Central Oklahoma, Edmond, Oklahoma, United States, ²Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States, ³Paleobiology, National Museum of Natural History, Washington D.C., District of Columbia, United States, ⁴Resource Management and Science, Petrified Forest National Park, Petrified Forest, Arizona, United States, ⁵Department of Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ⁶Natural History Museum of Utah, Salt Lake City, Utah, United States, ⁷Geology and Geophysics, University of Utah, Salt Lake City, Utah, United States

The Triassic Period was a transformative interval in the history of tetrapod evolution, when the survivors of the end-Permian mass extinction diversified and radiated into novel ecological roles. Triassic tetrapods display a higher disparity in tooth shapes compared to

Permian taxa, but many aspects about their dietary ecologies remain poorly understood. In particular, quantitative evaluations of diet are sparse and the specific ecological role that many groups occupied remain unresolved. To address this, we used micro-CT scans of 17 Late Triassic saurian taxa to create 3D surface models of teeth. Using the orientation patch count rotated (OPCR) method, we quantified phenotypic tooth shape to directly compare the dental complexity of extinct groups. These data were combined with existing OPCR data on extant saurians to provide a direct comparison to extant taxa. Dental complexities of Triassic taxa vary considerably (OPCR mean of 8.5–23.45 patches per tooth). The lepidosauromorph *Vinitasaura lizae* and the phytosaur *Wannia scurriensis* exhibit relatively simple teeth, each with ~10 patches per tooth. In contrast, *Trilophosaurus buettneri* has the highest average dental complexity in sampled taxa, followed closely by *Revueltosaurus callenderi* and the silesaurid *Kwanasaurus williamparkeri*. Between these extremes are a variety of early lepidosaurs, *Puercosuchus* (an azendohosaurid), lagerpetids, and dinosaurs. The range of dental complexities in our dataset overlaps those of sampled extant saurians. Only some iguanids (*Cyclura cornuta*) and teiids (*Dicrodon guttulatum*) exhibit more complex teeth on average than *Trilophosaurus*. Sampled early lepidosaurs (i.e., *Diphydontosaurus*, *Vinitasaura lizae*, *Eusphenodontia* sp.) display simple teeth suggestive of a diet comprising primarily annelids and arthropods. The overlapping disparity in dental complexities of Late Triassic and living taxa demonstrates that the range of ecological roles in our dataset matches that of extant saurians, with carnivores, insectivores, and herbivores, as well as potential omnivores, despite noteworthy differences in food items between the two time periods. Together, these results demonstrate that the ecological roles of terrestrial organisms have remain largely

static even as the specific clades that occupy those roles change.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

An XRF and SEM study of the integumentary system of the Jurassic euharamiyidans and its implication for paleobiology of early mammaliaforms

Meng, Jin¹, Mao, Fangyuan², Li, Zhihen²

¹Paleontology, American Museum of Natural History, New York, New York, United States, ²Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, Beijing, China

There is an increased interest in studying remains of soft tissues in fossil vertebrates, such as the integumentary system, ranging from their microstructures to chemical elements. Some of these studies aimed to address pigments, thus paleocolor and related physiology and paleobiology, of non-mammalian animals. It has been known that the body hair of mammals and pigment distribution in the skin and hair facilitate endothermy, protection, and camouflage for adaptation to diverse external environments. In an acutely vision-oriented world melanocytes played an important role in the rise of mammals to dominance in the natural world. It is also known that mammals show an increased diversity of melanosome form compared to ectothermic amniotes. However, fossil records of the integumentary system in early mammaliaforms are rare, and potentially microstructures, such as melanosomes, are poorly known and the reliability of detected microstructures, such as melanosomes, remain debatable. Here we document the chemical distributions and microstructures of the well-preserved holotype specimen of *Mirusodens caii* and other euharamiyidans, using the methods of

X-ray fluorescence (XRF), SEM, TEM and Raman spectrum. The full-area XRF revealed the spatial distributions of chemical elements of potentially endogenous biological structures in situ on the specimen slab. The SEM and TEM images showed convincing structures of melanosomes in the integumentary remains of the examined specimens. The Raman spectrum analyses also revealed the organic Raman shift on the melanosome bands compared to the sedimentary matrix. In addition to the gross morphology (bony structures and hair impressions), these chemical and microstructural features contribute to the discussion on the soft tissues and related paleobiology of the Mesozoic mammaliaforms. Based on the chemical and microstructural data, we conclude, tentatively, that eumelanosomes and phaeomelanosomes are both present in the skin and hair of euharamiyidans. However, identification of paleocolor of the integumentary system remains challenging, but it seems probable that the black and brown color, common in extant small and arboreal mammals could have existed in the integumentary system of the euharamiyidans that had lived in the Jurassic forests.

Funding Sources This work was supported by the National Natural Science Foundation of China (42122010, 42072002).

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

A Micro-CT based reconstruction of *Tetraceratops insignis* (Synapsida; Eupelycosauria) and new insights into its taxonomy and biology

Mercado, Magdalen M.¹, Benson, Roger B.², Angielczyk, Kenneth D.³

¹Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois, United States, ²American Museum of Natural

History, New York, New York, United States, ³Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Tetraceratops insignis is an enigmatic early Permian synapsid, known from a single skull collected by C. H. Sternberg in Baylor County, TX in 1897. Little documentation from its discovery survives, but its locality, Big Wichita River (Lower Clear Fork; Kungurian), is reported to be well-prospected, with vertebrate material exceedingly rare. The skull is ca. 10 cm in length and is mostly complete—but is flattened diagonally and partially crushed. This damage has prevented decisive interpretation of its anatomy, obscuring the phylogenetic affinity of *Tetraceratops* and its putative therapsid identity. If true, *Tetraceratops* would be the only lower Permian therapsid and would abridge the ghost lineage obscuring the origins of Therapsida. Debates about the relationships of this taxon have taken precedence over analysis of the specimen itself, and its morphology is relatively understudied. Its most notable features include the bony bosses or ‘horns,’ on the premaxillae, prefrontals, and angular. The ornamentation and degree of ossification suggest a mature individual, but the orbits are unusually large for an adult. The orientation of the first tooth root within the dentary is unusual for a pelycosaur and almost incisor-like in its protrusion. The maxilla and dentary bear enlarged caniniform teeth that differ from the slender, peg-like posterior dentition, but the degree of supracaniniform buttressing is obscured by the premaxillary horn. There appears to be a ventral keel on the angular, a potential homologue of the reflected lamina of the angular. The profile of the rostrum besides the bony ornamentation is short and round, unusual for a faunivorous pelycosaur, and the anterior part of the mandible is narrow and delicate in comparison with the rest of the skull. These traits allude to an unusual specialist whose morphological

uniqueness may be driven by yet-unknown functional demands. μ CT scanning of the specimen has provided new details of its anatomy and allows greater confidence in reconstructing and interpreting taphonomically damaged bone. The preserved microstructure of the fragmented posterior cranium clarifies the long-disputed identity of several elements by evincing their relative position and orientation. The evidence-based reconstruction of both the most problematic and phylogenetically informative aspects of this specimen will provide new insights into phylogenetic position of *Tetraceratops* and its significance to early synapsid evolution.

Funding Sources University of Chicago

Field Museum of Natural History

American Museum of Natural History

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Ankylothecondonty in rhynchosaurs (Archosauromorpha) involves true tooth sockets formed by cementum, alveolar bone, and the mineralized periodontal ligament

Mestriner, Gabriel^{1,2}, Funston, Gregory F.³, Nesbitt, Sterling J.⁴, Marsola, Júlio⁵, Langer, Max C.¹, Evans, David^{3,2}, Sidor, Christian A.⁶, LeBlanc, Aaron⁷

¹Biology, USP, Ribeirão Preto, SP, Brazil, ²Ecology & Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada, ³Natural History, Royal Ontario Museum, Toronto, Ontario, Canada, ⁴Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ⁵Federal University of Technology, Dois Vizinhos, Paraná, Brazil, ⁶Paleobiology, Smithsonian, Washington, District of Columbia, United States, ⁷Faculty of Dentistry, Oral &

Craniofacial Sciences, King's College
London, London, United Kingdom

The study of tooth attachment and implantation has yielded valuable insights into the paleobiology of amniotes. Whereas the term 'tooth implantation' categorizes teeth by their spatial relations in the jaws, 'tooth attachment' distinguishes teeth that are fused to the jaw (ankylosis) from those suspended by a periodontal ligament (gomphosis). The evolutionary significance of tooth attachment has been difficult to assess due to historical conflation with tooth implantation terminology, resulting in misinterpretations of reptilian attachment tissues (sometimes called "bone of attachment") and their homology to those of mammals: cementum, periodontal ligament, and alveolar bone. Among archosauromorphs, tooth attachment in dinosaurs and crocodilians is nearly identical to that of mammals, but closely related forms appear to have ankylosed teeth, similar to most other amniotes. Hence, studying tooth attachment of early archosauromorphs is pivotal to understand the main shifts in tooth attachment seen in the clade. Here we analyze the tooth attachment of rhynchosaurs, a group of quadrupedal herbivores that played a key role as primary consumers in many Triassic ecosystems. Their dentition consists of multiple tooth rows with posterolingual addition of teeth during growth, but their tooth attachment has rarely been characterized. Our histological data from three rhynchosaur specimens from the Triassic Manda Beds of Tanzania show that, despite fusion to the jaw, rhynchosaur teeth are surrounded by an extensive network of ligamentous Sharpey's fibers, layers of cementum, and zones of alveolar bone. What has been previously described as "spongy bone of attachment" in rhynchosaurs encompasses the same attachment tissues seen in mammals, dinosaurs, and crocodilians, albeit completely mineralized in mature teeth. Analysis of teeth at different

stages of development shows that ankylosis occurs by the growth of alveolar bone towards the cellular cementum, which eventually overprints the soft ligament. This suggests that the tissues conflated as "bone of attachment"—alveolar bone, periodontal ligament, and cellular cementum—are homologous across most archosauromorphs. Our data add to a growing body of evidence that heterochronic changes to the rates and extents of mineralization, not convergent evolution to mammal-like attachment tissues, led to the independent evolution of gomphosis across many amniote lineages, including at archosauromorphs.

Funding Sources FAPESP (2022/00171-9 and 2022/12395-9) to GM; NSERC and Vanier-Banting Comm. to GF; NSF EAR-1337291 and Nat. Geo. Res. & Exp. (9606-14) to SN; NSF EAR-1337569 to CAS.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Opening the digital door at MOR: reconfiguring the Paleontology Collections to increase accessibility

Metz, Eric T.¹, Lamm, Ellen-Thérèse¹, Scannella, John²

¹Museum of the Rockies, Montana State University, Bozeman, Montana, United States, ²Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, Montana, United States

Since the founding of the Paleontology Department at Museum of the Rockies (MOR) in 1982, the museum's paleontology collections have grown to an extensive representation of dinosaurs and other vertebrates (currently over 13,000 numbered specimens) from the northern Rocky

Mountain region. MOR is a repository for fossils found on state of Montana and federal lands and the collection continues to grow with ongoing fieldwork. To facilitate tracking of specimens and related data, the collections are being reorganized into a hierarchy of geological formation, land management agency, locality, taxonomy, and anatomy. This organizational structure prioritizes the preservation of paleoecological data and is attuned to the needs of land management agency inventories. Over the years, specimen tracking at MOR has evolved from the use of a card catalogue, to digital spreadsheets, to the recent implementation of the browser-based relational database system: Specify. This software has been customized to record individual elements preserved from each specimen, as well as depositional and taphonomic information. The database system permits the importation and tracking of specimen and locality images, as well as photomicrographs from the museum's archive of paleohistological specimens (n >2400). In 2024, MOR's paleontology collection will be made available to the public via a web portal, with certain data embargoed per federal and state regulations. Updating the organizational system in the paleontology collections at MOR and improving digital access to this library of information will greatly expand its use for paleontology research and education during both onsite and virtual visits to the collections.

Funding Sources Funding for the MOR Paleontology Collections reorganization provided in part by Department of Interior, Bureau of Land Management, and United States Forest Service.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A morphometric study of postcranial ontogeny in *Triceratops* from the Hell Creek Formation, Montana

Mezak, Curren K.¹, Chinnery, Brenda^{3,2}, Scannella, John¹

¹Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Touro College of Osteopathic Medicine, Great Falls, Montana, United States, ³Museum of the Rockies, Montana State University, Bozeman, Montana, United States

Studies of the large sample of the ceratopsid dinosaur *Triceratops* (n>100) from the uppermost Cretaceous Hell Creek Formation (HCF) in Montana have revealed growth changes in the skull, including postorbital horn core reorientation and compression of frill epioassifications. While *Triceratops* cranial material is abundant, postcrania is comparatively rare and, as such, growth trends in the rest of the skeleton have remained largely undeciphered. Here, we applied linear and geometric morphometrics to explore ontogeny of *Triceratops* postcrania in specimens with associated skulls.

Examined *Triceratops* ranged in size from a small juvenile (MOR 2951; basal skull length 59 cm) to large adults (including MOR 8148; estimated basal skull length 118 cm). The scapula, coracoid, humerus, ulna, femur, tibia, ilium, pubis, and ischium were targeted for this study due to larger available samples sizes of these bones; however, sample sizes are still relatively small compared to cranial datasets (e.g., n=11 for ischia). Landmark-based linear data were analyzed in PAST and 2D landmark morphometrics were collected using Image J and analyzed using the geomorph package in R. Reduced Major Axis regression analyses of the log-transformed dataset indicate isometry in most elements; however, allometry is detected in some aspects of the skeleton. For example, the anterior scapula and the proximal femur, including the femur head and greater

trochanter, expand throughout growth. Principal Component Analysis (PCA) of linear data recovers groupings largely consistent with juvenile, subadult, and adult growth stages. PCA of 2D landmark data highlights allometric changes throughout the skeleton that are undetected in the linear analyses, including increasing curvature of the ischium and widening of the olecranon process in the ulna through growth. These results suggest changes in posture and locomotion through ontogeny, possibly related to the increasing size of the skull as *Triceratops* develops.

Funding Sources Support provided by G. Ohrstrom.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Terror from the skies? Investigating the energetics and feeding ecology of the largest pterosaurs *Quetzalcoatlus*

Miller, Kierra¹, Zoller, Norah¹, Habib, Michael B.², Larsson, Hans C.³, Dececchi, Thomas A.¹

¹Biology, Dakota State, Vermillion, South Dakota, United States, ²UCLA, Los Angeles, California, United States, ³McGill University, Montreal, Quebec, Canada

Pterosaurs, a lineage of Mesozoic flying archosaurs, include the largest flying animals ever known. *Quetzalcoatlus nortropi* a Late Cretaceous representative, had a wingspan of over 10 m and likely weighed more than 200 kg. It presents a combination of features (large head, massive wingspan, shoulder height equivalent to an extant giraffe) that has led to ecological interpretations of it as a major predator in the North American Maastrichtian Biome, perhaps second to only *Tyrannosaurus rex*. Here we examine the probability of that from an energetics perspective. Despite the great wingspan of *Quetzalcoatlus*, the body length (gleno-acetabular distance) is relatively small (~500

mm) and a volume of ~1.5 times that of an average sized human male. When factoring in lung volume this restricted the gut capacity and thus prey size. We estimate, for a 200-250 kg adult, a maximum prey size of 5-7 kg. We then examined if this would be enough to sustain an adult *Quetzalcoatlus* and based on extant mammalian and avian field metabolic rates (FMR). We suggest that a daily food requirement would be around 3.5-5 kg per day using FMR. This suggests that such large creatures would be feeding on either very small prey items or could scavenge leftovers well after the larger theropods had secured their fill. In addition, take off and flapping flight would be so extremely costly at such a large size, as demonstrated by the fact that in extant birds this value is often 20 times basal metabolic rate or greater. Given these factors (expected glide speeds on the order of 20 m/s or more, the costs of landing and launching are high, the maximum gut capacity low) we suggest that the primary ecological role was a terrestrial walking small prey specialist and/or scavenger. In the largest adults, flight would likely be minimized to extreme cases like escape or long-distance migration, with the daily locomotion primarily done terrestrially, though juveniles were likely more aerial. Given the lack of mid-sized carnivores in the environment *Quetzalcoatlus* likely used its size to intimidate smaller rivals such as *Saurornitholestes*, while feeding on similar sized prey. It was not in competition with sub adult or mature Tyrannosaurs, nor preying on all but the smallest members of the dinosaurian fauna. Thus, we suggest it played the role of a lower trophic level consumer and not an apex predator.

Colbert Prize Session

Re-assessment of the relationships within the plesiadapiform family Microsyopidae in North America

Miller, Kristen, Beard, K. Christopher

Ecology and Evolutionary Biology, University of Kansas, Lawrence, Kansas, United States

Plesiadapiforms (Mammalia, Primatomorpha) are an extinct, paraphyletic group that figure prominently in discussions of primate origins. With a stratigraphic range extending from the late Paleocene to the middle Eocene, Microsyopidae is the second longest lived of any plesiadapiform family. With an extensive North American record, most microsyopids are known from the Western Interior, but fossils have also been recovered from Eocene strata in California and Mississippi. Two genera (*Arctodontomys* and *Navajovius*) have also been reported from the Tiffanian Black Peaks Formation (BPF) of Big Bend National Park in west Texas, marking the southernmost known geographic records of these taxa in North America. Additionally, the BPF microsyopids may represent the oldest known occurrences of *Arctodontomys* and *Navajovius*. The BPF microsyopids come from two late Paleocene (Tiffanian) localities, Ray's Bonebed (Ti3?) and Joe's Bonebed (Ti5?). While both taxa are present at both localities, *Navajovius* is more abundant at the older Ti3? locality while *Arctodontomys* is more abundant at the younger Ti5? locality.

While Microsyopidae was first described in 1892 by Osborn and Wortman, the relationships between the three subfamilies, Microsyopinae, Uintasoricinae, and Navajoviinae, remain unresolved. Twenty-one described microsyopid species represented by eight genera are currently recognized. However, a comprehensive phylogenetic analysis of the entire clade has never been performed. Here, we describe the two new microsyopid species from the BPF and present results from the first comprehensive phylogenetic analysis examining craniodental morphology of North American Microsyopidae, including all previously described species from North America and the new species of *Navajovius* and

Arctodontomys from the BPF. Our initial results suggest the subfamilies Uintasoricinae and Microsyopinae are sister to each other to the exclusion of *Navajovius* as both subfamilies possess broad, lower p4s that are more molariform than the narrow, simpler p4s of *Navajovius*. Additionally, *Navajovius* retains a reduced but distinct paraconid on lower m2-3 while the paraconid is greatly reduced or absent in microsyopines and uintasoricines.

Funding Sources Funding provided by the David B. Jones Foundation and the Leakey Foundation

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Bringing fossils to your fingertips: Photogrammetry techniques within paleontological exploration

Miller, Lacy L.¹, Przybyszewski, Eric², Cozart, Jennifer², Scofield, Garrett², Harvey, Jonathan¹

¹Geosciences, Fort Lewis College, Fort Collins, Colorado, United States, ²Colorado Northwestern Field Museum, Colorado Northwestern Community College, Craig, Colorado, United States

There is a large barrier within the field of paleontology between the public's knowledge and the information that is presented to them, whether that is site-specific data or the fossils themselves. The Evil Tree Site is an important late Jurassic-aged paleontological locality with valuable scientific interest, as well as a great opportunity for the public to learn more about Earth's history once shared. This communication barrier between paleontologists and the public can easily be solved by summarizing the prevailing methods of sharing and publishing site-specific data as well as reviewing these methods for improvements to make public

access and comprehension of these sites easier. This research led to the discovery of software that fits these requirements, doesn't share sensitive locality information, and can be used for scientific research. The software able to do all of this is Polycam, and it uses structure from motion capabilities and light detection and ranging to create full 3D models with high-resolution image quality. To test the accuracy of the Polycam software, four scans were completed in total, one of a fossil shell, one of a *Bistahieversor sealeyi* skull cast, and one of a local quarry that is 3 x 13m. The Evil Tree Site, which is comparably sized to the local quarry, was also done for comparison. It was the authors' experience that Polycam is easy to use, even for anyone with no prior experience using photogrammetry software or creating 3D models. The use of it by these authors' suggests Polycam is one of the most groundbreaking technologies to record paleontological discoveries both within the field as well as within museum spaces and has the potential to soon become the leading tool for sharing three-dimensional map data. The methodologies that were developed as a result of this research and the trial runs that were conducted for this project will be used in the upcoming summer fieldwork of 2025 at the Evil Tree Site, as well as within the fossil collections of the Colorado Northwestern Community College's repository.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

New *Champsosaurus* sp. (Diapsida: Choristodera) material from the Campanian Wapiti Formation of northern Alberta, Canada

Milligan, Jack R.¹, Wu, Yiyang², Bamforth, Emily^{3,1}, Sissons, Robin L.², Sweder, Jackson³, Campione, Nicolás⁴, Bell, Phil R.⁴, Sullivan, Corwin^{2,3}

¹Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, ²Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ³Philip J. Currie Dinosaur Museum, Wembley, Alberta, Canada, ⁴Palaeoscience Research Centre, University of New England, Armidale, New South Wales, Australia

The choristodere *Champsosaurus* is a distinctive component of Late Cretaceous faunas in western North America, notable for its dorsoventrally flattened skull with proportionally large temporal chambers and elongated snout. In southern Alberta, *C. albertensis* is known from the Campanian-Maastrichtian Horseshoe Canyon Formation, and *C. natator* and *C. lindoei* from the underlying Belly River Group. Previously reported material from northern Alberta has been limited to several elements from the Dinosaur-Chelonian (DC) Bonebed and the Kleskun Hill microvertebrate locality in Unit 3 of the Wapiti Formation. The Wapiti Formation dates to the late Campanian, overlapping temporally with the Belly River Group and the surficially exposed part of the Horseshoe Canyon Formation in southern Alberta. Herein, we describe additional Wapiti Formation *Champsosaurus* material from the DC Bonebed, the Bezanson microsite in Unit 2, and the Pipestone Creek *Pachyrhinosaurus lakustai* Bonebed in Unit 3. The material comprises nearly two dozen isolated and/or dissociated cranial and postcranial elements. These new specimens from the Wapiti Formation are referable to *Champsosaurus*, based on comparisons with more complete material from southern Alberta and elsewhere, but cannot be confidently identified to the species level. A prefrontal from the DC Bonebed shows differences in the curvature of the dorsal surface and posteroventral margin from the corresponding element in *C. lindoei*, but whether this indicates a taxonomic difference is uncertain. Comparison with available

Champsosaurus material from the Dinosaur Park Formation (DPF) reveals that the Wapiti Formation *Champsosaurus* sp. specimens are generally smaller than *C. albertensis*, and comparable to *C. lindoei* and *C. natator*. Wherever *Champsosaurus* occurs in the Wapiti Formation, this taxon is more abundant than crocodylians, which have been regarded as its closest modern analogue. Factors that could affect the abundance and variation in the overall body size of *Champsosaurus* in different locales include temperature, photoperiod, food availability, and the presence of competitors. Based primarily on body size comparisons and biostratigraphy, Wapiti Formation *Champsosaurus* sp. is comparable to both *C. lindoei* and *C. natator* from the DPF, pending the discovery of more complete material from the Wapiti Formation.

Funding Sources The Natural Sciences and Engineering Research Council of Canada, and endowment funds associated with the Philip J. Currie Professorship at the University of Alberta.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A New Microsite from the Mussentuchit Member of the Cedar Mountain Formation, Utah

Mitchell, Jonathan S.¹, Morse, Avalynn¹, Gabriel, Cornelia¹, Makovicky, Peter³, Zanno, Lindsay E.², Hedge, Joshua²

¹Biology, Coe College, Cedar Rapids, Iowa, United States, ²Geology, University of Minnesota, Minneapolis, Minnesota, United States, ³North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States

The Mussentuchit Member of the Cedar Mountain Formation (Cenomanian; 98-96Ma) has yielded a large number of well-

characterized microsites. The density of microsites, both stratigraphic and geographic, provides a framework for interpreting ecological and evolutionary change during this critical time period in North America.

Here, we report on a new locality showing a marked bias towards aquatic organisms. Most fossil remains are either unidentifiable bone fragments or fragments of eggshell. The density of identifiable bone fragments is, however, quite high (approximately 31 identifiable fossils per kilogram of unwashed matrix; similar to the NCSM Cliffs of Insanity [COI] site).

The overall fauna is predominantly mesoeucrocodylian teeth. At least four morphotypes, including a bernissatid-like form, have been recovered.

Mesoeucrocodylian osteoderms are also present. Actinopterygian remains are the next-most abundant fossil type, including teeth from gar and pycnodontiforms, and several abundant fish scales. Dinosaur teeth, particularly theropods, make up the third-most common fossil type. Turtles, squamates, and albanerpetonid remains have also been recovered. Mammals are so far absent.

Additionally, the site preserves two distinct eggshell morphotypes. Numerically, eggshell fragments are the most abundant identifiable fossil type at this locality, although their count is not comparable to counts of other fossil types. Amber is present in trace amounts, as is charcoal.

Funding Sources Collecting was funded by The Canyonlands Natural History Association. Support was also provided by the Pochobradsky grant and Coe College Research funds,

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Evolution of extrinsic eye muscles in vertebrates

Miyashita, Tetsuto¹, Janvier, Philippe², Tietjen, Kristen³, Coates, Michael⁴

¹Beaty Centre for Species Discovery, Canadian Museum of Nature, Ottawa, Ontario, Canada, ²Department of Origins and Evolution, Muséum national d'Histoire naturelle, Paris, France, ³Biodiversity Institute & Natural History Museum, University of Kansas, Lawrence, Kansas, United States, ⁴Department of Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States

Extrinsic eye muscles (also referred to as extraocular muscles) form a virtual constant in vertebrate anatomy. All living vertebrates have six extraocular muscles, and within gnathostomes there is little to no variation in the number, innervation pattern, and spatial arrangement of the six muscles. However, lampreys have different innervation (two rectus muscles innervated by the abducens nerve instead of just one in gnathostomes) and different organization (the muscle innervated by the trochlear nerve occurs on diagonally opposite sides of the orbit between lampreys and gnathostomes). Placoderms are inferred to have seven muscles, two of which were controlled by the abducens nerve. Therefore, the current transformation scenario is that: 1) lampreys represent the primitive pattern; 2) placoderms evolved one extra muscle; and 3) innervation and spatial organization were modified prior to crown gnathostomes. The challenge remains to describe the transitions leading to the gnathostome condition and thus establish the homology of the six muscles across extant vertebrates.

Here we present an alternative hypothesis based on new reconstruction of the orbital cavity in a jawless stem gnathostome, the osteostracan *Norselaspis glacialis*. Osteological correlates in *Norselaspis*

resemble the placoderm pattern, once more indicating the presence of seven extraocular muscles. Two rectus muscles received the innervation by the abducens nerve in *Norselaspis* as in lampreys and placoderms. The trochlear-innervated oblique muscle sat in the posterodorsal corner of the orbit, which is intermediate between the posterior oblique in lampreys and the dorsal oblique in crown gnathostomes. The oculomotor nerve penetrates an attachment scar for the dorsal rectus.

Given this new evidence from *Norselaspis*, we argue that the seven extraocular muscles as identified in both stem gnathostome lineages represents a primitive condition for all vertebrates. From this ground pattern, lampreys and crown gnathostomes lost one muscle each independently: the oculomotor-innervated medial rectus in lampreys and the abducens-innervated posterior rectus in crown gnathostomes. These independent loss events explain why the previously proposed homology spanning extant vertebrates requires elaborate changes in innervation and spatial arrangement. Our new scenario offers an altogether simpler solution within which the relationships between nerves and muscles remain conserved.

Funding Sources Funding for this work was provided by the Canadian Museum of Nature, National Science and Engineering Research Council, Canada, and the University of Chicago.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Animal, environmental, and health safety challenges facing paleontological collections in southern Arizona inform climate-calibrated roadmaps for fossil repositories

Mohler, Benjamin F.

Department of Geosciences, University of Arizona, Tucson, Arizona, United States

With regard to secure long-term housing of fossils in the United States, Arizona provides greater geological stability and insulation from natural disasters compared to the tectonically unstable Pacific, tornado-afflicted Great Plains and Midwest, and hurricane-threatened Eastern Seaboard and Gulf regions. Year-round low humidity inhibits corrosive decay of fossils (i.e., pyrite disease) without the need for indoor moisture control. In the latter half of the 20th century, southern Arizona was home to a robust paleontological program centered on the University of Arizona's Laboratory of Paleontology (UALP). Their activities resulted in the collection of 23,730 specimens across 9,000+ localities. Collection degradation resulted from the shuttering of UALP in 1996; reduction in access to public fossil collections also negatively impacted localized research and student training opportunities. Continued restoration of historical collections and opening of new collections is necessary for revitalizing paleontology in Arizona. However, collections management in the desert Southwest is not without its challenges, chief among them being inadequate funding and staffing. Non-administrative challenges to fossil collections and their stewards include animals, such as the termite *Heterotermes aureus* and the rodent *Neotoma* sp.; environmental hazards, including wildfires and floods; and finally, hazards to worker health, such as radioactivity from fossils themselves. Significant vertebrate material remaining in the region includes the "Empire Mountain Dinosaur" (UALP 4638), numerous mammals from the Miocene, Pliocene, and Pleistocene of Arizona (particularly camelids and proboscideans), as well as the early Cretaceous brachiosaurid and Arizona state dinosaur *Sonorasaurus thompsoni* from the Turney Ranch Formation, represented solely by ASDM 500. Initial radiological evaluation of

ASDM 500 reveals emissions averaging $\sim 3 \mu\text{Sv/hr}^1$ or roughly 10 times typical background radiation levels. This assessment was founded on experience with multiple regional collections and enhanced with mid- and end-century climate change projections for Arizona in the literature to create a roadmap for successful long-term housing strategies.

Funding Sources n/a

Technical Session 14: Paleobiology: Evolution, Ecosystems, Taphonomy, & Traces (Friday, November 1, 2024, 1:45 PM)

Comparative morphology and composition of Olenekian coprolites using 3D X-ray imaging

Montgomery, Chandelé¹, Dollman, Kathleen^{2,1}, Heckert, Andrew B.³, Hancox, John P.¹, Choiniere, Jonah¹

¹Evolutionary Studies Institute, University of the Witwatersrand, Randberg, Gauteng, South Africa, ²European Synchrotron Radiation Facility, Grenoble, France, ³Appalachian State University, Boone, North Carolina, United States

Coprolites, or fossilised faeces, are one of the few fossils that directly document dietary interactions and behaviours, providing unparalleled insights into palaeoecology. The utility of coprolites in ancient ecosystems remains poorly explored. The farm Driefontein 11, a fossiliferous Early Triassic (?Olenekian) locality in the Free State of South Africa has yielded an exceptional collection of coprolites, currently estimated to exceed 30 000 specimens. We used non-destructive propagation-contrast synchrotron radiation microtomography to investigate the contents and microstructure of approximately 80 coprolites from this collection. These coprolites represent the leavings of perpetrators from a terrestrial freshwater

ecosystem. Our findings provide direct information on the feeding behaviours, digestive systems and selectively preserve the remains of tiny prey items, addressing specific taphonomic and taxonomic deficiencies in the fossil record. The majority of the coprolites from Driefontein 11 contain inclusions ranging from 5 mm to submillimeter. The most common inclusions found in the coprolites are fish scales with associated jaws, teeth, and unidentified skeletal fragments. Two coprolites preserve the head and thoracic segments of a hexapod that could belong to larval insects or Entognatha, and in either case represent the first known from this stage of the Triassic. Other significant, but rare inclusions include bivalve molluscs, a charyophyte, and diaphyses of the long bones of terrestrial vertebrates. Although coprolites are relatively common in the fossil record, few assemblages have been subjected to broad micro-computed tomography investigation. Our findings are comparable in scope to recent discoveries from Late Triassic Polish localities, but predate them by at least 25 million years, helping to temporally expand our understanding of the trophic interactions of Triassic ecosystems.

Funding Sources This research was funded by GENUS the DSI-NRF Centre of Excellence in Palaeosciences, the University of the Witwatersrand and the European Synchrotron Radiation Facility

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Large varanid of the Uinta Formation, Utah and their place in the Uintan carnivore niche

Moon, Kelly¹, Morales, Ivory², Chen, Iris², Townsend, K.E. B.⁵, Stroik, Laura³, Murphey, Paul C.⁴, Friscia, Anthony²

¹Nuffield Centre for International Health and Development, University of Leeds, Leeds, United Kingdom, ²Integrative Biology & Physiology, UCLA, Los Angeles, California, United States, ³Anatomy, Midwestern University, Glendale, Arizona, United States, ⁴Biomedical Sciences, Grand Valley State University, Allendale, Michigan, United States, ⁵Paleontology, San Diego Museum of Natural History, San Diego, California, United States

In the Eocene epoch of North America, large varanids, typically assigned into the taxon *Saniwa*, present an interesting taxonomic challenge. This is because of their fragmentary nature and the large ontogenetic size variation of lizards. The difficulties in classification are further exacerbated by the reliance on the relatively complete but still fragmentary fossil of *Saniwa ensidens* as a taxonomic standard. New specimens of a particularly large varanid have been unearthed in recent paleontological expeditions in the Uinta Formation beds of the Uinta Basin. These represent a lizard as large as the modern Komodo dragon (*Varanus komodoensis*). The vertebrae of the Uinta specimen give an estimate for snout-vent length of ~77cm, which is near the average for Komodo Dragons, and which corresponds to a body mass of ~82kg. This implies that whatever their taxonomic affiliation, varanids represent a numerically small but important part of the middle Eocene ecosystem. The largest mammalian carnivores (excepting the problematic mesonychids), e.g., the carnivoran *Miocyon* and the oxyaenodont *Apataleurus*, have maximum body sizes of ~35 kg, corresponding to maximum prey size of ~40 kg. The large Uinta varanid likely targeted similar prey to that consumed by medium-to-large adult Komodo dragons. This includes medium-sized animals, such as juvenile ungulates and nesting birds, as well as prey as large as 50-70 kg. It is essential to consider varanids, as well as crocodilians, when studying the carnivore niche in early

Cenozoic ecosystems since these ectothermic predators provided distinct ecological contributions due to their diverse hunting strategies and resulting influence on prey dynamics.

Funding Sources NSF-EAR 2011677

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**Paleobiology of the first bipedal
lessemsaurid From the Late Triassic of
South Africa**

Moopen, Atashni¹, Chapelle, Kimberley
(Kimi)², Benson, Roger B.³, Barrett, Paul⁴,
Botha, Jennifer⁵, Choiniere, Jonah¹

¹Evolutionary Studies Institute, University of
the Witwatersrand, Johannesburg , Gauteng,
South Africa, ²Stony Brook University, New
York, New York, United States, ³American
Museum of Natural History, New York, New
York, United States, ⁴Natural History
Museum, London, United Kingdom, ⁵Genus
Centre of Excellence in Palaeosciences,
Johannesburg, South Africa

The Late Triassic-Early Jurassic Elliot
Formation (EF) of South Africa preserves a
diverse archosauromorph assemblage. The
most common dinosaurs preserved in the EF
are sauropodomorphs, with a variety of taxa
showing a range of body sizes and postures.
However, the Norian-Rhaetian lower EF (LEF),
has far fewer well-provenanced, associated
or articulated specimens in comparison to
the Hettangian-Sinemurian upper Elliot
Formation (UEF). Late Triassic non-sauropod
sauropodomorphs are key to understanding
the evolution of morphological and biological
innovations that appear throughout the
clade's history. Here, we discuss the
anatomy, paleobiology, and systematics of a
new Norian sauropodomorph (BP/1/8373)
from the LEF of Qhemegha, Eastern Cape
Province, whose remains consist of a well-

preserved, articulated skeleton of a large
individual. We used comparative anatomy,
quantitative estimates of body mass and
posture, phylogenetic analyses, and
osteohistology of multiple limb elements to
characterize the paleobiology of BP/1/8373.
Regressions based on humeral and femoral
circumferences indicate that this individual
was a 1.4 metric tonne, bipedal
sauropodomorph dinosaur with gracile limbs.
Some notable features, including a scapula
with expanded dorsal and ventral ends, a
proportionately smaller ilium, and a large
proximal end of the tibia with a distinct shaft,
likely support this as a new taxon. Using a
recent phylogenetic matrix of 419 characters
and 77 taxa, we ran a maximum parsimony
analysis using TNT, which consistently
recovers BP/1/8373 as a lessemsaurid. A
highly vascularized woven-parallel complex
with laminar to plexiform vascular orientation
throughout the cortex of all limb bones
indicates rapid growth to the time of death.
Secondary remodeling in the form of
resorption cavities and secondary osteons is
evident in the perimedullary area. There are at
least five lines of arrested of growth displayed
in the ulna and tibia. The presence of fast-
growing tissues and a few growth lines
combined with age-related morphological
correlates are consistent with BP/1/8373
being an early subadult. BP/1/8373
represents the first bipedal lessemsaurid and
raises some interesting questions.
Lessemsauridae is a key clade for
understanding the evolution of body size and
postural changes, and this specimen
suggests a possible reversal to bipedality in
later-branching non-sauropod
sauropodomorphs.

Funding Sources GENUS: DSI-NRF CoE in
Palaeosciences and DSI-NRF AOP grants
awarded to JNC (GUN No. 118974, 136516);
JB (GUN No. 136513) and the
Palaeontological Scientific Trust.

Colbert Prize Session

Preservational bias towards isolated premaxillary teeth in *Thescelosaurinae* (Dinosauria: Ornithischia)

Moore, Adam V.¹, Avrahami, Haviv M.^{2,3}, Zanno, Lindsay E.^{2,3}

¹Marine, Earth, and Atmospheric Sciences, North Carolina State University, Raleigh, North Carolina, United States, ²Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ³Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

Ornithischians evolved a wide array of highly specialized tooth morphologies during the Mesozoic. Small-bodied early diverging ornithischians (SBEDOs) including thescelosaurines, exhibit heterodonty manifested as laterally compressed leaf-shaped buccal teeth and pointed, sometimes serrated, peg-shaped premaxillary teeth. Although cheek teeth greatly outnumber premaxillary teeth in all SBEDOs, a previous study noted an unexpected preservational bias of isolated premaxillary teeth in one species of thescelosaurine, *Thescelosaurus neglectus*, from the Upper Cretaceous Hell Creek Formation of North America. We explored the prevalence of this bias in the thescelosaurine lineage by examining the isolated tooth record of *Fona herzogae*, the oldest definitive thescelosaurine from the Cenomanian age Mussentuchit Member of the Cedar Mountain Formation of Utah. To determine if a similar preservational bias occurs for the premaxillary teeth of *F. herzogae*, we surveyed a collection of isolated teeth from multiple localities representing allochthonous tooth assemblages. We excluded isolated teeth from localities with *Fona* skeletal material, as these teeth are expected to reflect in vivo dental proportions of individuals, not time-averaged accumulations. We differentiated

the isolated teeth into two qualitative categories—maxillary/dentary “buccal” teeth and premaxillary teeth. We then compared frequencies to proportions of the in situ dentition of *F. herzogae* (NCSM 33548, 36143, and 36153). Premaxillary teeth comprise only 12.5% of the dentition of *F. herzogae*, yet 67% of the isolated tooth sample. These results suggest a similar pattern favoring the preservation of premaxillary teeth is shared between *T. neglectus* and *F. herzogae*. The relative overabundance of isolated premaxillary teeth in thescelosaurines is likely attributable to differential dental replacement rates (nearly twice as fast in premaxillary teeth in immature individuals) as documented in early diverging ornithischians such as *Jeholosaurus*, and differential wear resulting in the near consumption of buccal teeth. Our data suggest heterogeneous replacement rates were likely widespread in early diverging ornithischians.

Funding Sources This material is based upon work supported by the National Science Foundation award #1925973 to LEZ

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Critical reappraisal of a putative dicraeosaurid sauropod dinosaur from the Middle Jurassic of Gondwana and a revised view of diplodocoid evolutionary relationships

Moore, Andrew¹, Mannion, Philip D.²

¹Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ²Department of Earth Sciences, University College London, London, United Kingdom

Diplodocoidea is a diverse clade of sauropod dinosaurs that comprises three major lineages (Diplodocidae, Dicraeosauridae and Rebbachisauridae, the former two united as

Flagellicaudata), with a fossil record extending from the early Middle Jurassic to the early Late Cretaceous. A recent spate of newly described taxa, as well as new information on existing species, provides substantial data to re-evaluate diplodocoid evolutionary and biogeographic history. Of particular significance among these recently described species is *Tharosaurus indicus*, from the Middle Jurassic of India, which was argued to represent the oldest known diplodocoid and to potentially evidence a Gondwanan origin for Flagellicaudata.

Here, we critically reevaluate the anatomy of *Tharosaurus* and leverage new morphological data to provide a revised view of diplodocoid phylogeny. We added 11 new diplodocoid operational taxonomic units (OTUs) and seven characters to the largest existing character matrix for eusauropods. The final matrix (562 characters; 137 OTUs) includes 38 uncontroversial diplodocoids and several OTUs with contested diplodocoid affinities (e.g., *Cetiosauriscus*). For the first time, we assess the phylogenetic affinities of BYU 17096, an isolated braincase from the Upper Jurassic Morrison Formation that was previously referred to *Apatosaurus*.

We find that *Tharosaurus* is a non-neosauropod eusauropod that lacks diplodocoid synapomorphies. Given its fragmentary nature and lack of autapomorphies, we regard *Tharosaurus indicus* as a *nomen dubium*. Topological results for Diplodocoidea are sensitive to parsimony method (equal vs. extended implied weights) and, to a lesser degree, to the K-value used for implied weighting. Given the superiority of extended implied weighting in simulation studies, we focus on the latter results. Notable results within Rebbachisauridae include the placement of *Xenoposeidon* as an early-branching member, and recovery of a diverse and entirely Argentinean Limaysaurinae. We also recover a diverse Dicraeosauridae that includes BYU 17096 and *Kaatedocus* among

its earliest-branching members. BYU 17096 bears several characters exclusive to dicraeosaurids (e.g., postparietal foramen; deep muscular fossae at the base of the paroccipital processes), and may represent a fourth species of dicraeosaurid from the Morrison Formation. Our results reinforce the view that Flagellicaudata originated in Laurasia, but increased Gondwanan sampling is needed to test this.

Funding Sources Research funding: The Royal Society (to PDM)

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

Future fossils on fans: The taphonomy of modern remains on the Pilcomayo fan, Paraguay, with insights into temporal and spatial averaging and environmental fidelity

Moore, Jason R.¹, Redman, Cory M.², Souberlich, Ricardo³, Sarubbi Jacks, Yennifer³, Colman, Christian³, Hutchinson, Ian S.¹, Apgar, Alexandra D.⁴, Bosch, Keely⁴

¹Honors College, University of New Mexico, Albuquerque, New Mexico, United States, ²Grand Rapids Public Museum, Grand Rapids, Michigan, United States, ³Facultad de Ciencias Exactas y Naturales, Universidad Nacional de Asunción, Asunción, Paraguay, ⁴Department of Earth and Planetary Sciences, University of New Mexico, Albuquerque, New Mexico, United States

The terrestrial fossil record is overwhelmingly composed of deposits that formed in sedimentary basins and all modern sedimentary basins are dominated by sediments laid down by fan systems. To better understand the compositional, spatial, and temporal fidelity of the terrestrial fossil record we have been studying modern remains on the Pilcomayo fan in Paraguay,

which we hypothesise to be analogous to much of the terrestrial fossil record. Although not without human influence, the Pilcomayo fan is relatively undisturbed by human agriculture and still supports a diverse vertebrate megafauna, albeit with a significant portion of human-introduced species. Over three field seasons we have recorded >120 localities of vertebrate remains over two field areas on the Pilcomayo fan, one (Pozo Hondo) within 50km of the fan apex and the other (General Diaz) ~200km from the apex. We have characterised the sedimentary environments of each locality for comparison to the rock record and have begun to assess the fidelity of each environment to its local fauna along with depositional rates, carcass residence times, and element transport.

Compositional fidelity with sedimentary subenvironment appears relatively good (in paleontological terms – small and fragile taxa remain underrepresented) in both apex-proximal and apex-medial localities, although future work carrying out subenvironment-specific censuses using camera and audio traps will confirm these patterns.

Depositional rates (hence fossil burial) near to the apex are generally low, except within channels, so while the surface assemblages may show fair fidelity to the living assemblage only a biased subset of these remains has the potential for deep-time preservation. In contrast, portions of the medial study area show very high depositional rates (>1.5m in a single event). Although the location of this deposition may be human-influenced in the Pilcomayo, this magnitude of deposition spanning a range of subenvironments suggests that time averaging in many medial fan settings may be shorter than frequently interpreted, and that compositional fidelity in such settings should also be good. Overall the Pilcomayo appears to be a good analogue for much of the terrestrial fossil record and insights from its study promise to unlock more of the ecology of the past.

Funding Sources We acknowledge the UNM Honors College HRI, the UNM RAC, a UISFL Field Research Award, the UNM Global Education Office, Michael Sasoni and William Verrillo.

Colbert Prize Session

A description of morphological variation among non-hadrosaurid ornithischian dentitions from the Dinosaur Park Formation (Alberta, Canada) with implications for dietary niche partitioning

Morley, Nathaniel E.^{1,2}, Wyenberg-Henzler, Taia C.¹, Hudgins, Michael N.³, Sullivan, Corwin^{1,4}

¹Department of Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Department of Earth and Atmospheric Sciences, University of Alberta, Edmonton, Alberta, Canada, ³Department of Earth and Environmental Sciences, Rensselaer Polytechnic Institute, Troy, New York, United States, ⁴Philip J. Currie Dinosaur Museum, Wembley, Alberta, Canada

The Campanian Dinosaur Park Formation (DPF) of Alberta, Canada was deposited during the last major transgression of the Western Interior Seaway and contains one of the richest vertebrate fossil assemblages in the world. Although ornithischian diversity is well-sampled in the DPF, the paleoecology of some ornithischians, particularly smaller-bodied taxa, is poorly understood as body fossils are relatively rare. Isolated teeth from vertebrate microfossil localities represent the DPF's most abundant source of potential data on the palaeoecology and biogeography of these taxa, but such teeth have proved difficult to fully exploit because they are too morphologically conservative to be easily identified with high taxonomic precision. However, in a morphometric study presented previously at SVP 2022, we identified better separation of ornithischian teeth at a fine

taxonomic resolution rather than a coarse resolution due to better partitioning of morphological variation. In this study, we set out to describe the dentitions from the specimens used in the morphometric study to determine whether any qualitative morphological features corroborate the morphometric conclusions. *In situ* dentitions from seven non-hadrosaurid ornithischians from the lower DPF were photographed and described, each representing an ornithischian clade that was ecologically prominent during the Late Cretaceous of North America. The descriptive results emphasized differences in tooth morphologies between ankylosaur families based on absolute size, cingulum prominence, and denticle morphologies. We also identified differences in tooth morphologies between ceratopsid subfamilies based on the overall shape, primary ridge prominence, and presence of denticles. These insights are useful for taxonomic identification, as isolated teeth are often diagnosed as Ankylosauria or Ceratopsidae *incertae sedis*. Thus, these descriptive results corroborate those of the morphometric study, indicating that a combination of qualitative features and morphometric analyses can lead to more precise taxonomic designations of isolated ornithischian teeth than previously recognized. Applying this combined descriptive and morphometric framework to future microsite studies should lead to many insights into the paleoecology and biogeography of non-hadrosaurid ornithischian dinosaurs in the DPF and, more broadly, the Late Cretaceous of North America.

Funding Sources This project was funded by an NSERC USRA and CGS-M awarded to N.M., and two NSERC Discovery Grants awarded to C.S. (RGPIN-2017-06246 and RGPIN-2023-04916).

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Osteological correlates of palatal soft tissues and choanae in extant birds and an assessment of the soft palate and nasopharynx in tyrannosaurs

Morris, Zachary S., Smith, Nathan D., Chiappe, Luis M.

The Dinosaur Institute, The Natural History Museum of Los Angeles County, Los Angeles, California, United States

The evolution of the avian palate has been an important topic of paleobiological research, particularly notable divergences within crown birds and key skeletal transformations from the ancestral theropod condition. In living birds, the palate skeleton buttresses the jaws during feeding, supports the nasopharynx and choana, and plays an important role in cranial kinesis. The fossil record of stem-birds reveals complex patterns, including homoplasy in multiple anatomical systems and mosaicism across the phylogeny. Although the evolution of the highly mobile avian beak is by no means a linear progression, it is clear a loss of temporal elements, the reduction of the quadrate ramus of the pterygoid, and the formation of a specialized condylar joint between the pterygoid and quadrate, in addition to changes to the palatine and vomer, were crucial modifications. However, the correlations between the skeleton and soft tissues of the palate remain poorly understood which limits our ability to reconstruct the complete palate of extinct dinosaurs and our understanding of the impact transformations in the skeleton have on palatal soft tissues. A remarkably well-preserved palate skeleton of a tyrannosaur from the Kirtland Formation (Upper Cretaceous) of New Mexico, tentatively identified as cf. *Bistahieversor sealeyi*, provides a unique opportunity to begin to resolve this issue. This specimen includes

both a palatine and pterygoid which are three-dimensionally intact and uncompressed, even showing fine surface details and sutural contacts. To more completely reconstruct this palate, we collected data on the direct associations between the skeleton and soft tissues of the palate using contrast-enhanced μ CT scanning. This dataset samples both the embryonic development of these tissues in chicken, from embryonic day 8 to near hatching, and the diversity of extant reptilian and avian palate anatomy (10 species). Using a combination of qualitative comparisons and 3D geometric morphometrics, we assess potential osteological correlates for the position of key soft tissues of the nasal capsule, nasopharyngeal duct, and soft palate relative to the skeleton. Based on these comparisons, we estimate the extent of the soft tissue of the palatal shelf, the length of the nasopharyngeal duct, and position of the choanae in tyrannosaurs. Future expansion of this study will facilitate quantitative reconstructions of the evolution of the complete avian palatal system.

Funding Sources Data collection was supported by the National Science Foundation (EAR-PF-1952888) and the Dinosaur Institute, Natural History Museum of Los Angeles.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Dental microwear analysis suggests inter- and intraspecific dietary partitioning as ecological mechanisms for high sympatric theropod dinosaur diversity and subsequent decline in the Late Cretaceous

Morrison, Cassius¹, Gregory, James², Jackson, Christopher², Schroeder, Katlin⁵, Bestwick, Jordan⁶, Gascoigne, Samuel⁷, Mannion, Philip D.⁴, Porro, Laura B.⁴, Bills, Paul², Barrett, Paul³

¹University College London and Natural History Museum, London, United Kingdom, ²University of Huddersfield, Huddersfield, United Kingdom, ³Yale University, New Haven, Connecticut, United States, ⁴Paläontologisches Institut und Museum, Zurich, Switzerland, ⁵University of Aberdeen, Aberdeen, United Kingdom, ⁶University College London, London, United Kingdom, ⁷Natural History Museum London, London, United Kingdom

The presence of numerous, similar, sympatric medium- to large-bodied theropod dinosaurs in the Morrison, Bahariya and Huincul formations raises questions regarding inter- and intraspecific competition, and its effects on community structure. Dietary niche partitioning may decrease such competition. However, establishing dinosaurian diets has often relied on tooth morphology or stomach contents, both of which have limitations: tooth morphology usually assigns taxa to broad dietary guilds only and stomach contents are exceedingly rare. Recent work examining the dental microwear of extant and extinct archosaurs and lepidosaurs has shown that dietary guilds can be determined for fossil taxa more precisely. Here, we use 3D dental microwear texture analysis (DMTA) to constrain the diet of 15 species across all dentulous neotheropod clades. Dietary guilds are defined via DMTA of extant crocodylians and varanids with known diets. Our results show evidence for piscivory in *Torvosaurus* and *Ceratosaurus*, and possible invertivory in the tyrannosauroid *Eotyrannus*, suggesting that faunivorous theropod diets were more diverse than previously thought. Finally, preliminary results suggest theropod clades exhibit different magnitudes of ontogenetic dietary shifts. Spinosaurid ontogenetic dietary shifts appear to be less pronounced than the clear shifts previously inferred in tyrannosaurids. Consequently, interspecific competition was likely less pronounced with respect to variation in dietary specialization and prey acquisition in non-tyrannosaurid-

dominated communities. The statistically significant inferred ontogenetic shifts in tyrannosaurid diets suggests that these genera occupied several distinctive roles during their life cycles (from feeding on smaller, more varied prey to hypercarnivory), which might have prevented the sympatry of other large-bodied theropod taxa by competitive exclusion. This inferred mechanism of competitive exclusion is supported by the absence of more than one medium-to-large-bodied faunivorous theropod from most Late Cretaceous Laurasian formations. By contrast prior to the Turonian diversification of tyrannosaurids, sympatry was most likely permitted by the clear dietary differences between allosauroid, ceratosaurian, tyrannosauroid, and megalosauroid taxa. Our results suggest significant ontogenetic niche shifts in some tyrannosaurids and provide an explanation for the increased diversity of carnivorous dinosaur guilds prior to the Turonian.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The northernmost record of *Uintatheriidae* (Mammalia: Dinocerata) in North America: phylogenetic and biogeographic implications

Mulcahy, Kevin D.^{1,2}, Beard, K. Christopher^{1,2}, Constenius, Kurt³

¹Department of Ecology and Evolutionary Biology, The University of Kansas, Lawrence, Kansas, United States, ²Biodiversity Institute and Natural History Museum, The University of Kansas, Lawrence, Kansas, United States, ³Department of Geosciences, The University of Arizona, Tucson, Arizona, United States

Uintatheres (Mammalia: Dinocerata) were some of the earliest mammals to achieve truly large body size. Among the most recognizable Paleogene mammals, North

American fossils of this enigmatic clade are currently reported only from Colorado, Wyoming, Utah, California, and Texas. Here, we report a new uintathere fossil, KUV 158337, an upper right molar from Carnegie Museum Locality M-7, a Uintan (middle Eocene, ~45 Ma) site in the Kishenehn Formation, northern Montana. Located just south of the Canadian border, this is the northernmost known occurrence of uintatheres in the North American fossil record by several hundred miles. Previous researchers have drawn on isotopic and palaeobotanical evidence to suggest that the Kishenehn strata preserved at M-7 represent a montane environment, making the presence of uintatheres all the more remarkable.

Here, we present preliminary morphological descriptions and systematic diagnoses of KUV 158337. Based on its morphology, namely the position of the hypocone, relatively weak metaloph, and transverse depth, we believe that this tooth is a right M1. Furthermore, based on the near absence of wear facets, we suggest that this individual died shortly after the tooth had erupted. To determine the affinities of this specimen, we compared it to teeth of several genera of North American uintatheres (*Prodinoceras*, *Bathyopsis*, *Uintatherium*, and *Eobasileus*) from the collections of the American Museum of Natural History (AMNH) and found that KUV 158337 most closely matches in size and morphology specimens assigned to *Uintatherium anceps*. However, while the KUV specimen resembles the molars of *U. anceps* in most regards, we note two potentially autapomorphic peculiarities. First, this tooth is quite small. Of the ten skulls of *U. anceps* surveyed at the AMNH, representing an apparent mix of mature and immature individuals, all but one possess larger M1 than KUV 158337. Second, the enamel of the KUV specimen is significantly more crenulated than any of the molars surveyed in the AMNH collections. As these

specimens represent a wide range of wear patterns, we do not attribute this discrepancy to ontogenetic wear. Therefore, while this tooth resembles those of *Uintatherium* in its morphology, size, and stratigraphic occurrence, we hesitate to assign it to *U. anceps*. More fossils from the Kishenehn are needed to determine the precise affinities of this unique uintathere.

Funding Sources Funding provided by the David B Jones Foundation and the KU Biodiversity Institute and Natural History Museum.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

2D morphological analysis of squirrel molars and the implications on taxonomy

Mullally, Finnian T., Flores, Deanna, Hopkins, Samantha

Earth Sciences, University of Oregon, Hillsboro, Oregon, United States

Rodentia is one of the most diverse modern orders of mammals, with species spanning a wide range of ecological and morphological variety. In the fossil record, members of Rodentia are key indicators of climate and habitat change due to their rapid evolutionary responses. One of the earlier-diverging groups within Rodentia are the squirrels, comprised of approximately 50 extant genera that range over all continents except Australia and Antarctica. Recent molecular analyses have substantially revised squirrel phylogeny and taxonomy, so it is critical to reexamine the relationships among modern and fossil squirrels in order to elucidate historical biogeographic relationships between continents, diversification patterns, and the effect of geologic and climatic events on speciation. This study tying patterns of morphological variation in modern squirrels to the variability we see in the fossil record.

We have used a sample of modern squirrel species to inform our understanding of species delineation within the fossil genera. Using photographs of specimens from several fossil and extant species, we digitized tooth outlines using 64 equally spaced semi-landmarks. These coordinates were analyzed with Elliptical Fourier analysis. Principal Component Analysis of the Fourier Coefficients of the first eight harmonics shows that the first five principal components encompass approximately 90% the variation found in the outlines and hence summarize much of the morphology captured by this technique. Using the first five principal components and centroid size of the lower and upper fourth premolar, linear discriminant analysis (LDA) shows that more than 75% of modern specimens can be assigned to the correct species by using just occlusal outlines. Modern specimens also show good species delineation within morphospace plots. Applying this method to the abundant fossil squirrels from the John Day Formation allows us to efficiently divide the sample into discrete morphospecies that we can investigate further for diagnosable morphological characters. The shape outline analysis of the molars and premolars offers promise as a way to discern squirrel species quantitatively.

Colbert Prize Session

Microstructural analysis of indeterminate dinosaur teeth from the Western Interior, refining the spatiotemporal bounds of the North American sauropod hiatus

Mulready, Ellis, Finch, Stephen, Zanno, Lindsay E.

Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States

Sauropods, a fundamental component of North American palaeobiodiversity in the

Jurassic, are hypothesized to have died out near the Early to Late Cretaceous boundary before reappearing in the terminal Cretaceous, a gap in the fossil record that spans nearly 30 million years. Testing for the presence and duration of a hypothesized “North American sauropod hiatus” is key to understanding the paleoecology of Cretaceous dinosaur assemblages, yet the lower bound of this proposed hiatus is marked solely by a handful of diminutive teeth, described as belonging to a “dwarf” brachiosaurid. These teeth were collected from the Mussentuchit Member of the Cedar Mountain Formation in central Utah over several decades. Recent field surveys resulted in the collection of several additional teeth of the same morphotype. These specimens were collected from sites temporally constrained between MAZ1 (99.49 ±0.057/-0.050 Ma) and MAZ2 (99.401 ±0.058/-0.066 Ma). Referral of these teeth to Sauropoda is controversial as dinosaur teeth are notably homoplastic. However, enamel microstructure is known to be taxonomically diagnostic, offering independent evidence for identification. In our novel analysis of a representative tooth, MM16-LCT-22, SEM imaging and histological analyses revealed a crystalline microstructure consistent with what is observed in Sauropoda. The depositional pattern exhibits the characteristic “en echelon” appearance of sauropods, adjacent to the basal unit layer, transitioning superficially to a thinner layer of parallel crystalline modules proximal to the outer enamel surface with a narrow column diameter (approximately 5-7 µm) throughout the longitudinal section. Column obliquity is maintained for the entirety of the enamel thickness without a superficial perpendicular transition, a trait observed in titanosaurs. Additionally, the specimen displays a basal unit layer with closely spaced incremental lines, similar to those observed in *Camarasaurus*. Enamel thickness increases apically with similar mean thickness between labial and lingual faces, a characteristic that

refutes alternative ornithischian hypotheses. Together, these traits provide a confident taxonomic diagnosis of Sauropoda to these poorly understood specimens, further solidifying the temporal constraints of the North American sauropod hiatus and confirming the presence of a sauropod taxon in the Western Interior during the earliest Cennomanian.

Funding Sources Funding was awarded by the North Carolina State University Office of Undergraduate Research Grant and a National Science Foundation award #1925973 to LEZ.

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

A comparatively large-bodied, high-latitude therian from the Upper Cretaceous (Campanian) Prince Creek Formation of northern Alaska (USA)

Muñoz, Xochitl¹, Eberle, Jaelyn J.², Wilson, Lauren N.¹, Wilson, John³, Erickson, Gregory M.⁴, Druckenmiller, Patrick S.¹

¹University of Alaska Museum of the North, University of Alaska Fairbanks, Fairbanks, Alaska, United States, ²Museum of Natural History and Geological Sciences, University of Colorado, Boulder, Colorado, United States, ³Independent researcher, Fairbanks, Alaska, United States, ⁴Department of Biological Science, Florida State University, Tallahassee, Florida, United States

At a paleolatitude of 80-85°N, the Campanian (~73 Ma) Prince Creek Formation (PCF) of northern Alaska preserves a globally significant faunal assemblage of birds, dinosaurs, fishes and mammals. Given the extreme environmental conditions inhabitants faced, including freezing winter temperatures and a highly seasonal light regime, the assemblage likely includes taxa

uniquely adapted for this paleo-Arctic ecosystem. However, the faunal composition and trophic structure of the PCF assemblage remain poorly understood. Among mammals, ongoing work indicates the presence of at least eight taxa, although only two taxa have been formally named. This includes an ecologically diverse array of small metatherians, multituberculates, and a gypsonictopid eutherian, *Sikuomys mikros*, the smallest terrestrial vertebrate yet described from the formation (~11 g). Here, we describe new postcranial material of a therian mammal from the PCF, similar in size to comparative skeletal material of the extant Virginia opossum (*Didelphis virginiana*), and therefore large amongst North American Late Cretaceous mammals. The material includes a partial proximal ulna and a nearly complete cervical vertebra. The ulna is referred to Theria based upon the radially-extended distal corner of its humeroulnar joint, a plesiomorphic metatherian trait. The cervical vertebra is referable to Mammalia and, given its proportionately large size and occurrence from the same microsite as the ulna, we infer they likely belong to the same taxon. In the Late Cretaceous of North America, the stegodontid *Didelphodon vorax* is the largest known metatherian, and *Altacreodus magnus* is the largest known eutherian. Body mass estimates for *D. vorax* vary from ~1 to 6 kg (depending on the element used), and size estimates from molars suggest that *A. magnus* and some large pediomyoids possibly overlapped in body mass with *D. vorax*. The material from the new PCF mammal increases the mammalian richness of the PCF and demonstrates that in the Late Cretaceous, larger-bodied mammals were latitudinally widespread in North America, and present at polar latitudes. Although the diet of the new mammal is currently unknown, its larger size suggests the existence of a previously unrecognized mammalian niche, and greater complexity in food webs, in this ancient polar ecosystem.

Funding Sources National Science Foundation EAR 1226730 and EAR 1736515; University of Alaska

Fairbanks Undergraduate Research and Scholarly Activities grants to XM and LNW.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

A new Paleogene fossil and a new dataset for waterfowl (Aves: Anseriformes) clarify phylogeny, ecological evolution, and avian evolution at the K-Pg Boundary

Musser, Grace¹, Clarke, Julia²

¹Ornithology, The Smithsonian National Museum of Natural History, Manassas, Virginia, United States, ²Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas, United States

Despite making up one of the most ecologically diverse groups of living birds, comprising soaring, diving and giant flightless taxa, the evolutionary relationships and ecological evolution of Anseriformes (waterfowl) remain unresolved. Although Anseriformes have a comparatively rich, global Cretaceous and Paleogene fossil record, morphological datasets for this group that include extinct taxa report conflicting relationships for all known extinct taxa.

Correct placement of extinct taxa is necessary to understand whether ancestral anseriform feeding ecology was more terrestrial or one of a set of diverse aquatic ecologies and to better understand avian evolution around the K-T boundary. Here, we present a new morphological dataset for Anseriformes that includes more extant and extinct taxa than any previous anseriform-focused dataset and describe a new anseriform species from the early Eocene Green River Formation of North America. The new taxon has a mediolaterally narrow bill which is rarely found in previously described

anseriform fossils. The matrix created to assess the placement of this taxon comprises 41 taxa and 719 discrete morphological characters describing skeletal morphology, musculature, syringeal morphology, ecology, and behavior. We additionally combine the morphological dataset with published sequences using Bayesian methods and perform ancestral state reconstruction for select morphological, ecological and behavioral characters. We recover the new Eocene taxon as the sister taxon to (Anseranatidae+Anatidae) across all analyses, and find that the new taxon represents a novel ecology within known Anseriformes and the Green River taxa. Results provide insight into avian evolution during and following the K-Pg mass extinction and indicate that Anseriformes were likely ancestrally aquatic herbivores with rhamphothecal lamellae.

Funding Sources NSF GRFP(DGE-16-4486), Ornithology Collections Study Grant AMNH, Jackson School of Geosciences UT Austin

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Reorganization of the theropod wrist facilitated the origin of avian flight

Napoli, James G.^{1,2}, Fabbri, Matteo³, Ruebenstahl, Alexander A.⁴, O'Connor, Jingmai⁵, Bhullar, Bhart-Anjan S.⁴, Norell, Mark A.⁶

¹Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ²Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ³Center for Functional Anatomy and Evolution, Johns Hopkins University, Baltimore, Maryland, United States, ⁴Earth & Planetary Sciences, Yale University, New Haven, Connecticut, United States, ⁵Negaunee Integrative Research Center, Field Museum of Natural

History, Chicago, Illinois, United States, ⁶Paleontology, American Museum of Natural History, New York, New York, United States

The avian wrist (carpus) has a complex evolutionary history. The plesiomorphic condition for theropod dinosaurs is to have six discrete carpals, but only four persist in modern birds, and the homologies of these carpals have been historically contentious. The posterior-proximal carpal has proven especially problematic – while often identified as “ulnare”, recent embryological studies demonstrate that this element is actually the pisiform. The pisiform is primitively a small, peripheral sesamoid, but in birds it migrates into the main carpal block, impeding development of the ulnare before replacing it both topologically and functionally. The enlarged, translocated, and elaborated pisiform of modern birds is considered to represent a key component of the flight apparatus, preventing dislocation of the distal wing and facilitating automating mechanisms that govern wing kinematics. The apparent absence of a pisiform in all non-avian theropods has led to proposals that it was lost as an ossified element early in theropod evolution, and secondarily regained only within Avialae. We report two new exceptionally preserved theropods from the Gobi Desert of Mongolia that preserve articulated carpi, and clearly demonstrate the presence of a pisiform within the broader clade Pennaraptora. The first of these is a new specimen of *Citipati osmolskae*, which preserves a fully articulated carpus including a small, simple element in the posterior-proximal position that we identify as a pisiform. The second is a new species of troodontid, which also preserves an articulated carpus and has a small pisiform in the posterior-proximal position. Both pisiforms possess a subtle projection that may be homologous to the muscular process of the avian pisiform. Our ancestral state optimizations infer the re-acquisition of an

ossified pisiform in Maniraptoriformes, with translocation of the pisiform into the posterior-proximal carpal position as a synapomorphy of Pennaraptora, and elaboration of the pisiform into a large, complex element characterizing avialans. This evolutionary scenario places the reorganization of the theropod carpus as coincident with the origin(s) of flight in theropods. Given our results and the kinematic importance of the integration of the pisiform (a sesamoid of *M. flexor carpi ulnaris*) in modern birds, we propose that the reorganization of the theropod wrist represents a key pre-adaptation in the assembly of the avian wing and the origin of avian flight.

Funding Sources Funded by the Newt and Calista Gingrich endowment, a Richard Gilder Graduate School student fellowship, and NSF CAREER DEB 2046868.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Exceptionally large jackets required: Collection of an adult gomphothere skeleton from a sandy bone bed in north-central Florida

Narducci, Rachel E.^{1,2}, Hulbert, Richard C.¹, Woodruff, Aaron¹, Riegler, Mitchell^{1,3}, Zbinden, Samantha P.¹, Lockner, Cindy¹, Bourque, Jason R.¹, Poyer, Art¹, Randall, Zachary⁴, Bloch, Jonathan I.¹

¹Vertebrate Paleontology, Florida Museum, Gainesville, Florida, United States, ²Biology, University of Florida, Gainesville, Florida, United States, ³Geology, University of Florida, Gainesville, Florida, United States, ⁴Digital Imaging Division, Florida Museum, Gainesville, Florida, United States

The Montbrook Fossil Site is a latest Miocene (~5.5Ma) fluvial deposit in Levy County, Florida with sediments consisting of alternating layers of unconsolidated sand and clay. The most common mammal recovered is the gomphothere *Rhynchotherium* sp. represented by over 38 individuals, mostly juvenile to subadult. In April 2022, the first articulated adult skeleton was exposed, initially by the right forelimb. Further excavation revealed a nearly complete skull with in-situ left tusk and mandible, the left forelimb, paired scapulae, numerous thoracic vertebrae and ribs, the pelvis, and both femora; all articulated or nearly so. This individual was likely a young adult male based on tooth eruption (heavily worn M2/m2; fully erupted and lightly worn M3/m3), the large size of major limb bones, and circumference of the tusk.

The progress of the skeleton's year-long excavation was documented with photogrammetry providing taphonomic information otherwise lost. Using the 3D models as a map, individual elements were tracked after removal. Collection of the skeleton required numerous plaster jackets, including one of extraordinary size (~4.09m³). Prior to jacketing, the fossils were heavily consolidated with a solution of acetone and Paraloid B-72. Two inches of surrounding sandy matrix was applied as a buffer between the fossils and jacket. Perimeters of the pedestaled fossils were vertically undercut by up to 12 inches at a 45-degree angle along a clay layer to avoid collapse of the sand. Jackets were constructed using up to 12 layers of burlap strips soaked in Hydrocal gypsum cement and 2" x 4" wood struts were incorporated for structural support. A telephone cable attached to an excavator bucket was used to detach the base of each jacket, much like a wire cheese slicer; a method devised by one of our volunteers. The jackets were flipped onto ratchet straps with the excavator bucket, using underlying, relatively non-fossiliferous sediments as a

buffer between the bucket and jackets. Once flipped, jackets were lightened in the field by removing matrix and cutting down the burlap walls, and then lifted out of the 3m deep pit with the ratchet straps and excavator. Despite excess removal, the largest jacket still weighed 1,211kg, making it the largest jacket successfully removed from unconsolidated sediments in Florida and perhaps more broadly. Following preparation, the complete skeleton will be light scanned, resulting in the first virtual 3D model of a gomphothere.

Funding Sources We thank Chase and Eddie Hodge for access, equipment, and time. Generous funding was provided by the Felburn Foundation and effort provided by our amazing volunteers.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A partial caenagnathid (Theropoda: Oviraptorosauria) hindlimb from the uppermost Cretaceous Hell Creek Formation, Montana, suggests ontogenetic changes in cursoriality

Naskov, Alexander N., Scannella, John

Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, Montana, United States

Caenagnathidae is an enigmatic family of Cretaceous pennaraptoran theropods from North America and Asia. To date, most described specimens are isolated, partial individuals. Two taxa are currently recognized in the uppermost Cretaceous Hell Creek Formation (HCF) of western North America: *Anzu wyliei* and the smaller *Eoneophron infernalis*. Due to small available sample sizes, growth trends in this group remain largely undeciphered. In 2000, the partial hindlimb of a caenagnathid oviraptorosaur (Museum of the Rockies [MOR] specimen 1134) was discovered in the lower unit of the

HCF in Garfield County, Montana. The specimen includes a proximal tibia, nearly complete set of metatarsals (MT), and distal pedal phalanges IV-1 and III-3. Traits indicating caenagnathid affinities include an arctometatarsalian condition, a plantarly concave metatarsus, and MT-III with plantar cruciate ridges and chiasma-shaped shaft cross section. The specimen is distinguished from the similarly sized *Eoneophron* by the possession of a plantar-longitudinal sulcus terminating proximal to the shaft constriction of MT-III. MOR 1134 is here tentatively referred to *Anzu wyliei*. It is approximately 22% smaller than larger cf. *Anzu* material (~277 mm MT-III length compared to 355 mm in NSM PV 21086) and approximately 36% smaller than overlapping *Anzu* holotype (CM 78000) material. The arctometatarsus of MOR 1134 is proportionally more elongate (ratio of maximum MT-III shaft to condyle width) than in larger recorded specimens. Greater arctometatarsus elongation is noted in a smaller isolated cf. *Anzu* MT-III from the HCF (MOR 797; length ~191 mm). This suggests a decrease in arctometatarsus elongation through ontogeny. As such, younger *Anzu* may have been more cursorial than older individuals, perhaps reflecting different survival strategies. MOR 1134 fills a gap in our understanding of *Anzu* ontogeny and adds resolution to the ecological dynamics of HCF caenagnathids.

Funding Sources Field collection of MOR 1134 supported by donors to the Hell Creek Project.

Technical Session 18: Carnivora & Co (Saturday, November 2, 2024, 8:00 AM)

Mexican wolves are significantly different from all but one group of grey wolves (Eastern grey wolves) and have changed significantly morphologically in captivity

Nelson, Allison E.

Bureau of Land Management, Roswell, New Mexico, United States

Despite experiencing near eradication in a coyote filled environment, Mexican wolves (*Canis lupus baileyi*) do not show genetic evidence of hybridization. This is notable as canids tend to hybridize under stressed conditions, like extirpation. Red wolves are a known example of this. Captive bred since the 1970s, Mexican wolves have been carefully managed thanks to their Endangered Species List (ESL) endangered status, listed since 1967. As of 2023, the captive breeding program had about 700 Mexican wolves. Morphologically, captive and wild wolves typically differ significantly. Although analyses of the morphological progression of Mexican wolf captivity have been performed (though reintroduced captive wolves were separated from captive wolves in that analysis despite human managed interbreeding), how Mexican wolves morphologically compare to other North American canids (wolves, coyotes, and hybrids) has not been analyzed. Are coyotes more similar than previously thought? What about Plains wolves? Eastern grey wolves? Do captive Mexican wolves differ greatly from the pre-1970s Mexican wolves? Were Mexican wolves as contained in their breeding as the genetic analyses suggest?

Paleontological methods were used to study morphological differences between extant canids. New data of 78 Mexican wolf skulls (both captive and wild) have been added to a dataset of 626 grey wolves, red wolves, coyotes, and canid hybrids from across North America, all separated into analytical groups based on geographic origin and captive status. Procrustes, two-dimensional geometric morphometrics, and one-way permutational analysis of variance (PERMANOVA) were performed. A p-value of 0.01 was considered significant. Wild Mexican wolves differ from all groups (including coyotes), except for Eastern grey and captive grey wolves. Captive Mexican

wolves differ from all analytical groups, including captive grey, captive red, and wild Mexican wolves. The closest geographic group, the Plains wolves are significantly different from Mexican wolves (both wild and captive). These data support the hypothesis that Mexican wolves kept to themselves, especially since both coyotes and plains wolves are significantly different from Mexican wolves. The significant difference between all but one group of grey wolves and Mexican wolves supports their continued and separate listing on the ESL, and therefore the continued existence of the subspecies. Loss of protections would likely result in extinction.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

A new basal homodont odontocete from the Aquitanian of the Northeast Pacific, and reflections on the distribution and phylogeny of the putative “*Chilcacetus* clade”

Nelson, Margot D.¹, Lambert, Olivier²

¹Calvert Marine Museum, Solomons, Maryland, United States, ²Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Among the ages of the Cenozoic, cetacean paleontologists recognize the first age of the Miocene, the Aquitanian, as a dark age for the alpha diversity of Cetacea. This is especially true for the baleen whales, or Mysticeti, for which no named taxa are known from the Aquitanian; but it also holds true for the Odontoceti, or toothed whales. Our knowledge of the Aquitanian is limited to a handful of critical regions, particularly those along the Pacific rim where Aquitanian rocks have been uplifted by subduction forces. One such location is the Clallam Formation in Washington state, which has produced fossils of early homodont odontocetes such

as squalodelphinids and *Squaloziphius*. We describe the excellently preserved cranium of a new homodont dolphin from the Clallam Formation. Its inclusion in phylogenetic analysis reveals an affiliation with the “*Chilcacetus* clade”, an unofficial grouping of several basal homodont odontocetes including the aforementioned *Chilcacetus cavirhinus* as well as several species in the genus *Argyrosetus* and *Macrodelphinus kelloggi*. With the exception of *Argyrosetus patagonicus*, which is from the Gaiman Formation of Argentina, all other species in the “*Chilcacetus* clade” are from the eastern Pacific, with a first appearance in the Chattian, last appearance in the Burdigalian, and occurrences in the Aquitanian. Thus, the “*Chilcacetus* clade” forms a significant component of the Aquitanian odontocete assemblage. Within our phylogenetic analysis, we also recover the “*Chilcacetus* clade” as a monophyletic group within crown Odontoceti, which includes the nominal *Chilcacetus* with the Clallam odontocete as its sister taxon, all three species in the genus *Argyrosetus*, and *Macrodelphinus*. The inclusion of another early homodont odontocete from the northeast Pacific, *Yaquinaetus*, in our analysis also provided support for another component of the Aquitanian assemblage, the Squaloziphiidae. Our phylogenetic analysis demonstrates the robusticity of the “*Chilcacetus* clade” despite the absence of the critical tympanic-periotic complex in all taxa.

Funding Sources Burke Museum Vertebrate Paleontology Collections Study Grant—2021

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

New samples of Late Cretaceous multituberculate mammals from the Judith River Formation of Hill County, Montana

Newbins, Isiah R.^{1,2}, Lavin, Samuel T.³, Danosky, Payton R.^{1,2}, Wilson Mantilla, Gregory^{1,2}

¹Biology, University of Washington, Seattle, Washington, United States, ²Burke Museum of Natural History and Culture, Seattle, Washington, United States, ³Ecology and Evolution, Stony Brook University, Stony Brook, New York, United States

Multituberculate mammals were one of the most evolutionarily successful clades of Mesozoic mammals. The Judithian (North American Land Mammal Age) of the Late Cretaceous (Campanian) was a pivotal interval in their evolutionary history, when they reached significant levels of taxonomic and ecomorphological diversity. It also represents the dynamic lead-up to environmental conditions before the Maastrichtian and the K/Pg mass extinction. However, Judithian local faunas have typically been analyzed in aggregate across this ~7-million-year interval; there has been little attempt to arrange these local faunas into a temporal sequence that would allow for a more detailed view of mammalian faunal dynamics during this critical interval. Here, we take a step toward this goal by providing revised specimen identifications and describing new multituberculate fossils from new and existing sites that we place in stratigraphic context in the Judith River Formation of Hill County, north-central Montana.

Since 2019, we restarted dedicated vertebrate microfossil collecting in the Judith River Formation exposures near Havre and Rudyard, Montana, after a 25-year hiatus. We located nine new fossil localities in Kennedy Coulee alongside the well-known Makela-French 1 and Put's Plunder localities, ~43 km north of Rudyard. We also prospected unexplored outcrops ~40 km northwest of Havre, where we identified 14 new vertebrate microfossil localities. We surface-collected fossils at all localities and bulk-sampled only

the most productive, collecting over 1,350 kg for underwater screenwashing. Fossil picking of new and previously collected sediment has thus far led to the recovery of over 300 isolated mammal teeth, mostly from Makela-French 1 and Put's Plunder. Recent revisions to multituberculate taxonomy and new occurrences in our fossil samples necessitate an update to the multituberculate faunal list for the Judith River Formation in Hill County. We document the presence of *Filikomys*, *Stygmimys*, new cimolomyids, and a possible cimolodontid from the formation. We also place the Put's Plunder, Makela-French 1, and new localities from near Havre into a stratigraphic succession that will allow a preliminary evaluation of faunal dynamics within the Judith River Formation.

Funding Sources Funding for this work was provided by the University of Washington, the Burke Museum of Natural History and Culture, and the NSF Graduate Fellowship Research Program.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Keeping warm in a changing world: reviewing where we stand in understanding physiological evolution amongst synapsids

Newham, Elis^{1,2}, Gill, Pamela G.^{3,4}, Brewer, Philippa⁴, Morales-Garcia, Nuria M.³, Rowe, Andre J.³, Rayfield, Emily³, Schultz, Julia², Martin, Thomas²

¹School of Engineering and Materials Science, Queen Mary University of London, London, United Kingdom, ²Section Palaeontology, Bonn Institute of Organismic Biology, Rheinische Friedrich-Wilhelms-Universität Bonn, Bonn, Germany, ³School of Earth Sciences, University of Bristol, Bristol, United Kingdom, ⁴Earth Sciences Department,

Natural History Museum London, London, United Kingdom

The evolution of the endothermic physiology of living mammals and birds has been a cornerstone of palaeontological enquiry for decades. As metabolic physiology in vertebrates is most directly related to soft tissues which are rarely fossilized, a wealth of strategies have been developed to interpret elements of hard tissues that correspond to aspects of physiology in living and fossil animals. For synapsids, these have been used to suggest the emergence of endothermy anywhere from the earliest emerging representatives in the Carboniferous to the radiation of crown mammals in the Mid Jurassic. Here, we present our most recent analyses of the physiologies of non-mammalian mammaliaforms and early crown mammals, using synchrotron X-ray tomography to study histological growth markers in fossil teeth that provide evidence for longevity, growth rates, and growth patterns in a range of Jurassic taxa. These metrics are directly related to metabolism in living mammals, and allow for quantitative comparisons between living and fossil animals. Significant differences in the physiological metrics of all studied fossil taxa and extant small-bodied mammals suggest that, while early crown mammals had begun to develop similar growth patterns to extant mammals, Jurassic mammaliaforms did not occupy the same metabolic grade as extant mammals. Several metrics also show plasticity between closely related populations, potentially reflecting differing environmental and ecological pressures. We place this evidence in the context of other recent holistic approaches for estimating life history in fossil synapsids, that consider relationships between physiological metrics (e.g. encephalisation quotient, long bone histology), morphological information, and inferred environment and ecology to reinterpret complexities and seeming contradictions in estimated

metabolic potential across time and phylogeny. We conclude that physiological evolution was complex amongst synapsids. As opposed to a linear development of whole-body physiology through time, different aspects evolved under differing ecological and environmental adaptive pressures, with different clades experiencing a mosaic of inherited and derived physiological properties. It is critical to acknowledge these effects when interpreting the life histories of fossil synapsids and the acquisition of the modern mammalian physiology.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Isolated ziphodont crocodyliform teeth from the Paleocene-Eocene of tropical South America

Newsom, Shion^{1,2}, Riegler, Mitchell^{1,2}, Suarez, Catalina^{3,4}, Vallejo-Pareja, Maria C.^{1,5}, Bourque, Jason R.¹, Bloch, Jonathan I.¹

¹Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States, ²Department of Geology, University of Florida, Gainesville, Florida, United States, ³Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET), Buenos Aires, Argentina, ⁴División Paleontología de Vertebrados, Museo de La Plata, La Plata, Buenos Aires, Argentina, ⁵Department of Biology, University of Florida, Gainesville, Florida, United States

Paleocene and Eocene crocodyliformes with ziphodont (serrated) teeth include sebecids in South America and planocraniids in North America. The serrations, characterized by blade-like edges with individual denticle units, are indicative of carnivorous terrestrial feeding habits. The Paleocene-Eocene terrestrial fossil record of South America is largely restricted to mid-to-high latitudes, limiting our understanding of Neotropical

ecosystems in the early Cenozoic. Here we describe a sample of isolated crocodyliform teeth from two localities spanning the late Paleocene and early Eocene in the terrestrial Bogotá Formation outcropping along Mochuelo Creek in southern Bogotá, Colombia. Recovered teeth exhibit a diversity of forms categorized into four main types based on denticle patterns. The Eocene locality (~100 meters above the Paleocene-Eocene Thermal Maximum, PETM; ~55.6 Ma) includes specimens with smooth carinae lacking denticles, denticles of uniform width and length with slight progression in size moving up the carinae with a straight orientation, and denticles of uniform width and length, but with a slanted orientation. The Paleocene locality (~59 Ma) includes specimens with some forms not found in the Eocene locality. In these specimens, the denticles have alternating width and length measurements moving along the carinae and denticles of uniform width and length with slight progression in size moving up the carinae with a straight orientation. Some samples display a heteromorphic denticle pattern between the apical tip and the base of the tooth. However, this may be caused by wear near the apical tip leaving the denticles near the base better preserved. We used microCT scanning and microscopic imaging to measure features such as tooth curvature, denticle length, and width, allowing for comparison with known sebecid and planocraniid teeth of the same time period. Results show the greatest similarity to other South American sebecids. Differences in crocodyliform tooth morphology types between the Paleocene and the Eocene in tropical South America are compared to those found in mid-to-high latitudes, providing a better understanding of faunal dynamics across the PETM hyperthermal.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A reassessment of the Eocene crocodylid *Asiatosuchus grangeri* and its implications on the phylogenetic relationships and evolution of Paleogene crocodiles

Nguyen, John Joseph, Brochu, Christopher A.

Earth and Environmental Science, University of Iowa, Carrollton, Texas, United States

The name *Asiatosuchus* has historically been applied liberally across basal crocodyloids from the Paleogene and includes species from across North America and Eurasia. These species represent some of the closest extinct relatives to crown-group Crocodylidae, possessing a combination of ancestral and derived traits of the crocodile lineage. Many of these species are represented by only fragmentary remains and are poorly described in the literature, leading to a lack of resolution regarding the phylogenetic relationships between them and the tentative informal designation of “*Asiatosuchus*-like.”

This study reassesses the type species for this genus, *Asiatosuchus grangeri*, from the early to middle Eocene of Inner Mongolia, China. All known fossil specimens were reexamined to construct and comprehensively describe the species. It largely resembles a modern crocodile, with a dorsoventrally compressed skull and triangular snout, but with a more lingual tooth occlusal pattern, flatter orbits, and longer dentary symphysis.

A maximum parsimony analysis was conducted to ascertain the nature of its evolutionary relationships with other basal crocodyloids and to compare it to other species which have been previously referred to *Asiatosuchus*. Compared to previous analyses, *A. grangeri* was found to be somewhat more derived and less closely related to most other species previously referred to the genus, such as *Crocodylus affinis* and *Asiatosuchus germanicus*. The phylogenetic trees generated from this study

demonstrate a phylogenetic grade across which the *Asiatosuchus*-like group is spread, further reflecting the need for many of these species to be renamed at the generic level. A new diagnosis for *Asiatosuchus* is suggested here which reflects the Asian clade of early crocodile returned from this analysis, with the Paleocene *Asiatosuchus nanlingensis* being in a sister species relationship with *A. grangeri*. Further studies are required among basal crocodyloids to both resolve the remaining degree of uncertainty in their phylogenetic relationships and revise species that should no longer be referred to *Asiatosuchus*, as well incorporate these findings with other groups to assess the evolutionary relationships of other problematic clades within Crocodylia.

Funding Sources Funding for this study from the Max and Lorraine Littlefield Fund.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Digital preservation of titanosaur (Sauropoda) tracks with remarkable soft tissue anatomy from the latest Cretaceous of Mongolia using photogrammetry

Nguyen, Khoi¹, Bell, Phil R.², Mainbayar, Buuvei³, Woodruff, Cary⁴, Currie, Philip J.¹

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Paleoscience Research Centre, University of New England, Armidale, New South Wales, Australia, ³Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia, ⁴Phillip and Patricia Frost Museum of Science, Miami, Florida, United States

The Nemegt locality in Mongolia has been intensively sampled for dinosaur body fossils for nearly 80 years, yet the discovery of dinosaur footprints is a recent development, having been first reported 20 years ago. Since

then, a diverse assemblage of ankylosaur, hadrosaur, sauropod, and tyrannosaur tracks have been described, many of which belong to vast track-bearing layers that span several kilometers.

We discovered multiple new sauropod tracks during the Canadian-led 2023 Nemegt expedition. Two tracks came from a previously-reported footprint site FS-06 in Central Sayr, while others are from a new exposure found in Eastern Sayr. The new exposure is approximately 3 km northeast of FS-06 but most likely belongs to the same horizon. Among these tracks, two tracks stood out for their exceptional preservation: The first track is a left pes with a potentially pathological digit I from FS-06. The second track is the first sauropod manus track reported from Nemegt. This track shows digit impressions and a scale morphology that have not been documented in sauropods. However, neither track was collected in one piece: the pes track was never collected, while only part of the manus track was collected due to limited time and the remote location of the track. We used photogrammetry, which is currently the gold standard in non-invasive, 3D data collection of ichnofossils, to preserve these tracks in their entirety. The resulting photogrammetry model, supplemented with close-up photos and field observations, provides an invaluable asset for quantitative measurements, observations, and data exchange between our institutions after fieldwork. The trackmaker was most likely a titanosaur, as this is the only known sauropod group in the locality. Although both tracks bear features that fall within the *Brontopodus* paradigm and are consistent with previously described Nemegt titanosaur tracks, the soft tissue impressions are unique and have important implications for the reconstruction of sauropod mani and pedes.

Funding Sources Dinosaur Research Institute

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Investigating fossil preservation in Alligator from the Miocene of Florida (USA)

Nienaber, Braden W.¹, Hastings, Alex K.²

¹Geology, Macalester College, Princeton, Minnesota, United States, ²Paleontology, Science Museum of Minnesota, St. Paul, Minnesota, United States

The early Miocene Miller site of north-central Florida has yielded a diverse fauna of mammals and reptiles. At this location, numerous remains of a small-bodied alligatorid were found along with comparatively far fewer remains of a much larger bodied alligatorid. The smaller remains bear internal consistency to each other and represent a new species of the genus *Alligator*. The larger remains (just 3 elements) seem to come from one individual and lack diagnostic capability. Given the potential for the single larger one to be the result of deposition from upslope, we undertook detailed analyses to see if these may have been deposited at very different geologic times (potentially implying a younger age for the larger individual).

In order to properly evaluate, we analyzed matching bone elements between the two size classes, including ribs and osteoderms (2 small and 1 large for each). At a macroscopic scale, the color and surface modifications were compared under high magnification. The samples do not vary in color or surface modifications. Microscopic and chemical analyses of the samples were also employed using Fourier transform infrared spectroscopy (FT-IR), Micro X-ray fluorescence (μXRF), and scanning electron microscopy (SEM). The FT-IR spectra are consistent with the data from surface sampling, suggesting a similarity between small and large specimens. All specimens

contain a “Francolite Shoulder” and similar phosphate and carbonate bands. μ XRF analysis also indicates the presence of Ca, P, Fe, S, and Sr within the bones of all specimens, but there were differences in the concentrations of Zn, Y, U, La, and Ce between size groups and within the skeleton of each size. SEM indicated the presence of calcite and clay within all specimens, but there were differences in the presence of pyrite, sphalerite, and Co- and Ni-enriched pyrite between all specimens. The inconsistencies between specimens make it difficult to confirm that both sizes were deposited within the same locality, but the similarities in preservation across the sample support the hypothesis that both existed contemporaneously. The results of this study will be employed when assigning probable taxonomic identification to the fragmentary remains of the larger alligatorid remains.

Funding Sources Funding for this project was provided by Macalester College and the Macalester Summer Internship Grant program

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

New anuran material from the Dockum Group in the American Southwest provides insight into frog novelty, evolution, and biogeography in the Late Triassic

Nohomovich, Mark¹, Nesbitt, Sterling J.¹, Haridy, Yara², Shubin, Neil², Heckert, Andrew B.³, Barrett, Paul⁴, Lauer, Bruce H.⁵, Lauer, Rene⁵, Stocker, Michelle R.¹

¹Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ²Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ³Geological & Environmental Sciences, Appalachian State University, Boone, North Carolina, United States, ⁴Ecology & Evolution, Stony Brook University, Stony Brook, New York, United

States, ⁵Lauer Foundation for Paleontology, Science and Education, Wheaton, Illinois, United States

Salientians, living anurans and their extinct relatives, are first known from the Early Triassic ~250 million years ago. These early taxa include *Triadobatrachus* and *Czatkobatrachus* from the high latitudes of Madagascar and Poland, respectively, and are characterized by derived skull characteristics such as wide orbits and fused frontoparietals, but still retain plesiomorphic postcranial features such as non-reduced vertebrae, a tail, no urostyle, and lack of fusion in the limb bones. Until recently, the next appearance of salientians in the fossil record was not until the Early Jurassic, with *Prosalirus bitis* preserving a skeletal bauplan is more similar to that of extant frogs. The discoveries of new anuran material from the Chinle Formation, Arizona, and Jameson Land Basin, Greenland revealed remarkably similar pelvic morphology to crown group frogs, pulling those morphologies back to the Late Triassic and adding an equatorial component to their early evolutionary history. To add to the growing number of salientian fossils, we introduce new material from the American Southwest from the Late Triassic Dockum Group of Texas and New Mexico, including both Adamanian and Revueltian localities. This includes an elongated ilium, fused tibiofibulae, fused radioulnae, the distal end of a humerus, possible vertebrae, and urostyles. These new materials share similar morphology with the Chinle frog and *P. bitis*. Their presence in the Dockum Group extends the range of the clade east in equatorial Pangea and demonstrates that these taxa are components of several Upper Triassic microvertebrate assemblages. The new urostyle shows a segmented morphology following the ossified hypochord and caudal vertebrae as previously demonstrated through developmental data. These could also represent skeletally immature individuals, though the urostyle measures 6.3

mm. Additionally, the Early Triassic salientians did not yet have the fusions resulting in the radioulna and tibiofibula as our Dockum specimens do, indicating adaptations toward the ability to absorb landing forces while reducing weight. These new specimens from the Dockum Group show that salientians from the Late Triassic already had evolved an anuran like bauplan and were widespread geographically prior to the Late Triassic.

Funding Sources Funding for this work was received from NSF EAR 1943286 and David B. Jones Foundation,

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A seasick crocodile: Goniopholidid postcrania from the marine Austin Group of north Texas

Nolan, Travis^{1,2}

¹Southern Methodist University, Richardson, Texas, United States, ²Whiteside Museum of Natural History, Seymour, Texas, United States

Crocodylomorph remains are abundant in portions of the Cretaceous strata of Texas and in coastal deposits of the Western Interior Seaway of North America. In Texas they are best known from the Early Cretaceous of north central Texas and from the Late Cretaceous of the Big Bend area. More recently, Cenomanian crocodylomorphs have been described from Dallas-Fort Worth area. Here we describe the first crocodylomorph specimen ever found in the fully marine strata of north central Texas above the Cenomanian. SMU 70680 was found in the Atco Formation (Austin Group; Coniacian), and contains elements of the pelvic girdle and right hindlimb, as well as several incomplete osteoderms. The specimen was CT scanned, and models of

the elements were produced via manual segmentation. The elements are described herein and compared to relevant neosuchian remains. Comparative analysis of these elements supports assignment of the specimen to Goniopholididae. This assignment helps to fill a gap in the crocodylomorph fossil record of Texas, and documents goniopholidids in a fully marine environment, unprecedented for a taxon typically understood to be a semi-aquatic form. We consider possible explanations for this discrepancy and close by challenging the long-held idea that crocodylomorph postcranial elements are not diagnostic.

Funding Sources The computed tomography scan was funded by the Institute for the Study of Earth and Man at Southern Methodist University in Dallas, Texas.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Histologic analysis of a large coprolite from the Permian period provides clues regarding the diet and eating habits of a large terrestrial predator

Norris, Steven J.¹, Temple, David P.²

¹Pathology & Laboratory Medicine, UTHealth McGovern Medical School, Pearland, Texas, United States, ²Paleontology, Houston Museum of Natural Science, Houston, Texas, United States

A cylindrically shaped coprolite (~2.5 x 6.5 cm) found in the Arroyo Formation stratum near Seymour, Texas was characterized by sectioning and histologic examination. Prior studies indicate that materials in this location are from 282 to 286 ma and represent a fresh water-terrestrial interface. The size, shape, and lack of spiraling or a mucus layer (the latter being typical of *Xenacanthus* shark excrement) indicated that the coprolite was from a large terrestrial predator, such as a

member of the genus *Dimetrodon*. Light microscopy revealed the predominance of small, densely packed bone fragments in an amorphous matrix. In general, histological features were exceptionally well preserved. The bone fragments were commonly small shards and often retained clearly demarcated canals, lacunae and canaliculi. The coprolite also included small teeth (<1 mm in length) and structures consistent with fossilized tendon, cartilage, and scales. This coprolite thus appears to represent the excrement of a large predator that thoroughly masticated its prey and had a varied diet of both terrestrial and aquatic animals, potentially including small reptiles, amphibians, and fish.

Funding Sources This work was supported in part by the Houston Museum of Natural Sciences.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Supplementing modern 3-D data with historical records of serially sectioned specimens

Norton, Luke A.¹, Angielczyk, Kenneth D.², Simpson, William F.², Benoit, Julien¹

¹Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ²Field Museum of Natural History, Chicago, Illinois, United States

X-ray and neutron microtomography (μ CT) have become commonplace in paleontology, particularly to study internal structures of both body fossils (e.g., inner ear, maxillary canal, etc.) and trace fossils (e.g., coprolites). These techniques are generally accepted as being non-destructive. Prior to μ CT scanning, researchers relied on low-tech solutions—either inducing cracks using a hammer and chisel, or cutting specimens into a series of

sections with a circular saw. The latter technique of serial sectioning usually results in a series of slices ~1–2 cm thick, with a space of ~5 mm lost between each slice. This technique was refined, becoming serial grinding, and allowed for sections to be made at fractions of a millimeter. Despite completely destroying the original specimen, serial grinding was used extensively to study therapsids from the Karoo Basin. This has resulted in the permanent loss of over 60 specimens. The only record(s) of these specimens are those created before the grinding process (e.g., casts and photographs), or those created during the grinding process (e.g., pencil drawings, nitrocellulose peels, photographs, etc.). Records of a specimen prior to grinding provide limited information of the internal anatomy. Similarly, the amount of internal detail recorded during the grinding process is restricted by the thickness of section intervals and the amount of time taken to record the sections. For example, pencil drawings and tracings might only preserve the most prominent features (i.e., teeth, sutures, bony canals, etc.), whereas photographs and peels may preserve additional details such as trabecular structure. Fortunately, records of the sectioning process have been preserved for a majority of these 60 specimens. By digitizing the various records of serially sectioned and ground specimens, we have been able to produce three-dimensional visualizations of specimens for restudy. This has facilitated the re-identification of a specimen of anomodont as *Brachyprosopus*, the description of the maxillary canals in the dinocephalian *Jonkeria*, and a description of the replacement teeth in the basal cynodont ‘*Scalopocynodon*.’ These data have allowed us to supplement existing samples of μ CT data, in some cases expanding the diversity of species for which internal anatomy is known. Furthermore, by digitizing the physical records of serially ground and sectioned specimens, these data can be preserved,

archived and curated as objects in a data repository.

Funding Sources GENUS (DSI-NRF Centre of Excellence in Palaeosciences, UID 86073), University of the Witwatersrand, Johannesburg, and Field Museum of Natural History, Chicago.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

Paleontological discoveries in SW Argentina: New insights into the end of the Dinosaur Era in South America

Novas, Fernando E.¹, Agnolin, Federico. L.¹, Rozadilla, Sebastián¹, Aranciaga-Rolando, Alexis¹, Chimento, Nicolas¹, Motta, Matías¹, Manabe, Makoto², Tsuihiji, Takanobu³, Isasi, Marcelo¹, Pol, Diego¹

¹Museo Argentino de Ciencias Naturales “Bernardino Rivadavia”, Buenos Aires, Argentina, ²Center for Collection, National Museum of Nature and Science, Tsukuba, Ibaraki, 305-0005, Japan, Tsukuba, Japan, ³Department of Earth and Planetary Science, The University of Tokyo, Hongo, Bunkyo-ku, 113-0033, Japan, Tokyo, Japan

Paleontological records from the latest Cretaceous are historically biased toward deposits from the Northern Hemisphere. Fieldwork conducted since 2019 has revealed the Upper Cretaceous Chorrillo Formation (Santa Cruz Province, SW Patagonia, Argentina) to be a productive source of early Maastrichtian fossils from the Southern Hemisphere. This diverse nonmarine fossil assemblage includes plants (water ferns, water-clovers, water lilies, and algae), gastropods, three-dimensionally preserved insects (Chironomidae, Lepidoptera, Ephemeroptera), and vertebrates. Vertebrates are represented by fishes, anurans, turtles, snakes, sphenodontians, crocodyliforms,

abundant dinosaurs, and mammaliaforms. The dinosaur assemblage includes sauropods (*Nullotitan glaciensis*); elasmarian iguanodonts (*Isasicursor santacrucensis*); megaraptoran and avialan theropods; indeterminate hadrosaurids and ankylosaurids; and sauropod and theropod eggshells. The large-bodied *Maip macrothorax* represents the youngest known occurrence of Megaraptora. Saltasaurine and aeolosaurine sauropods and abelisaurid theropods are virtually absent, in contrast to coeval strata in central and northern Patagonia. Instead, large-bodied basal titanosaurian sauropods and megaraptorans are the most abundant non-avialan dinosaurs of the Chorrillo Formation. The diverse avialan record comprises enantiornithines (*Yatenavis ieujensis*), derived ornithurans (*Kookne yeutensis*), and probable hesperornithiforms. Mammaliaforms are known from isolated teeth, jaw fragments, and postcranial bones from monotremes (*Patagorhynchus pascuali*), gondwanatherians (*Magallanodon baikashkenke*), meridiolestids, and therians. Monotremes are absent from the well-sampled Los Alamitos Formation in northern Patagonia, so their presence here reveals possible biotic provincialism. The body mass of the therian *Patagomaia chainko* is estimated to have been 14 kg, which exceeds the maximum 5 kg body mass of coeval mammaliaforms from the Northern Hemisphere. This demonstrates that Late Cretaceous mammaliaform faunas from South America were taxonomically diverse and attained large body size. The Chorrillo Formation was deposited at high latitudes, and palynofloral and paleobotanical records suggest a humid and tropical-to-temperate climate. These discoveries encourage further exploration of the Cretaceous of southern Patagonia, particularly of younger strata closer to the K-Pg boundary.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**Microphotography as a method to illustrate
and highlight ultra-fine details preserved in
microfossils**

O'Callaghan, Ezekiel¹, Abolt, Rebecca²

¹Northern Arizona University, Flagstaff,
Arizona, United States, ²Unaffiliated, St.
Johns, Arizona, United States

We established a method using low-cost microphotography to examine microfossils from a new late Triassic Chinle Formation locality (Seven Hills Quarry) which contains fossils with preserved fine details. The software we used (EOS Utility, CombineZP and ImageJ) is open source freeware and the equipment we used includes a standard DSLR camera with a macro lens (Canon 77D, EF-S 60mm). This method was originally used as a substitute for microscopy to aid sorting of the specimens into distinct morphotypes, by examining structures as small as 20-30 micrometers (approximately 2 micrometers per pixel). The microphotographs show fine details which were then used to begin development of a table of morphotypes. Some notable examples of these fine details include apically directed triangular denticles in a ziphodont tooth; compound denticles on several new morphotypes besides *Crosbysaurus*; and potential traces of von Ebner lines in phytosaur teeth, identified with only light polishing done on partial teeth; fine subsurface elasmodine layers under the ganoine as well as surfacial micropits in ganoid fish scales; and spongiform bone texture in an *Acaenasuchus* lateral osteoderm. The method provides high-fidelity imagery of fossil microstructures, can be done rapidly, doesn't require sending samples for thin-sectioning, and is relatively inexpensive with little to no recurring costs. The destructive methods used in polishing are also less destructive than other methods of identifying fossil microstructures. Future

work will be using these methods to describe the previously mentioned morphotypes.

Regular Poster Session 2 (Thursday, October
31, 2024, 4:30 - 6:30 PM)

**Pathological phytosaur teeth from the
Triassic Chinle Formation, near St. Johns,
Arizona**

O'Callaghan, Ezekiel¹, Abolt, Rebecca²

¹Northern Arizona University, Flagstaff,
Arizona, United States, ²Unaffiliated, St.
Johns, Arizona, United States

Dental pathologies are well documented in archosaurs, including phytosaurs. Pathologic phytosaur teeth are reported from a new Chinle Formation microvertebrate site which has produced over 10000 teeth from multiple taxonomic groups. One pathologic phytosaur tooth has many short supernumerary carinae (less than 5.7 mm) in contrast to long (greater than 1 cm) singular or split carinae documented in other archosaurs. The second tooth represents a new pathologic morphotype, with corrugations across the face of the tooth, near the tip, which appears to have experienced limited growth, due to a narrowed band across the tooth surface. Comparison to other phytosaur teeth from the same and similar localities identify these specimens as posterior phytosaur teeth. Measurements of the pathologic teeth suggest similar overall height, width, length, and denticle densities to non-pathologic posterior phytosaur teeth. Supernumerary carinae may represent rapid enamel growth after damage to the tooth, or an overactive gene creating additional carinae. The corrugated specimen may represent a period of stunted tooth growth due to famine or injury. Testing the overall effect these pathologies had on tooth function remains to be seen, but is planned. Phylogenetic bracketing suggests pathological supernumerary carinae may be ancestral to

crown Archosauria. Future research should prioritize increasing sampling for early archosaur dental pathologies, using internal imaging to examine pathology microstructures, and using comparative modeling of pathological and non-pathological teeth to quantify the effects of the pathologies on tooth performance.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Chicago *Archaeopteryx* reveals early transformations in the avian skull

O'Connor, Jingmai¹, Hu, Han², Fabbri, Matteo¹, Kuo, Pei-Chen¹, Clark, Alexander¹, Shinya, Akiko¹, Van Beek, Connie¹, Wang, Min²

¹Field Museum, Chicago, Illinois, United States, ²Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The 13th *Archaeopteryx*, here designated the Chicago specimen, preserves a nearly complete skull revealing new information regarding the cranial structure and biology of this iconic taxon. The skull is exposed in ventrolateral view, revealing the construction of the palate and basicranium. The updated palatal morphology is intermediate between troodontids and other stem birds. The rostralmost portion of the premaxillae and dentaries preserve large neurovascular openings that are continuous with maxillary and mandibular branches of the trigeminal nerve, respectively. These openings are present in other early-diverging toothed avians but absent in non-avian theropods. Their presence in *Archaeopteryx* suggests the tip of the rostrum was capped with a small, innervated soft tissue structure that was likely protected by a keratinous rhamphotheca, as previously hypothesized for the non-ornithurine ornithuromorph *Yanornis*. Small circular projections preserved along the medial margin of the

palatine are interpreted as remnants of dermal papillae. This suggests that these structures, widespread in Neornithes and considered functionally homologous to palatal teeth, co-evolved with the highly mobile tongue indicated by the basihyal in paravians, preserved for the first time in an *Archaeopteryx*. The greatest observed differences in the skull of *Archaeopteryx* compared to closely related non-avian paravian theropods are related to potential changes to the feeding apparatus. These may have evolved early in avian evolution in response to the increased caloric demands associated with volant behavior.

Funding Sources None to disclose

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

A new genus of elasmosaur from the Santonian Haslam Formation of Vancouver Island, British Columbia, with aristonectine-like postcranial adaptations

O'Keefe, F. R.¹, Armour Smith, Elliott², Otero, Rodrigo A.³, Trask, Patrick⁴

¹Biological Sciences, Marshall University, Huntington, West Virginia, United States, ²University of Washington, Seattle, Washington, United States, ³Universidad de Chile, Santiago, Chile, ⁴Courtenay and District Museum, Courtenay, British Columbia, Canada

An elasmosaurid skeleton from the Haslam Formation (Upper Santonian) of the Nanaimo Group (Late Cretaceous) on Vancouver Island was first described in 2002 by Elizabeth Nicholls, and has recently been declared the Provincial Fossil of British Columbia. Nicholls referred the skeleton to Elasmosauridae; however the poor preservation of most bones prevented a generic diagnosis at that time. Since then, additional fossils have been

recovered: an isolated right humerus; and a well-preserved, osteologically immature skeleton, comprising thorax, girdles, and limbs. When coupled with recent elucidation of ingroup relationships of Elasmosauridae, the Haslam material can now support further taxonomic assessment.

The new animal possesses a strange mosaic of features. The mandible is relatively well preserved, and this indicates that the skull differed little from the plesiomorphic elasmosaurid condition seen in *Callawayasaurus*; the skull is narrow, the teeth large, and the symphysis broad, and the skull therefore lacks any of the radical oral cavity adaptations seen in even basal aristonectines such as *Futabasaurus*. The neck of the Haslam animal is also plesiomorphic. The number of cervicals is not known, but at least 30 are preserved, and most of these have VLIs well over 100. Yet the cervical ribs trend forward, a condition known only in derived aristonectines and *Vegasaurus*. The autapomorphic coracoid of the Haslam elasmosaur differs greatly from *Vegasaurus*; the cardiform recess is reduced and posteriorly located, with some similarities to that of *Aristonectes quiriquinensis*. The scapular blade of the Haslam elasmosaur is low and square in lateral outline, a feature typical of aristonectines and related weddellonectians. The humerus is autapomorphic, possessing a relatively straight shaft, pronounced ventral camber, and an articular facet on the leading edge that makes a 90 degree angle with the radial facet. Taken together, these features demonstrate that the Haslam elasmosaur is a new taxon, and that while its axial skeleton is plesiomorphic, its appendicular skeleton shares several adaptations with derived aristonectines. Given the lack of characteristic aristonectine cranial adaptations the cladistic position of the new taxon is uncertain; preliminary analyses find it to be a basal aristonectine, but the alternative hypothesis of convergent

evolution of postcranial adaptations cannot be disregarded.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Assessment of taxon and character sampling across neoceratopsian phylogenies

Obuszewski, Kyle D.^{1,2}, Zanno, Lindsay E.^{1,2}

¹Paleontology, North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ²Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

Neoceratopsians were an exceptionally diverse group of ornithischian dinosaurs with a fossil record spanning the Cretaceous of Laurasia. Although key for understanding the radiation and hypothesized paleobiogeographic dispersal of ceratopsians across northern landmasses during the Cretaceous, early diverging neoceratopsians have received far less attention than their ceratopsid kin. Several recent studies have attempted to assess the phylogenetic relationships of early neoceratopsians; however, ingroup relationships are often poorly resolved and inconsistent between analyses. One particularly problematic clade is Leptoceratopsidae, a group of small-bodied taxa that co-evolved alongside Ceratopsidae for at least 20-30 million years. Relationships within Leptoceratopsidae typically differ between studies due to the addition of successive discoveries and the incomplete nature of many taxa. However, it is unclear how leptoceratopsid completeness compares with other early diverging neoceratopsians and impacts topology resolution.

Here we evaluate how taxon and character sampling influenced the resolution of various ceratopsian subclades among different

matrices by testing several optimality criteria. Preliminary results suggest that average trends in taxon and character completeness are fairly consistent across matrices. Whereas the average completeness of most early ceratopsians is matrix-dependent, leptoceratopsids consistently represent the least complete ceratopsian OTUs. Postcranial character data are generally less complete than those of cranial characters. Dental character data is the most complete for cranial partitions; however, the most complete character data varies for postcranial partitions due to smaller sample sizes. Sampled matrices vary in stratigraphic congruence metrics calculated for matrix-specific most parsimonious trees (MPTs) and strict consensus trees. The most data-rich matrix in our sample has the fewest OTUs and is the least stratigraphically congruent, raising questions about the balance of taxonomic representation and character data, relative to stratigraphic fit. By incorporating a diverse range of neoceratopsian matrices and phylogenetic analyses, we offer a comparative framework for assessing the robustness of future ceratopsian phylogenetic datasets.

Funding Sources This material is based upon work supported by the National Science Foundation award #1925973 to LEZ

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

The distribution and degree of heterodonty among squamates and a morphometric approach to its underlying mechanisms

Olroyd, Savannah L.¹, Singh, Suresh³, Huttenlocker, Adam², Bhullar, Bhart-Anjan S.¹

¹Earth and Planetary Sciences, Yale University, New Haven, Connecticut, United States, ²University of Bristol, Bristol, United Kingdom, ³University of Southern California, Los Angeles, California, United States

Reptilian dentition has received far less research attention than that of mammals, with basic questions about tooth development still unanswered. A major example of this is the fact that we do not understand heterodonty in reptilian dentitions. Heterodonty, or a difference in tooth size and/or shape, is typically seen as a mammalian feature, but there are notable exceptions to this among reptiles. A few examples such as snake fangs have been studied to some extent, but we still have not explored how common it is to have multiple forms of heterodonty among squamates and what the mechanisms are that contribute to establishing differences along the tooth row. We surveyed all squamate skeletons in the Herpetology Collections in the Peabody Museum of Natural History and noted the degree and type (size/shape/both) of heterodonty across the sampled species. We also used 3D geometric morphometrics to identify subtle regions in squamate toothrows, and this served as a starting place for understanding what mechanisms might be at play in establishing heterodonty. We CT scanned 20 individuals each from two squamate species and placed digital landmarks on each tooth in every specimen. We used segmented linear regression to identify break points in tooth morphology in the jaws of each species.

We found that at least subtle, size based heterodonty was present in almost every squamate species. There were only a few exceptions among geckos, which could be considered to be truly homodont. This begs the question of why teeth grow to be different sizes and shapes along squamate jaws, seemingly as a rule rather than an exception. Our morphometrics approach successfully identified visibly different regions. In *Agama agama*, a distinct premaxillary region is present, hinting at developmental associations with the bone contributing to heterodonty in this species. Regions within the maxilla reflect with the permanent

addition of larger teeth to the posterior end of the jaw during growth. The tooth regions in *Varanus niloticus* were much more subtle, but regionalization of the maxillary teeth was present despite constant tooth replacement. Our preliminary results demonstrate that heterodonty in some form is probably the default state in squamates. Different mechanisms may contribute to heterodonty in different species, but there may be a shared developmental mechanism at play that may explain the prevalence of heterodonty among squamates.

Funding Sources NSF PRFB (2109588)

NSF CAREER (2046868)

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

Paleoarctic vertebrate and invertebrate assemblages from lakes with winter ice from the Late Triassic-Early Jurassic Junggar Basin of northwestern China

Olsen, Paul E.¹, Fang, Yanan², Sha, Jingeng², Slibeck, Bennett¹, Chang, Clara¹, Wang, Bo²

¹LDEO, Columbia University, Palisades, New York, United States, ²State Key Laboratory of Palaeobiology and Stratigraphy, Nanjing Institute of Geology and Palaeontology, Chinese Academy of Sciences, Nanjing, Jiangsu, China

Plate circuit models and local paleomagnetic data show the Junggar Basin (NW China) was in the arctic during the Late Triassic and Early Jurassic. Despite 3 to 21 times pre-industrial $p\text{CO}_2$, abundant lake-ice rafted debris (L-IRD) corroborates climate models showing that the early Mesozoic Arctic experienced prolonged winter freezing. We found crustaceans, insects, fragmentary to articulated actinopterygians and tetrapod fragments, including possible plesiosaurian teeth in the Norian-Rhaetian, coal-bearing,

Haojiagou Fm with L-IRD as well as large, plausibly dinosaurian footprints in marginal lake strata. The laterally equivalent Baijiantan Fm also has abundant L-IRD as well as mollusks, abundant arthropods (including kazacharthrans), insects, and actinopterygians including *Saurichthys* and a gibbose form (described by others). We also found +10cm possible sub-glacially striated dropstones. The overlying Hettangian-Pliesbachian, coal-bearing Badaowan Fm also has abundant L-IRD associated with bivalves, gastropods, spinocaudatans, insects and dinosaur footprints including the ornithischian ichnite *Anomoepus* (previously described). The Pliensbachian-Toarcian Sangonghe Fm mostly lacks L-IRD and coal but produces bivalves, gastropods, spinocaudatans, abundant insects, articulated and fragmentary actinopterygians, the shark egg case *Palaeoxyris* sp., and dinosaur footprints including *Anchisauripus* (Theropoda) and ?*Anomoepus*. The importance of these assemblages is that they are the only known Late Triassic-Early Jurassic, paleoarctic continental vertebrate and invertebrate assemblages. We hypothesize that the Arctic was a cold incubator of clade-specific traits that became key to allowing dinosaurs and other insulated groups to survive and thrive through the volcanic winters at the close of the Triassic, while nearly all uninsulated Pseudosuchia were wiped out. This may explain the sudden appearance of ornithischians, only immediately after the end-Triassic mass extinction, despite a +30 Myr ghost lineage.

Funding Sources National Natural Science Foundation of China (42288201, 41730317), Chinese Academy of Science PIFI, Lamont Climate Center, Heising-Simons Foundation

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A new zalambdodont apternodontid from the early Chadronian of Trans-Pecos Texas

Olson, Selby V., Kirk, Edward C.

The University of Texas at Austin, Austin, Texas, United States

“Bone Hash Hill” (TMM 44305) is a fossil locality located in the Chambers Tuff, a geological formation outcropping in the Tornillo Basin of Trans-Pecos Texas that is bracketed by volcanic units dated to between about 37.8 and 36.7 million years old (early Chadronian NALMA). The locality boasts a rich microvertebrate assemblage of disarticulated fossil material encased in blocks of siliciclastic sedimentary matrix. The arrangement of the fossils and properties of the matrix make mechanical preparation of the individual bones extremely difficult, as mechanical exposure of fossils deepest within the matrix would require the destruction of other fossil material that lies closer to the surface of the matrix. To preserve the integrity of fossiliferous matrix from TMM 44305, 58 matrix samples of varying sizes were imaged using micro-computed tomography at the UTCT facility in Austin, Texas and digitally “prepared” in favor of traditional mechanical methods. So far, over 350 fossils have been digitally extracted from these μ CT scans, including a diverse assemblage of squamates, birds, herpetotheriid metatherians, rodents, primates, and insectivore-grade mammals.

Here we highlight a new apternodontid specimen recovered at Bone Hash Hill in January 2024. The specimen consists of an associated cranium and left hemimandible found within a single matrix fragment. The cranium is missing large sections of the neurocranium, but matrix infill has preserved a natural endocast of part of the anterior braincase. The rostrum is largely intact, including the nasal turbinates and most of the upper dentition. Displaced fragments of the basicranium are preserved within the natural

endocast, including both ectotympanic rings and a petrosal with a well-preserved bony labyrinth. The specimen is provisionally attributed to the genus *Oligoryctes* based on the presence of zalambdodont upper molars with a hypertrophied paracone, reduced protocone, and absent metacone, as well as lower molars with highly reduced talonid basins, trigonids that decrease progressively in width from m1-m3, and a hypertrophied P4 with well-developed shearing crests and an anteriorly projecting parastyle. Compared with *Apternodus*, the specimen also has a more gracile anterior lower dentition and a shallower mandibular corpus. This new specimen thus represents the first apternodontid known from the Tornillo Basin, and may also represent the southernmost occurrence of *Oligoryctes* in North America.

Funding Sources Funding for this work was provided by an anonymous donor.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Ecophysiological influences on the metaplastic tissues of end-Cretaceous pan-trionychian turtle shells

Ong, Nathan S.

Anatomy and Cell Biology, Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma, United States

Most extant aquatic turtles use their shell as a calcium storage reservoir to combat blood acidosis in anoxic conditions, but some modern soft shelled turtles (e.g. *Apalone*) implement extrapulmonary respiration to circumvent the anoxic metabolic processes that induce blood acidosis. As a result, modern and fossil trionychids reliant on normoxic water generally exhibit unremodeled bone histology, allowing this trait to be examined in deep time. Most turtles survived the K/Pg extinction, but select taxa

like *Helopanoplia* and *Gilmoremys* disappear for unknown reasons, so the selective relevance of extrapulmonary/cutaneous respiration was evaluated herein by examining the paleohistology and ornamentation/sculpture (i.e. surface texture) of 200 Pan-Trionychian turtle shells spanning the K/Pg boundary.

To quantify shell texture, Surface Topographic Analyses like Orientation Patch Count Rotated and Relief Index were applied to 3D ornamentation scans. To quantify shell histology, over 25,000 osteohistological data points like zonal thickness, porosity, and vascular orientation were collected. Data were then statistically compared against latitude, stratigraphic position, lithologic context, ontogeny, phylogeny, and K/Pg survivorship to better understand how each respective variable covaries with ornament and histology.

Distinctly-sculptured shells had ornament pits devoid of Sharpey's fibers, suggesting that ornamentation cradled a dense cutaneous capillary bed. These turtles also exhibited smaller medullary cavities, indicating that the shell was seldom remodeled. These data suggest that like *Apalone*, K/Pg turtles adopted varying degrees of extrapulmonary respiration to prevent blood acidosis, but their unique sculpturing and vascular correlates indicate that they relied on cutaneous respiration more than the cloacal/buccopharyngeal respiration utilized by *Apalone*. Trionychids with distinct ornamentation and minimal remodeling go extinct at the K/Pg boundary, suggesting that cutaneous respiration-induced normoxic reliance was a liability when photosynthesis halted and freshwater ecosystems became anoxic.

K/Pg recovery was rapid; trionychids from approximately 9,500 years after the extinction are only modestly more remodeled compared to later Paleogene specimens, suggesting that freshwater ecosystems had almost fully

recovered by this interval.

This study demonstrates that beyond ontogeny and phylogeny, the shell is deeply shaped by physiology and ecology.

Funding Sources Oklahoma State University Center for Health Sciences, Paleontological Society, Geological Society of America, Natural History Museum of Los Angeles, Burke Museum

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Cranial ontogeny of the extinct dwarf tapir *Tapirus polkensis*; with comparison to that of the extant *Tapirus bairdii*

Orendorff, Johannah, Wallace, Steven C.

Geosciences, East Tennessee State University, Johnson City, Tennessee, United States

The Gray Fossil Site (GFS) of eastern Tennessee, which dates to ~5Ma, preserves an exceptional forest-adapted biota from North America. Among the taxa recovered is an extinct dwarf tapir (*Tapirus polkensis*) thought to be closely related to the extant Baird's tapir (*T. bairdii*). This relationship seems questionable considering the morphological differences between the crania of the taxa. For example, *T. bairdii* exhibits the telescoping morphology typical of most tapirs, whereas that of *T. polkensis* is relatively flat. Additionally, the nasal septa (and related structures) are significantly different between the two. Such differences, and the conservative nature of the postcrania within the family Tapiridae, supported a focus on the crania for this study. Thus, we have chosen to concentrate on the nasal region, because much of tapir evolution has centered around its proboscis. Images capturing left lateral and dorsal orientations of the crania and jaws were taken for 10 near-complete skulls of *T. polkensis* from the GFS,

representing the full ontogenetic series. Landmarks were placed on all images with X and Y coordinates for each image. Landmarks were transformed through superimposition into shape coordinates, then analyzed for statistical patterns. Principal Component Analysis (PCA), which looks for patterns in the raw data, helped resolve which areas of the cranium and jaw were growing faster relative to others. Preliminary results support the hypothesis that areas around the trunk are growing at a much faster rate relative to the overall size of the cranium. To further visualize the changes, thin plate splines (TPS) were generated to interpret changes between landmarks through ontogeny. To expand the scope of the project, 46 skulls of *T. bairdii* from the Smithsonian Institution will be digitized, following the same protocol, to compare the growth and development of the two taxa and clarify their relationships. These results will set a baseline for future studies on the GFS tapirs, and could provide crucial understanding regarding the ecology of extant endangered tapirs.

Funding Sources Funding for this work was received from the Don Sundquist Center for Excellence in Paleontology.

Colbert Prize Session

Use of elliptical Fourier analysis to discriminate osteoderm placement in Alligatoroidea (Crocodylomorpha)

Orlowski, Hayley K.¹, Hastings, Alex K.²

¹Earth and Environmental Sciences, University of Minnesota—Twin Cities, Oak Creek, Minnesota, United States, ²Science Museum of Minnesota, Saint Paul, Minnesota, United States

Osteoderms (ossifications within the dermal tissue) are a common component of many vertebrate skeletons and can be found in all living species of crocodilian, as well as many

fossil species. Under certain taphonomic regimes, soft tissue decay and transport may lead to disarticulation of osteoderms or even complete dissociation from endoskeletal remains, complicating the study of morphology in fossil taxa. Despite fossil crocodylomorph osteoderms being common at numerous fossil sites, their proper placement within the body has received little analytical study. We report on the skeletonization and archiving of a nearly complete (>95%) dermal skeleton of a Cuvier's Dwarf Caiman (*Paleosuchus trigonatus*), with anatomical observations and new terminology for the positional identification of individual osteoderms. Individual osteoderms were digitally photographed and their outlines extracted, allowing for morphometric examination using two-dimensional elliptical Fourier analysis (EFA). As the dermal shield of *Paleosuchus* has an unusually high osteoderm count (>800 individual elements) and extends across much more of its body than is typical for crocodilians, EFA has only been attempted for dorsal osteoderms. Following Fourier decomposition, osteoderms were analyzed using linear discriminant analysis (LDA) to examine whether EFA constitutes a valid method of identifying anatomical position of isolated osteoderms. Results show promising discrimination ability between caudal and sacral osteoderms, with over 70% classification accuracy, but poor discrimination of thoracic osteoderms (>40% accuracy). Poor discrimination between left and right sides of the body axis was also found (~50% accuracy). As a means of testing the potential utility for this method in the fossil record, these methods were applied to a sample of isolated osteoderms from the holotype of *Wannaganosuchus brachymanus*, an alligatoroid from the Paleocene Bullion Creek Formation of North Dakota, USA, which is of comparable size to *P. trigonatus*. These data allow for tentative anatomical placement of *Wannaganosuchus* osteoderms, but further analysis of

osteoderm shape variation within and among alligatoroid species is needed for confident assignment.

Funding Sources N/A

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Taxonomic diversity of trematopid temnospondyls at Dolese in the Early Permian of Oklahoma

Osterling Arias, Adrian F.¹, Bevitt, Joseph², Reisz, Robert^{3,1}

¹Biology, University of Toronto Mississauga, Mississauga, Ontario, Canada, ²Australian Centre for Neutron Scattering, Australian Nuclear Science and Technology Organisation, Lucas Heights, New South Wales, Australia, ³Dinosaur Evolution Research Center, Jilin University, Changchun, Jilin, China

Trematopids were an impressive group of Late Pennsylvanian and Early Permian terrestrial temnospondyls from North America and central Germany that make their modern-day relatives appear mediocre in comparison. These monstrous predators have a largely unresolved phylogeny and poorly understood ontogeny as a result of a lack of substantially informative fossils representing several taxa. Recent discoveries of numerous skulls of trematopids at the famous Richards Spur (Ft. Sill) locality have allowed for the use of a non-invasive form of technology, known as neutron computed tomography (The Dingo Beamline at ANSTO, Australia), for taxonomic and ontogenetic analysis on these new, well-preserved partial and complete trematopid skulls from the cave infills at the Dolese Brothers Limestone Quarry, Richards Spur, Oklahoma. Hydrocarbon impregnation of these skulls makes them ideally suited for neutron tomography, resulting in very high quality data for segmentation. Representing

various ontogenetic stages, these skulls can be used to address the interesting challenges that can arise from distinguishing ontogenetic variation from taxonomically relevant features. We already have been able to produce detailed anatomical reconstructions of these skulls and were able to identify features that are both ontogenetically variable and ontogenetically independent among these specimens. This new set of data will not only create a more accurate representation of the taxonomy and ontogeny of this clade at Richards Spur, but it also resolves some of the questions regarding whether or not ontogenetically influenced characters were appropriately considered in previous taxonomic interpretations of juvenile and adult specimens of trematopids from this famous locality. Our preliminary data indicate that at least two, possibly three, distinct taxa of trematopids can be identified on the basis of the combined features of skull shape, internarial fontanelle size and shape, and the lateral exposures of the palatine and ectopterygoid bones beneath the orbits. This pattern conforms well to the level of taxonomic diversity found among various taxa of tetrapods in the Richards Spur terrestrial vertebrate faunal assemblage, which includes multiple species of dissorophid and amphibamid temnospondyls, recumbirostran microsaurs, acleistorhinid parareptiles and captorhinid eureptiles.

Technical Session 5: Paleozoic Herpetology (Wednesday, October 30, 2024, 1:45 PM)

The world comes crawling: restructuring of terrestrial ecological communities during the Carboniferous driven by insect, rather than tetrapod, herbivores

Otoo, Benjamin¹, Roopnarine, Peter³, Angielczyk, Kenneth D.²

¹Earth Sciences, Carleton University, Ottawa, Ontario, Canada, ²Invertebrate Zoology and Geology, California Academy of Sciences,

San Francisco, California, United States, ³Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

The Carboniferous Period (359-299 million years ago) was a pivotal time in Earth history, during which tetrapods expanded beyond the water into the terrestrial realm; by its end, tetrapods were well-established and diverse on land. The development of terrestrial vertebrate ecosystems during this time, by contrast, is less understood. Tetrapod biotas from the Carboniferous/Permian transition interval have been hypothesized to represent the 'primitive' state from which terrestrial tetrapod communities developed during the Permian. However, it is unclear how the structure and function of these latest Pennsylvanian communities compare to their predecessors in the Devonian and Mississippian. Establishing a comparative dataset is necessary for understanding how terrestrial vertebrate communities originated.

Here we reconstruct food webs for 11 vertebrate biotas from the Carboniferous of North America to compare their taxonomic composition and network structure.

Tetrapod diversity is overwhelmingly aquatic and faunivorous until the latest Pennsylvanian. Terrestrial tetrapods are mostly either 'microsaurs' (early Pennsylvanian, Bashkirian-Moscovian) or synapsids (late Pennsylvanian, Kasimovian-Gzhelian). Terrestrial tetrapod herbivores are only represented by a small number of species in the dataset. We find that Mississippian and early Pennsylvanian (Bashkirian-Moscovian) food webs, dominated by aquatic vertebrates, are characterized by higher mean network trophic position (NTP), link density (LD), and connectance (C). Mean values for NTP and LD skew lower in the late Pennsylvanian (Kasimovian-Gzhelian), driven by the appearance of diverse entomofaunas of herbivores and detritivores; any impact from

tetrapod herbivores is minimal. However, tetrapod herbivores create novel guilds by reaching body sizes not attained by arthropods.

These results provide quantitative support for the hypothesis that while tetrapod communities retained strong ties between their aquatic and terrestrial components at the end of the Carboniferous, these communities were still structurally different from their predecessors. These differences were chiefly due to the proliferation of insect primary consumers and growth of low trophic levels. Further work is needed to investigate how these differences in network structure affected community stability- and thus ability to persist over evolutionary time- and clarify interactions between community composition, floral diversity, and climate.

Funding Sources National Science Foundation Postdoctoral Research Fellowship in Biology

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Advances in early Mesozoic paleoichthyology in the American southwest: New discoveries of ray-finned fishes from the Upper Triassic Dockum Group

Ott, Spencer M., Gibson, Sarah Z.

St. Cloud State, St. Cloud, Minnesota, United States

Ray-finned fishes are one of the largest groups of vertebrates on the planet, having first shown up in the fossil record 480 million years ago. Despite being such a long lived and diverse group, little is known about many extinct genera of fishes, particularly stem actinopterygians from the Early Mesozoic, a time where fish were diversifying into and exploiting empty niches following the End-Permian Extinction Event. Herein we describe

recent advances in knowledge regarding actinopterygians from the Upper Triassic Dockum Group of New Mexico and Texas (approximately 230–200 Ma). The Dockum basin contains a distinct assemblage of fishes belonging to the orders Redfieldiiformes (Actinopterygii: “Palaeoniscimorpha”), Scanilepiformes (Actinopterygii: Cladistia), Semionotiformes (Neopterygii: Holostei), and Dapediiformes (Neopterygii: Holostei). Several new species of fishes have been identified from the Colorado City Formation, Dockum Group of western Texas; we describe their morphology and unique three-dimensional preservation. We describe a unique mass mortality of juvenile semionotiforms from the Redonda Formation, Dockum Group of eastern New Mexico. We compare this assemblage to the similar but distinct assemblage found in the Upper Triassic Chinle Formation of Utah, Arizona, and Colorado, and discuss evolutionary relationships among stem actinopterygians.

Funding Sources SCSU student research grant and SCSU faculty improvement grant.

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

The Pleistocene vertebrate paleontology of Belize: Results from the first paleontological resource assessment in Belize

Ovando, Alison, Schubert, Blaine W.

Department of Geosciences, East Tennessee State University, Dangriga, Stann Creek, Belize

The current knowledge on the natural history of Belize is drawn from inferences using regional information and smaller well studied areas of the country. Historic paleontological research conducted in Belize is documented

as early as 1952 during the first industrial oil explorations of British Honduras (Belize). Geologic surveys conducted at the time utilized fossils found across the country to estimate the age of geological formations. From the 1960s to the early 2000s, archaeologists and cavers working in Belize came across fossils of extinct Pleistocene species that have led to remarkable scientific discoveries. This study highlights the contributions of paleontology from Belize and its impacts on the greater scientific community. The gaps in knowledge and research on the vertebrate paleontology from Belize leave many questions to be answered. The results from the most recent reconnaissance mission portray the first effort to better understand the country’s fossil record.

There are approximately 14 locations known to produce Pleistocene fossils in Belize so far. These sites include several karst features such as: caves, sink holes, cenotes, rivers, and gravel pits. The location and current state of these sites are presently understudied. Therefore, localities were visited to photograph and document the geology associated with previously found fossils. These sites have a high potential for microfossil studies which could likely produce fossils from various small mammals, birds, reptiles, amphibians, and fish. At least 27 vertebrate taxa across 12 families are known thus far, the majority of which are presently extinct or extirpated. Taxa such as Canidae and Toxodontidae have not yet been found in the country but are expected to be found in the future based on the fossil record from the region.

The results from this study describe the substantial on-going natural processes in the changes of ecosystems and the ecology of species in Belize. In addition, this research demonstrates the universal value of protecting sites containing fossils from the point of view of conservation paleobiology. As paleontology continues to develop in Belize,

these new and exciting findings can help to enhance Belize's understating and awareness of the Earth's natural heritage. Furthermore, connecting humans to the past through natural history can be used as a catalyst for improving Belizean led initiatives to safe guard paleontological resources through policy and public engagement.

Funding Sources ETSU Center of Excellence in Paleontology

ETSU Department of Geosciences

ETSU Graduate School

The Kingsport Gems and Minerals Society

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Winter is coming: The Richmond Hill Local Fauna and the Pliocene/Pleistocene transition in the Black Hills of South Dakota

Pagnac, Darrin C., Fox, Nathaniel, Wright, Samantha, Keenan, Sarah

Geology, South Dakota Mines, Rapid City, South Dakota, United States

The Richmond Hill local fauna consists of eleven individual sites accumulated in fissure fills in the Pahasapa Limestone (Mississippian) during the Pliocene/Pleistocene transition. The local fauna was collected from an open pit gold mine near Lead, SD, during the late 1990s. Diversity estimated based on Shannon indices is extremely high at most sites, with both macro- and microfaunal components ranging in size from Camelidae (*Gigantocamelus*) to Soricidae (*Sorex*). Seven localities appear to be Blancan based on the co-occurrence of *Blarina*, *Paenemarmota*, *Pliogeomys*, *Pliophenacomys*, and *Ondatra*, and four appear to be Irvingtonian based on the co-occurrence of *Allophaiomys*/*Microtus*, *Cynomys*, *Mictomys* cf. *kansasenses*, and

Prodipodomys. Dissimilarity analysis clusters Blancan sites distinctly from Irvingtonian sites, indicating unique, temporally delineated assemblages. Preliminary age estimates based on rodent biochronology are 3.9-3.1 Ma and 2.0-1.3 Ma for Blancan and Irvingtonian sites, respectively. A diverse macrofauna is most significantly represented by Canidae, Camelidae, and several unique taxa of Mustelidae. Microfaunal abundance is high, with the most prominent families being Cricetidae, Sciuridae, and Leporidae. Due to the co-occurrence of forest (*Neotamias*/*Tamias*, *Neotoma*), prairie (*Antilocapridae*, *Cynomys*, *Ictidomys*, *Geomys*), and lacustrine taxa (*Ondatra*, *Lissamphibia*), the local environment is interpreted as a high-altitude, montane meadow associated with a marsh or pond adjacent to closed forest. Rarefied diversity estimates indicate that, despite exhibiting already high diversity, the potential for encountering new taxa is high at most sites. Initial sampling and analysis indicate less taxonomically diverse and less even Irvingtonian assemblages that are heavily dominated by environmentally generalist cricetid rodents, whereas the most common taxa in Blancan assemblages are Xerinae (ground squirrels). The faunal disparities between the Blancan and Irvingtonian sites may be in response to more variable floral and environmental conditions at the onset of the Pleistocene.

Funding Sources Institute for Museum and Library Services Museums for America Grant MA-251772-OMS-22

Colbert Prize Session

Detailed morphology of an isolated avian quadrate from the Upper Cretaceous of southern Alberta (Canada) provides evidence of hesperornithiform affinities

Palmgren, Romain¹, Kuo, Pei-Chen², Stidham, Thomas A.³, O'Connor, Jingmai², Sullivan, Corwin¹

¹University of Alberta, Edmonton, Alberta, Canada, ²Field Museum of Natural History, Chicago, Illinois, United States, ³Chinese Academy of Sciences, Beijing, China

Avian material from the Upper Cretaceous has contributed importantly to understanding the evolutionary history of birds. Given the rarity of bird fossils from the Upper Cretaceous of North America, and of skull bones in particular, avian cranial material from these deposits is of great interest. While Upper Cretaceous strata in Alberta, Canada have yielded a number of isolated avian elements, particularly fragments of appendicular bones, a right quadrate (UALVP 16262), is the first avian skull bone to be reported from the Cretaceous of Alberta. The specimen was recovered in 1974 from the Dinosaur Park Formation slightly south of Irvine, Alberta, via screenwashing. Using micro-CT scans and traditional microscopic methods, we examined the interior and exterior morphology of UALVP 16262. The orbital and otic processes, which would likely have been the most diagnostic and informative parts of the quadrate if intact, are incomplete. Nevertheless, the presence of a distinctly protruding pterygoid condyle rules out referral to Enantiornithes or any non-ornithothoracine lineage and suggests phylogenetic placement within the ornithuromorph clade. The tricondylar nature of the mandibular articular surface indicates that the specimen is not referable to either the neornithine clade Galloanserae or the non-neornithine ornithuromorph *Ichthyornis*. Furthermore, the medial and caudal mandibular condyles are confluent on this specimen, a feature seen on basal hesperornithiform quadrates. Additionally, the medially extended base of the broken orbital process and triangular shape of the pterygoid condyle are shared with all hesperornithiforms, corroborating referral to

that clade. The preserved part of the quadrate contains five interconnected, exquisitely preserved internal cavities, which communicate with the exterior via a canal. The canal exits the quadrate via two small openings, one within the basiorbital fossa and one situated ventral to the orbital process. The fossil derives from fluvial sediments, adding to the evidence that hesperornithiforms had a significant presence in non-marine settings in North America during the Late Cretaceous.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Comparisons among morphologies from modern and quaternary collections in a widespread mustelid (*Neogale vison*)

Pamfilie, Alexandra M., Vitek, Natasha S.

Ecology and Evolution, Stony Brook University, Coram, New York, United States

Phenotypic variation within a species is a necessary component of morphological response to changing environments, whether that change be plastic or adapted. The mandible, as a dietary functional interface between an organism and its environment, is expected therefore to show variation in morphology among different environments that may place different functional pressures on individuals. Characterizing this variation, especially in the fossil record, is challenging due to the high sample sizes and data density required. The American mink (*Neogale vison*) is a widespread generalist species that possesses documented morphological variation across its range. Mink inhabit such disparate habitats as coastal swamps and tundra, though much of the mink's range is within temperate plains and forests with ample water supply. This presents an opportunity to study the geographic organization of intraspecific morphological variation among modern and fossil

(Irvingtonian to present) individuals and its potential changes over glacial-interglacial cycles. Here, we describe these patterns of variation in mandibular morphology among Recent American mink (*Neogale vison*) specimens from across the species range (N ~ 200). In the context of this breadth of variation, we analyze the morphology of fossil mink mandibles and lower cheek teeth (N ~ 40). To characterize shape, we used auto3dgm, a high-density point-based morphometric method. Most variation in shape among individuals was observed in the distal parts of the mandible, especially the ramus and bony processes where masticatory muscles attach. However, among modern specimens there was little evidence of broad-scale trends in shape driven by habitat or barriers to dispersal. This result reflects the mink's generalist niche: though mink are known to inhabit many disparate habitat types, much of the species resides in regions with prey species that are similar in size, lifestyle, and processing requirements. Similarly, preliminary data suggest fossil *N. vison* mandibles and cheek teeth also vary more in shape within populations than between populations. Twenty fossil mandibles attributed to *N. vison* from a single site show qualitatively high variability in the shapes of the ascending ramus and talonid basin of the carnassial. The high levels of variability in traits correlated to masticatory function may reflect high levels of plasticity and differences among individuals' roles in the environment.

Funding Sources Department of Ecology and Evolution, Stony Brook University; The Paleontological Society Student Research Award

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

The Frontier Formation of southwestern Montana: a new paradigm to understand

the middle Cretaceous transition and faunal provincialism of North America

Panascí, Giulio, Varricchio, David J., Prall, Jack

Earth Science Department , Montana State University, Bozeman, Montana, United States

The middle Cretaceous (Albian-Santonian) is a critical period to understand the evolution of the North American Cretaceous terrestrial ecosystems at the end of the Mesozoic Era. However, the scarce fossil record reported in Turonian-Santonian formations limits our understanding of this important faunal transition. Among the middle Cretaceous fossil records, those described from the Frontier Formation are one of the few ever reported from Coniacian deposits of western North America. Fossil remains are preserved in thick non-marine successions exposed in Southwestern Montana and assigned to channel lags, paleosols, and overbank sediments deposited in a broad alluvial coastal plain setting. The dinosaurian fossil record is comprised of hadrosauriform ornithopods, ankylosaurs, and theropods as indicated by tracks, bone remains, and eggshell fragments. The fossil record also includes baenid, and nanhsiungchelyid turtles as well as fragmentary crocodilian remains. The Frontier paleocommunity is dominated by ornithopod dinosaurs as observed in other Albian-Cenomanian formations, but it also reflects a mixed composition with elements typical of Upper Cretaceous formations. Notably, the formation denotes the first occurrence of endemic North American turtles assigned to *Neurankylus* sp. and *Basilemys* sp., so far only restricted to Santonian-Maastrichtian formations. This paleocommunity was established in southwestern Montana by the lower Coniacian and is indicative of increasing faunal provincialism. Dispersal of Asian taxa, (i.e. nanhsiungchelyid turtles) to North America and the establishment of a North American provincial fauna can be

traced back to at least the Coniacian and may support a possible initiation for dispersal and vicariance of this fauna earlier in the Turonian.

Funding Sources No funding for this work was received

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Tradeoffs between the secondary palate and vomeronasal organ in dicynodonts

Pardo, Jason, Angielczyk, Kenneth D.

Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Secondary palates are a common feature among amniotes, with notable parallelism of this structure in therapsids. Although a variety of functions of the secondary palate have been proposed, the primary consequence of the secondary palate is to posteriorly displace the choana from the front of the palate to the back. Different therapsid lineages produce the secondary palate in different manners, either in a front-first pattern where palatal shelves are initially formed from contributions of the premaxilla and maxilla (observed in dicynodonts and some therocephalians), or a rear-first pattern, where palatal shelves are formed from contributions of the palatine and maxilla (primarily seen in cynodonts). Rear-first closure preserves a palatal exposure of the vomeronasal organ via the incisive foramen, whereas front-first closure either displaces or closes off the vomeronasal organ from the palatal surface, creating conflict between function of the palate itself and chemosense via the vomeronasal organ.

We used μ CT to relate secondary palate morphology to osteological correlates of the vomeronasal organ in dicynodonts, with a focus on the endothiodontids, a group of

derived non-bidentalian dicynodonts, which are characterized by increased separation between the palatal shelves, a rare case of a definitive loss of a complete secondary palate. We show that the choanal space in dicynodonts preserves traces of two parallel structures: the passage of the choanal tube and the vomeronasal organ. The latter is located along the anteroventral margin of the choanal tube and is apparent as a distinct fossa formed by the maxilla and vomer. In most dicynodonts, the vomeronasal canal opens into the palatal surface through a small notch on the anterior margin of the choana. In endothiodontids, the vomeronasal canal is short and wide, with a diameter approximately half that of the choanal tube. μ CT scans show that the vomeronasal canal exhibits a typical dicynodont organization in juveniles but grows allometrically to produce the unique adult morphology. We hypothesize that this apparent reduction of the secondary palate is a consequence of increased reliance on chemosensory roles of the vomeronasal organ around the transition to adulthood. More broadly, this suggests that constraints of palatal development and geometry did impose strict tradeoffs between chemosensing and functional benefits of the secondary palate, which must have been overcome in derived therapsid groups.

Funding Sources JDP was supported by an NSERC Banting Postdoctoral Fellowship and an NSF EAR Postdoctoral Fellowship Award 2204569.

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Geographic variation in carnivoran dentition in relation to environment

Parham, Joshua, Samuels, Joshua X.

Geoscience, East Tennessee State Univ., Mars Hill, North Carolina, United States

Functional traits of organisms reflect the environmental conditions they inhabit. Ecometric approaches are commonly used to relate functional traits at a community scale to environmental parameters like temperature and precipitation. Previous ecometric studies have been conducted on dentition of ungulates and glires (rodents and lagomorphs), as well as limb characteristics of carnivorans, but how the dentition of carnivoran guilds reflect environments has not been as well studied. 51 measurements were gathered from both the upper and lower dentitions of 45 species of extant carnivorans. These measurements were used to calculate a series of functional indices regularly used to study carnivoran guilds (e.g. relative carnassial blade length, relative grinding areas, etc.). We computed mean values for carnivorans from various communities across North America, and then compared community means across latitudes and climate conditions. The preliminary results show greater grinding area at lower latitudes and within wetter climates reflecting greater proportion of omnivorous and frugivorous species, while relatively more bladelike carnassials were observed at higher latitudes in colder climates reflecting a greater proportion of hypercarnivorous species and the absence of frugivores. Application of these methods has the potential to yield new information about how carnivoran guilds reflect their environments, facilitate estimation and interpretation of past environmental conditions based on fossil carnivorans, and inform understanding of how carnivoran guilds may change in the face of ongoing climate change.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Redescription of the cranial anatomy of the holotype of *Pinacosaurus grangeri* (Ankylosauria: Ankylosauridae) and a revision of the genus

Park, Jin-Young^{1,2}, Son, Minyoung³, Lee, Yuong-Nam⁴, Lee, Sungjin⁴, Kim, Su-Hwan⁴, Tsogtbaatar, Khishigjav²

¹Research Institute of Basic Sciences, Seoul National University, Seoul, Korea (the Republic of), ²Institute of Paleontology, Mongolian Academy of Sciences, Ulaanbaatar, Mongolia, ³Department of Earth & Environmental Sciences, University of Minnesota Twin Cities, Minneapolis, Minnesota, United States, ⁴School of Earth and Environmental Sciences, Seoul National University, Seoul, Korea (the Republic of)

The holotype of *Pinacosaurus grangeri* belongs to an adult individual and includes a cranium, two cervical vertebrae, and free osteoderms. It was collected from the Upper Cretaceous (Campanian) Djadokhta Formation at Bayan Zag in the southern Gobi Desert, Mongolia. Due to the dorsoventrally crushed condition of the holotype, the original reconstruction and description of *P. grangeri* were not entirely accurate, and most studies since have relied instead on less deformed referred materials. These referred skulls were much smaller, with the holotype of *P. grangeri* representing the only adult specimen described for the genus, further complicating morphological comparisons with other taxa. We provide a redescription of the holotype cranium of *P. grangeri*, to add new information on its morphology. The holotype cranium exhibits a unique set of features, including two pairs of small bulbous internarial caputegulae, large supranarial caputegulae, lacrimal incisure, pyramidal prefrontal caputegulae, anterior and posterior supraorbital caputegulae with distinct apices, a “neck” at the base of the quadratojugal horn, well-defined postorbital fossa, and short paroccipital processes. The combination of these characters is shared by another ankylosaur from the Djadokhta Formation, *Minotaurasaurus ramachandrani*, which otherwise lacks diagnostic features. Therefore, we propose that *M. ramachandrani* be considered a junior synonym of *P. grangeri*.

The type and only known specimen of *Minotaurasaurus* is thought to be from Ukhaa Tolgod. Combined with the juvenile materials previously assigned to *P. grangeri*, this further supports that *P. grangeri* was also present at Ukhaa Tolgod. Furthermore, '*Pinacosaurus*' *mephistocephalus*, the second species of *Pinacosaurus* from the Upper Cretaceous (Campanian) Bayan Mandahu Formation at Bayan Mandahu of China, lacks many key diagnostic features present in the holotype and referred specimens of *P. grangeri*, and may represent a separate genus.

Funding Sources National Research Foundation of Korea (grant number 2022R111A2060919) to Yuong-Nam Lee.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Size doesn't matter (as much as we thought): new discoveries from paleoproteomics demonstrate that morphometric analyses are not a reliable estimator of sex in extinct lions

Parker, Glendon J.², Dunn, Regan³, Farrell, Aisling³, Ghezzi, Elena¹, Lindsey, Emily³

¹Department of Environmental Toxicology, UC Davis, Davis, California, United States, ²La Brea Tar Pits and Museum, Los Angeles, California, United States, ³Environmental Science, Informatics, and Statistics, Ca' Foscari University of Venice, Venice, Venice, Italy

During the Pleistocene, lions were widely distributed throughout Africa, Eurasia and North America, with at least three recognized species: *Panthera fossilis*, *Panthera spelaea*, and *Panthera atrox*. Traditionally, studies of Pleistocene lions have used morphometric measures from modern African lions (*P. leo*) to estimate sex, and assume sexual dimorphism as part of the extinct species' variability consistent with *P. leo* population

biology. However, skeletons of modern lions in museum collections may be biased for several reasons, like selective collection or preparation of preferred animals, and museum labels of historically-collected specimens frequently lack important metadata. On the other hand, extinct populations may reflect different social structures and/or time averaging, which cannot always be estimated without further invasive analyses. Therefore, comparative statistics that use only museum specimens may not accurately represent intraspecific variability and the real degree of sexual dimorphism.

Recent molecular techniques are enabling new ways to analyze sex and test assumptions derived from morphological data. One such method is looking for X and Y amelogenin (AMELX and AMELY, respectively) on tooth enamel. Presence of AMELY is diagnostic for males, while high amount of AMELX, and no detection of AMELY, is indicative for females.

We tested tooth enamel from six modern African lions (*P. leo*) and three extinct Pleistocene lions from Rancho La Brea (*P. atrox*) to verify the applicability of amelogenin technique in extinct lions. All results were definitive – four of the modern lions and one of the fossil lions were determined to be male based on the presence of AMELY; two modern lions and two fossil lions were inferred to be female because they had significantly higher values of AMELX than the other specimens and no detected AMELY. Interestingly, all three of the fossil lions were classified by traditional morphometric analyses as probable males. The fact that two of these were revealed through paleoproteomics to be females has important implications for future studies of evolution and demography in extinct felids.

Funding Sources This project has received funding from the European Union's Horizon 2020, under the Marie Skłodowska-Curie

Action, Global Fellowship (E.G. grant n. 785821).

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Redefining the Late Triassic Land Vertebrate Teilzones in the Chinle Formation of Petrified Forest National Park

Parker, William G.¹, Marsh, Adam¹, Martz, Jeffrey W.², Wagner, Deborah E.¹, Allen, Timothy J.¹

¹Department of Science and Resource Management, Petrified Forest National Park, Petrified Forest, Arizona, United States, ²Department of Natural Sciences, University of Houston Downtown, Houston, Texas, United States

The Upper Triassic Chinle Formation at Petrified Forest National Park (PEFO, Arizona, U.S.A.) is one of the best studied Late Triassic terrestrial sequences in the world. The total section of the Chinle Formation in the park is approximately 334 meters and preserves a diverse fossil record of vertebrates, invertebrates, traces, and plants. Since 1930 it has been recognized that the Chinle Formation strata in the park can be divided into local biozones, interval teilzones, by utilizing the lowest known occurrences of certain phytosaur taxa. The park bears the type assemblage for the Adamanian estimated holochron which has been proposed for global biochronologic correlation. Previously only fossil assemblages characterizing the Adamanian and Revueltian teilzones were recognized in the park, with the Revueltian being topless owing to missing characterizing fossils.

The recent discovery of a phytosaur skull referable to *Redondasaurus* sp. from approximately 1 m above the Black Forest bed of the Petrified Forest Member now defines the bottom of the Apachean teilzone

as well as the top of the Revueltian. At PEFO the Otischalkian teilzone encompasses the Mesa Redondo Member and the lower part of the Blue Mesa Member. The Adamanian teilzone encompasses the upper part of the Blue Mesa Member and the lower part of the Sonsela Member to the level of the 'persistent red silcrete' in the lowermost Jim Camp Wash beds. The Revueltian teilzone encompasses the remainder of the Sonsela Member as well as the Petrified Forest Member up to 1 m above the Black Forest bed. The Apachean teilzone encompasses of the top several meters of the Petrified Forest Member and what is present of the Owl Rock Member. Based on published U-Pb ages from detrital zircons, the corresponding ages for the Otischalkian estimated holochron for PEFO are ~225–221 Ma, the Adamanian is ~221–214 Ma, the Revueltian is ~214–210 Ma, and the Apachean is ~210–<208 Ma. The superpositional relationship of the aetosaurs *Scutax deltatylus* and *Calyptosuchus wellsi* allows for the subdivision of the Adamanian into the St. Johnsian (221–218 Ma) and the Postian (218–214 Ma). The determination of the base of the Apachean at PEFO allows for stronger geochronological correlations for Late Triassic exposures across the southwestern United States.

Funding Sources The NPS Cyclic Funding Program (Project #307954B) to D.E.W.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A survey of gain and loss of osteoderms in Archosauromorpha reveals complex patterns of evolutionary change

Patellos, Emily¹, Smith, Nathan D.², Bottjer, David¹

¹Earth Sciences, University of Southern California Dana and David Dornsife College of Letters Arts and Sciences, Los Angeles, California, United States, ²Dinosaur Institute,

Natural History Museum of Los Angeles
County, Los Angeles, California, United
States

Osteoderms, elements of the vertebrate integumentary skeleton, have evolved independently multiple times in several vertebrate lineages. Their presence in groups from the earliest tetrapods to crown amphibian, reptile, and synapsid groups, hints at a deep underlying evolutionary homology of these elements and an innate ability for the dermis to ossify. Broad patterns of osteoderm evolution have been discussed by various authors, but outstanding questions surrounding the specific patterns of osteoderm evolution remain. For example, are osteoderms more likely to be gained or lost throughout evolutionary history? How homoplastic is the evolution of osteoderms and osteoderm traits? Does the presence of osteoderms affect diversification rates and ecological opportunities, and therefore potentially represents a key innovation? To attempt to answer these questions, a supertree of Archosauria (and immediate outgroups in Archosauromorpha) mapping osteoderm presence and absence is used to reconstruct ancestral states using three different approaches: a parsimony model, a two-rate likelihood model, and a stochastic mapping model. The group Archosauria was selected to test these hypotheses due to the difference in osteoderm abundance between the two major branches: Pseudosuchia and Avemetatarsalia. Pseudosuchia, the branch that includes modern crocodiles, has many lineages with extremely variable osteoderm morphologies. This is in contrast with Avemetatarsalia, the branch that includes dinosaurs and birds, which is mostly devoid of osteoderms. Osteoderms were lost early in the evolution of bird-line archosaurs, as seen by their presence in the earliest taxa, and notable lack soon after. Osteoderms only evolved in avemetatarsalians after the initial diversification of Dinosauria, having appeared at least three times independently.

Preliminary results show that osteoderms are present in 13 of 40 archosauromorph families from the Early Triassic through to the Middle Jurassic. Parsimony-based ancestral state reconstructions show that osteoderm presence is a synapomorphy of Archosauria (evolving at or before the *Euparkeria* + Archosauria node). Osteoderms were lost once within Avemetatarsalia, and three times within Pseudosuchia, prior to the Middle Jurassic. Osteoderms evolved once within Avemetatarsalia, and were not regained within the three pseudosuchian groups that lost osteoderms, prior to the Middle Jurassic.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

The amniote common ancestor was "synapsid"

Peacock, Brandon R.¹, Jenkins, Xavier A.¹,
Ford, David², Choiniere, Jonah³, Benson,
Roger B.⁴

¹Idaho Museum of Natural History &
Biological Sciences, Idaho State University,
Pocatello, Idaho, United States, ²Natural
History Museum, London, United
Kingdom, ³Evolutionary Studies Institute,
University of the Witwatersrand,
Johannesburg, South Africa, ⁴Department of
Vertebrate Paleontology, American Museum
of Natural History, New York, New York,
United States

Patterns of temporal fenestration have been central to taxonomies and evolutionary scenarios for amniote evolution for most of the history of paleontology. Indeed the single-holed 'synapsid' condition of the mammal crown group and the doubly-holed 'diapsid' condition of the reptile crown group largely hold up (with notable modifications). However, the fenestration patterns of early amniotes and their close relatives in the late Carboniferous and Permian periods have meant that 'synapsid' and 'diapsid' conditions

have rarely fit neatly onto phylogenetic topologies. The early evolution of reptiles has been particularly problematic with the positions of unfenestrated ‘anapsid’ protorothyridids, captorhinids, and ‘parareptiles’ implying multiple origins of temporal fenestration within Amniota.

We have assembled high-resolution synchrotron phase-contrast tomography data for multiple Permian taxa, including: varanopids, ‘parareptiles’, araeoscelidians, and neodiapsids, in order to incorporate highly-conserved and formerly inaccessible character data of the inner ear, neurocranium, and palate into our phylogenetic analyses. Our resulting topologies are robust and remain consistent even when characters coding temporal fenestration are excluded, allowing for the following four proposals: 1) Protorothyrididae and Captorhinidae are stem-amniotes and their ‘anapsid’ skulls are plesiomorphic. 2) The common ancestor of Amniota was fenestrated and that fenestra is the single lateral temporal fenestra of Synapsida and the lower temporal fenestra (LTF) of most reptiles. 3) ‘Parareptiles’ are polyphyletic and spread along the reptile stem, with the ‘anapsid’ skulls seen in multiple clades representing some of the first of many modifications to the ancestral amniote fenestration. 4) The evolution of a second, upper temporal fenestra in early reptiles (diapsid fenestration pattern) possibly occurred independently in at least two or three clades; the most important being that the diapsid condition of the late Carboniferous araeoscelidean *Petrolacosaurus* is unlikely to be homologous with the diapsid condition of later neodiapsids like *Youngina* and the crown group.

This high degree of plasticity of temporal architecture among early reptiles may have resulted from the high functional relevance of fenestrae to jaw kinematics. This scaffold for Permo-Carboniferous reptile evolution

complements accepted patterns of fenestration modification in later Mesozoic clades.

Funding Sources ESRF ES873 and LS3248; BLM-IMNH; AMNH Collections Study Grant; ISU BRSC; NRF AOP (136516, 118794), NSF 1949901/GSA Grad GeoSci 13090-21; Genus Centre for Excellence

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Quantitative analyses reveal divergence and convergence of ecomorphological features in non-avian paravian dinosaurs

Pei, Rui¹, Xu, Xing^{1,2}

¹Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China, ²Yunnan University, Kunming, China

Dromaeosauridae and Troodontidae are two major lineages of non-avian paravians which are traditionally united as Deinonychosauria. Highly disparate osteological features and ecological proxies have been detected in these two taxa with similar ecomorphological traits pertaining to body size, the cranial shape, the dental configuration and the limb form appear multiple times along the topology. The evolutionary pattern of these features is understudied and the mechanism behind the convergence remains unclear.

Here we supplement previous works with more detailed sampling of discrete and continuous morphological data as well as the geometry of the cranium, dentition and limb bones of recently reported paravian specimens to investigate the divergence and convergence of non-avian paravians with multivariate analyses and an updated phylogenetic reconstruction. Our preliminary results reveal that the morphospaces of early-diverging troodontids and

dromaeosaurids as well as other early paravians overlap with each other, all featuring a lightly-built and short-snouted cranium. The majority of late-diverging troodontids (most Late Cretaceous troodontids) and dromaeosaurids (eudromaeosaurians) both have an elongate cranium and enlarged second pedal claws, but their morphospaces become separated. The elongate cranial shape is achieved through different morphological configurations in these lineages, with the dromaeosaurid cranium robust and the troodontid cranium relatively lightly-built. However, the late-diverging troodontid *Linhevenator* develops a long-snouted cranium with the dromaeosaurid configuration and acquires a robust cranial profile convergently. The different forelimb proportions and pedal shapes also make later forms of the two lineages diverge in morphospaces. Late Cretaceous troodontids show a more expanded morphospace than eudromaeosaurians due to the high disparity of dental traits. Late Cretaceous troodontids develop both serrated and unserrated ziphodont or folioid teeth, while eudromaeosaurians only have serrated and ziphodont teeth, which indicates that eudromaeosaurians are more conservative in diets and feeding behaviors. Non-avian paravians show higher disparity and more convergence in osteological features than previously expected, indicating the complexity of the ecomorphological adaptations in this group, partially driven by their scavenging strategies.

Funding Sources This study was supported by the National Natural Science Foundation of China (42372031, 42288201, 41972025).

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Volcanism and vertebrate evolution: insights from multi-agent based modeling

Peltier, Danielle M.

Earth and Atmospheric Sciences, Indiana University Bloomington, Bloomington, Indiana, United States

The hazards associated with volcanic eruptions and the correlation between large igneous provinces (LIPs) and global mass extinction events often lead to the perception that volcanism is detrimental to ecosystems and vertebrate species. However, despite ecosystem disturbance, post-eruption volcanic landscapes are nutrient-rich and facilitate colonization of open niche space which creates opportunity for vertebrate diversification. Despite the increased stress, occupation in unstable volcanic habitats has been suggested to lead to rapid speciation through stress-induced transposition. Vertebrates can be further impacted as volcanic uplift and eruptive material can isolate populations, blocking gene flow and/or forming genetic bottlenecks. I aim to better understand the relationship between volcanic processes and vertebrate evolution by utilizing multi-agent based modeling to investigate how speciation rates are influenced by various eruption types. A base landscape is populated with agents which represent individuals of a theoretical species, capable of movement and interaction with each other and the landscape, allowing for reproduction, dispersal, and gene flow. Agents are assigned values that represent ecological and phenotypic preferences that control interactions. Successful reproduction results in offspring with values obtained from a normal distribution centered on the parent's mean values, representing hybridization of parent genomes and the potential for genomic changes through mutation. Along with a null model of no volcanism, models were run before, during, and after eruptive events with iterations of varying eruption type, volume, and total number of eruptions. Agents are impacted by the eruptions through stress-induced mutations, resulting in new genetic variants,

and populations are impacted by the removal agents, reducing genetic diversity. Additionally, eruptive material can also create physical barriers to gene flow. Results indicate effusive eruptions facilitate greater speciation rates than explosive eruptions and that multiple eruptive events lead to more rapid speciation compared to single events as gene flow is further reduced. This work provides valuable insight for better understanding vertebrate evolution after volcanic disturbances. Further, this can be of interest when investigating diversification of vertebrate fauna after mass extinction events correlated with LIPs, which produce effusive eruptions.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Multivariate analysis of ecological diversity in Asian Rodentia in the context of tectonism and environmental change

Peng, Amanda W.^{1,2}

¹Earth Sciences, University of Oregon, Eugene, Oregon, United States, ²Geosciences, Fort Hays State University, Hays, Kansas, United States

The Asian continent is unique for its exceptional biodiversity and its complex geologic and climatic history. Much of this complexity stems from the collision of Eurasia with the Indian subcontinent, resulting in uplift of the Himalaya and Tibetan Plateau and subsequent changes to local and global climate patterns. The effects of these events on biotic assemblages have not been comprehensively investigated and the consequences for mammalian assemblages in particular are unclear. Asia offers a unique setting to test these effects given its considerable taxonomic, ecologic, and morphologic diversity, as well as its robust fossil record. In this study, I present an investigation of morphological and ecological

diversity in response to three significant events in the geological and climatic history of Asia: the uplift of the Tibetan Plateau and subsequent changes to monsoon circulation during the early Miocene, the aridification of central Asia during the late Miocene, and the intensification of dust transport during the Pliocene-Pleistocene. I consider these responses in the order Rodentia, the largest and most species-rich order of modern mammals. I first present data on rodent taxonomic, dietary, tooth crown height, locomotor, and body mass diversity obtained from the New and Old Worlds database and supplemented by the primary literature. Then, I examine site dissimilarity among sites occurring before and after these key geologic and climatic events. Lastly, I examine sites in a multivariate ecomorphospace created by Principal Coordinate Analysis of Gower distances. I perform these analyses across significant geologic and climatic events, with findings suggesting that rodent ecomorphological diversity has evolved in a stepwise manner through time, resulting in distinct ecomorphospace occupation in most time bins. Notably, I find that ecomorphospace occupation contracts across aridification events and expands during the period of increased dust transportation. I conclude that ecomorphological diversity responds alongside environmental drivers and is detectable in the fossil record of Asian rodents, suggesting that large-scale landscape and climatic shifts have had important influences on mammalian evolution.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Back to the Future: Two case studies for applying AI techniques to fossil data

Peredo, Carlos M.¹, Strauch, Rebecca J.², Berv, Jacob³, Brand, Nickolas A.^{4,5}, Uhen, Mark D.^{6,5}

¹Biological Sciences, Miami University, Oxford, Ohio, United States, ²Earth and Environmental Science, Miami University, Oxford, Ohio, United States, ³Ecology & Evolutionary Biology, University of Michigan, Ann Arbor, Michigan, United States, ⁴Schiele Museum of Natural History, Gastonia, North Carolina, United States, ⁵Environmental Science & Policy, George Mason University, Fairfax, Virginia, United States, ⁶Atmospheric, Oceanic, and Earth Sciences, George Mason University, Fairfax, Virginia, United States

The fossil record serves as a window into Earth's past which provides critical context for our rapidly changing modern world. However, the utility of the fossil record is inherently undermined by sizable gaps and other limitations, such as taxonomic, preservation, size, or other inherent biases that influence what kinds of organisms fossilize. Thankfully, these limitations can be mitigated; for decades researchers have employed sophisticated statistical models to elucidate broader patterns from the fossil record.

Recent breakthroughs in machine learning have ushered in a renaissance of artificial intelligence in life and earth sciences. Several machine learning techniques have become more accessible and have a high potential for bridging gaps in the fossil record. These include Natural Language Processing (NLP), Neural Networks (NN), Computer Vision (CV), and Cognitive Computing (CC).

Here, we focus on two of these techniques: neural networks and computer vision. We apply these AI techniques directly to paleontological datasets as case studies to assess their utility for answering paleontological questions and to evaluate their efficacy relative to traditional methods. The first case study involves using computer

vision to train a model to identify and categorize mammal teeth into predetermined taxonomic groups. The model was trained and tested against a traditional metric of tooth shape: Elliptic Fourier Analysis. The second case study uses a neural network to train a model that can infer missing morphological data from incomplete specimens. This model uses the existing morphological information, as well as phylogenetic context, to infer incomplete data points.

In both case studies, the AI techniques outperform traditional methodologies for both speed and accuracy. The computer vision model is capable of accurately predicting taxonomic identity and preliminary results suggest that a well-trained model will be able to quickly classify specimens of uncertain taxonomy. The neural network model can successfully infer missing datapoints with high efficacy and has enormous potential for increasing the utility of incomplete specimens in the fossil record. Collectively, our results suggest that continued improvements in machine learning have a high potential to revolutionize modern paleontological research.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Postcranial osteohistology and bone appositional rates of *Crocodylus niloticus* Laurenti, 1768

Pereyra, Maria Eugenia, Chinsamy, Anusuya

University of Cape Town, Rosebank, Buenos Aires, South Africa

The fossil record of Crocodyliformes exhibits a great disparity in body sizes, which raises pertinent questions about their paleobiology and paleoecology. In order to understand the biology of the fossil crocodylians, it is

imperative to enhance our understanding of the biology of modern species.

Osteohistology allows us to assess various aspects of the biology of vertebrates, such as longevity, growth dynamics, and maturation. Thus, by studying the bone microstructure of extant taxa, with known life history data (e.g., sex, age, sexual maturity, etc), it is possible to infer paleobiological information about extinct forms. Here, we conducted a detailed osteohistological study of postcranial elements of specimens of *Crocodylus niloticus* Laurenti, 1768 on thin sections of the bones of forelimbs and hindlimbs of four (two males and two females) two-year-old captive specimens from a crocodile farm in Cape Town, South Africa. These specimens were labeled *in vivo* with two different fluorochromes over three specific time periods to assess the daily bone appositional rate, as well as to validate the occurrence of annual growth marks. The results revealed that bones such as the femur and humerus exhibited a cortex composed of highly vascularized parallel-fibered bone, woven bone and fibrolamellar bone. In contrast, bones such as the fibula and radius exhibited scarce vascularized parallel-fibered bone compacta. The daily bone appositional rate tends to be higher in the ulna and femur, and lower in the fibula. Growth marks (lines of arrested growth and/or annuli) were found in all bones under study. These results demonstrate intraskeletal variability of both primary bone tissue types and rates of appositional in the postcranial skeleton of *C. niloticus*. Our findings are consistent with previous studies on other modern crocodilian species. This study contributes to our understanding of the diversity of growth dynamics of extant crocodilian taxa which is essential for assessing the paleobiology of their extinct relatives.

Funding Sources This research was supported by National Research Foundation (NRF), South Africa, grant number 136510 to

AC, and its grant holder linked postdoctoral funding to MEP.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Taphonomy and taxonomic diversity of “Happy Mary,” a polytypic bonebed from the Cretaceous Judith River Formation of Montana, USA

Perry, Zachary¹, Orme, Devon A.², Hyland, Ethan G.⁴, Hall, Lee³, Williams, Scott A.³, Schweitzer, Mary^{5,3}, Scannella, John¹

¹Museum of the Rockies & Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ³Marine, Earth and Atmospheric Sciences Department, North Carolina State University, Raleigh, North Carolina, United States, ⁴Museum of the Rockies, Montana State University, Bozeman, Montana, United States, ⁵Department of Biological Sciences, North Carolina State University, Raleigh, North Carolina, United States

The Campanian Judith River Formation is a dinosaur-bearing rock unit in Montana, USA, with coeval formations extending into Alberta, Canada. In 2017, a low-density polytypic bonebed (“Happy Mary,” Museum of the Rockies locality no. JR-1208) was discovered in the Judith River Formation of Valley County, Montana. Initially, dinosaur material including shed tyrannosaur teeth, ornithischian vertebral remains, and a ceratopsid humerus in a sandstone concretion were discovered at the site. In-field sampling of the humerus for molecular studies was conducted and revealed the presence of soft tissues in the element. Extensive excavation of the site was conducted between 2018 and 2022. Fossils were uncovered from three horizons: a gray

mudstone that underlies a fossil-rich red siltstone and an overlying sandstone containing isolated elements and concretions that sometimes encase fossils. The “Happy Mary” depositional environment is interpreted as a transition from a poorly-drained to a well-drained attritional floodplain, followed by a higher energy aquatic system. Macrofossils recovered from the siltstone include at least 53 postcranial elements of brachylophosaurine hadrosaurs, primarily axial and pelvic bones, representing a minimum of two individuals. The fossils show signs of abrasion due to transport, but limited weathering. Bite marks are evident on a few specimens, and over 15 shed teeth belonging to tyrannosaurs, troodontids, dromaeosaurs, and crocodilians were found at the site. The overlying sandstone contained ornithomimosaur and ceratopsian remains. Microfossil material from the site, comprising over 400 specimens, includes amber, plant seeds (at least 4 morphotypes), freshwater clams, *Myledaphus* rays, bony fishes (gars, *Belonostomus*, and teleosts), amphibians (frogs, salamanders, and albanerpetontids), turtles, mammals, and possibly birds. In-progress detrital zircon and geochemical analyses will refine the site’s geochronological and paleoenvironmental context and further increase resolution of this Campanian ecosystem.

Funding Sources Funding for this project was provided by NSF-GCR-1934844.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

The scientific and economic impacts of 25 years of public fossil digs at the North Dakota Geological Survey

Person, Jeff, Boyd, Clint A., Barnes, Becky

North Dakota Geological Survey, Bismarck,
North Dakota, United States

The North Dakota Geological Survey initiated our public fossil dig program in 2000, providing the opportunity for members of the public to join our paleontologists on a dig in the Late Cretaceous Pierre Shale Formation. The program was an immediate success and over the past 25 years, we have hosted 83 public fossil digs (~5,300 total spots offered over 445 days) that were attended by more than 2,500 individuals, making it one of the largest non-commercial public fossil dig programs in North America. Each summer we also host several local high school summer biology classes and offer a hands-on continuing education class for teachers. These public digs have provided us with over 37,000 hours of volunteer work, far more than the original two staff members could have accomplished on their own. Over the past 15 years, 1,159 jackets were collected on these public fossil digs, along with hundreds of bags of smaller specimens and thousands of pounds of rock for screen washing. Work on those specimens has thus far resulted in the description of eight new taxa, including the newly described mosasaur *Jormungandr walhallaensis*, with work on several additional taxa currently in progress. Fossils collected during these public fossil digs are also used to educate North Dakotans about the region’s prehistoric past via the development of fossil exhibits (currently 25) in museums, visitor centers, and libraries across North Dakota. The success of this program has resulted in the hiring of two more full-time paleontologists to support the public fossil digs (2008 and 2023) and financial support for twelve student interns since 2013. Attendance at these public fossil digs is fairly evenly split between North Dakota residents and non-residents, and the majority of non-residents report that the main purpose of their trip to North Dakota was to attend the public fossil digs. Given that non-residents are estimated to spend ~\$120 per day locally (not including lodging), our program injects at least \$70,000 into North Dakota’s tourism industry each summer at

current attendance levels. Demand for the program remains strong, with over 2,000 individuals signed up for our email notifications and registration filling up in less than an hour each year. These results confirm that the general public's deep interest in paleontology can be effectively harnessed to increase an institution's educational and scientific impact and also provide an economic benefit to the local communities.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A squamate fauna from the Early Danian of the Denver Formation of Colorado, USA, highlights ecosystem-disruption after the end Cretaceous mass extinction

Petermann, Holger, Lyson, Tyler

Department of Earth and Space Sciences,
Denver Museum of Nature and Science,
Denver, Colorado, United States

Over the last decade, intensive fieldwork in the Denver basin of Colorado has unearthed several faunal and floral assemblages that have greatly improved our understanding of the Cretaceous–Paleogene (K–Pg) mass extinction event. These discoveries have sparked a multitude of studies exploring the assembly of modern ecosystems after this dramatic event in Earth history. This research has allowed us to refine our understanding of changes in diversity and the extinction severity among major vertebrate and plant groups in the Rocky Mountain West. Here, we report a squamate fauna from the early Danian (Puercan 1 North American Land Mammal “age”) Gar’s Galore locality (DMNH Loc.2560) of the Denver Formation. The locality is ~9 m (~128 ky) above the K–Pg boundary and abundant microvertebrate remains are preserved in a medium- to fine-grained sandstone unit interpreted to represent a meandering river. Microvertebrate remains cover all major surviving vertebrate

clades, including mammals, crocodylians, testudines, amphibians, chondrichthyans and actinopterygians, and squamates. To date, the locality has produced over 50 squamate remains that can be attributed to only two taxa – *Odaxosaurus piger*, *Palaeoscincosaurus* sp. – and potentially a third taxon that currently is identified as Morphotype A. This high-abundance, low-diversity locality is in stark contrast with the nearby Ian’s Slope locality (DMNH Loc.3648), a Cretaceous microvertebrate locality (~4m or ~57kyrs below K–Pg) that is less than 400 m from Gar’s Galore and preserved in a similar facies. We previously presented Ian’s Slope’s high diversity of ca. 24 taxa and morphotypes representing most Late Cretaceous squamate clades – boreoteiids, anguids, platynotans, ophidians, scincomorphs, iguanomorphs – and various feeding adaptations (herbivorous, insectivorous, faunivorous, omnivorous); by comparison, the Gar’s Galore squamate fauna is 87.5% less diverse and consists only of insectivorous or omnivorous species. All three squamates present in the Gar’s Galore material are also present at Ian’s Slope and represent true survivors of the K–Pg.

Funding Sources Sparkjoy Foundation; Lyda Hill Philanthropies; National Science Foundation (NSF-FRES-2317666)

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Comparison of limb musculature of the Triassic turtles *Proterochersis* (Testudinata, Proterochersidae) and *Proganochelys* (Testudinata, Proganochelyidae) suggests different habitat adaptations

Piechowski, Rafal, Szczygielski, Tomasz

Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Mazovia, Poland

Proterochersidae and Proganochelyidae are key clades to understand the evolution of the oldest turtles (Testudinata). Both show a mosaic of characters suggesting either terrestrial or semiaquatic ecology. This is reflected mainly by their limb morphology. We examined muscle scars on the shell and limb bones to reconstruct the locomotor musculature of *Proterochersis* spp. (Norian of Poland and Germany), and *Proganochelys quenstedtii* (Norian of Germany and Switzerland). The most significant differences are present in the shoulder and hip joints, and in the contact between the pelvis and the shell. Scapula in *Proterochersis* is vertical, whereas it is anteriorly deflected and shorter in *Proganochelys*. Humerus has a radiodistally oblique head and a proximally facing facet formed by the connection between the head and the lateral process in *Proterochersis*, but a more rectangular head and shoulder and thinner, ridge-like connection with the lateral process is present in *Proganochelys*. Pelvis is free in *Proganochelys* and fused to the shell and immobile in *Proterochersis*, similarly as in pleurodires. Femur has a posterodistally abbreviated head and intertrochanteric fossa forming a distinct, proximally facing facet in *Proterochersis* and the femoral head is more rectangular, and the fossa ventroproximally directed and more expansive distally in *Proganochelys*. Protractors in *Proterochersis* were stronger and more developed, which usually shows a more intense swimming activity compared to walking. Among the extensors and retractors, the attachments of muscles used during swimming are also stronger and more developed in *Proterochersis*. In *Proganochelys*, stronger and more developed are retractors, as in extant terrestrial turtles. In both taxa, the attachment sites for the forelimb muscles mm. latissimus dorsi, deltoideus, coracobrachialis, suprascapularis, supracoracoideus, pectoralis, triceps brachii, biceps, and brachialis inferior, as well as attachment sites

for the hind limb muscles mm. iliofemoralis, puboischiofemoralis internus, puboischiofemoralis externus, flexor tibialis internus, flexor tibialis externus, ischiochantericus, and femorotibialis are expanded in respect to other turtles. Aquatic adaptations in *Proterochersis* are more pronounced in younger individuals. Unlike in pleurodires, two muscles, mm. obliquus abdominis and rectus abdominis, preserved the ancestral attachments to the plastron and probably were involved in respiration.

Funding Sources Project funded by the National Science Centre, Poland, grant 2020/39/B/NZ8/01074.

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Nature of the beast? Identifying drivers of prey choice, competition and resilience in wolves: a stable isotope approach

Pigiore, Fabienne F.¹, Bista, Diksha², Burtt, Amanda A.¹, Lamb, Angela², Schreve, Danielle¹

¹School of Geographical Sciences, University of Bristol, Bristol, Richmond, United Kingdom, ²National Environmental Isotope Facility, British Geological Survey, Nicker Hill, Keyworth, Nottinghamshire, NG12 5GG, UK, Keyworth, Nottinghamshire, United Kingdom

The wolf (*Canis lupus* L., 1758) was a keystone predator throughout the Pleistocene in Europe and its ability to adapt ecologically has ensured its longevity to the present day. While this great dietary plasticity remains today, the conditions and timing of this flexibility is poorly understood. The 'Nature of the beast' project aims to reconstruct wolf palaeodiet in Britain from the late Middle Pleistocene through to the Holocene in order to investigate the adaptation of wolves to forcing factors, including changing climate, environment and competition from other

predators. Stable isotope analysis is a well-established method to reconstruct dietary practices. The ratios of $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ in the isotopic composition of carnivores allow the reconstruction of predator-prey interactions and the level of competition for resources to be inferred. The present research carries out a triple analysis of carbon ($\delta^{13}\text{C}$), nitrogen ($\delta^{15}\text{N}$) and sulfur ($\delta^{34}\text{S}$) stable isotopes to investigate the timing and conditions under which wolves adopted their now well-established dietary plasticity, characterised by consumption of large and medium-sized wild ungulates and supplemented by smaller prey, including small mammals, fish and plant foods. The combined analysis is aimed at better quantifying the seasonal diversity of food resources. Indeed, the integration of Sulfur enables us to investigate more elusive feeding practices in the past, such as fish consumption (either through hunting or scavenging), which is a well-known occasional food source in modern wolves. This presentation will discuss a new dataset of Carbon, Nitrogen, and Sulfur stable isotope analyses on wolves, potential prey and other predators from several British sites in order to define contrasting prey choices and dietary niches between wolves and other competitors through the Pleistocene and Holocene.

Funding Sources This research is funded by the United Kingdom Research and Innovation, Natural Environment Research Council (NE/W006103/1).

Colbert Prize Session

New material sheds light on the position of *Calsoyasuchus valliceps* within Crocodyliformes

Platt, Nathan C.¹, Wilberg, Eric², Brochu, Christopher A.¹

¹Department of Earth and Environmental Sciences, University of Iowa, Iowa City, Iowa,

United States, ²Department of Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States

Goniopholidids are some of the most common and distinctive crocodyliforms from continental freshwater and estuarine deposits of Jurassic and Cretaceous Laurasia. However, most of the group's diversity is restricted to the Late Jurassic and Early Cretaceous. *Calsoyasuchus valliceps* is known from the Early Jurassic (Sinemurian-Pliensbachian) Kayenta Formation of Arizona, making it the oldest-known member of Mesoeucrocodylia. Most recent phylogenetic analyses recover it as the earliest diverging member of Goniopholididae. However, there is a significant age gap between *C. valliceps* and the next oldest goniopholidid, *Sunosuchus* from the Oxfordian. The skull of *Calsoyasuchus* is broadly similar to that of basal goniopholidids (including a shallow maxillary fossa), yet it possesses several features not found in other members of the group, such as a dorsoventrally tall cranium, an antorbital fenestra, an elongate and somewhat slender rostrum, and serrated dentition. This temporal and morphological disparity raises doubt of the phylogenetic position of *Calsoyasuchus*, and a recent analysis suggested that *C. valliceps* is not a goniopholidid, but rather closely related to the basal mesoeucrocodylian *Hsisosuchus*.

Here we present new cranial material of *C. valliceps* from the Kayenta Formation of Arizona. This new material includes overlapping elements with the holotype, as well as parts of the braincase and suspensorium not present in the holotype. A maximum parsimony analysis, including the new material, conducted in TNT recovers *C. valliceps* outside of Goniopholididae as sister to *Hsisosuchus*. *Calsoyasuchus* and *Hsisosuchus* share a shallow maxillary depression, serrated dentition, and paired anterior palatal fenestrae. Though similar in position, the maxillary depressions of these taxa differ significantly from the distinctive

fossae of goniopholidids. In goniopholidids, the fossa is deep, unornamented, and chambered, while in *Calsoyasuchus* and *Hsisosuchus*, it is shallow, lightly sculptured, and unchambered. These results shift the first appearance datum of Goniopholididae into the Late Jurassic, and help clarify the distribution of antorbital fenestrae among mesoeucrocodylians.

Funding Sources Funding for this work was received from the Paleontological Society Rodney M. Feldmann Grant and the Max and Lorraine Littlefield fund University of Iowa.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Fillets of fish: segmenting computed tomography (CT) scans to morphologically describe ray-finned fish (Actinopterygii) from the Snyder quarry of the Upper Triassic (Revueltian) Petrified Forest Formation in northern New Mexico

Plesh, Kathleen¹, Heckert, Andrew B.¹, Stiegler, Josef²

¹Department of Geological and Environmental Sciences, Appalachian State University, Apex, North Carolina, United States, ²Renaissance School of Medicine, Stony Brook University, Stony Brook, New York, United States

The Snyder quarry, located in the Upper Triassic Petrified Forest Formation of northern New Mexico, is known primarily for its abundance of larger vertebrates, but it also yields a diverse assemblage of microvertebrate fossils, especially of osteichthyans (bony fish). The osteichthyan microvertebrate fossils collected thus far are primarily scales, bone and toothplate fragments, and, rarely, complete teeth. The lineages represented are predominantly actinopterygians (ray-finned fish), principally semionotids, redfieldiids, and

palaeoniscoids, though there are also a few indeterminate sarcopterygians (lobe-finned fish) represented by probable coelacanth fossils. However, this range of diversity is not mirrored by the macrovertebrate fossil record, as the only osteichthyan recovered previously was a small (51 mm) incomplete, compressed, articulated skeleton of a semionotid (NMMNH P-29043). Articulated fossil fish skeletons from the Chinle in general are rare, however, in the 2023 field season, three articulated, relatively three-dimensional actinopterygian fish skeletons were collected from the Snyder quarry. Computed tomography (CT) scans of these specimens were taken and used to create 3D models of the fish skeletons in Dragonfly. The goals of this ongoing project are to analyze the skeletal morphology of the specimens and compare their morphological characteristics to the other known Triassic actinopterygian lineages, especially those present in the macro- and microvertebrate assemblages of the Snyder quarry. Not only will this provide more taxonomic information on the Snyder quarry fossil assemblage, but it will also offer a rare glimpse into the internal anatomy of Triassic fish fossils by being able to view their morphology in three dimensions rather than the typical two dimensions offered by analyzing them *in situ*. The fossil fish specimens appear to be related to stem holosteans through cursory observations of their exposed morphology, but differ in scalation from NMMNH P-29034. Further analysis through the segmentation of the CT scans is still needed to further narrow down this taxonomic placement.

Funding Sources Funding for CT scanning was provided by Appalachian State University Office of Student Research with a research grant. Fieldwork was supported by Stony Brook University.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

New record of a pachycephalosaurid partial dome from the lower Hell Creek Formation, Montana (USA)

Poferl, Adam, Hastings, Alexander K.

Paleontology, Science Museum of Minnesota, St. Paul, Minnesota, United States

A partial dome of a pachycephalosaurid dinosaur was collected from the lower Hell Creek Formation of Montana during prospecting fieldwork in 2019. The partial dome was collected within a fine-grained, loosely compacted sandstone, well above the Colgate Member marking the lower boundary of the Hell Creek Formation. The site was initially identified by a small area (approximately 1 square meter) with numerous scattered bone fragments atop a high ridge. The bulk of the float was approximately 1–2 meters downslope of the peak of the ridge, with some that had fallen slightly further down the slope. Return work in 2021 under an excavation permit did not yield any further material despite excavating approximately 0.7 m into the hillside and 0.95 m down vertically. After reassembly and preparation, the specimen (SMM P2019.5.1) has a preserved anteroposterior length of 22 cm, and a preserved mediolateral width of 9 cm. The maximum preserved thickness of the partial dome is 13.3 cm, although since the braincase itself is not preserved, the original thickness was greater. SMM P2019.5.1 is very smooth along its preserved external surface, and does not include ornamentation found in other specimens of pachycephalosaurids, although this may be due to preservation solely from the central part of the dome. The dorsal curvature of the partial dome is only slight. There is a noticeable ridge with a steep decline on the right side, toward the posterior end. Due to the overall preserved shape and large size, the taxon this specimen matches best with is *Pachycephalosaurus wyomingensis*, the most common pachycephalosaurid in this section. Other known pachycephalosaurids are typically

significantly smaller in size, although the existence of a much larger individual cannot be fully excluded. The known range of *Pachycephalosaurus* extends from western South Dakota in the east to the western-most occurrences in southeastern Alberta. This new occurrence extends the known range further west than recorded yet in the United States. Given the relative rarity of pachycephalosaurids, as compared to other dinosaurs of the Hell Creek Formation, this record represents a meaningful expansion of their fossil record.

Funding Sources This work has been supported by the Marjorie-Bolz Allen Fund.

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

A new iguanodontian dinosaur from the Cedar Mountain Formation (Early Cretaceous) of Utah

Poole, Karen¹, Warner-Cowgill, Ethan², DeBlieux, Donald D.², Kirkland, James I.²

¹Biomedical and Anatomical Sciences, NYIT College of Osteopathic Medicine at Arkansas State University, Jonesboro, Arkansas, United States, ²Geological Mapping and Paleontology, Utah Geological Survey, Salt Lake City, Utah, United States

The Doelling's Bowl Bonebed in the Paradox Basin of eastern Utah lies in the lower Yellow Cat Member of the Cedar Mountain Formation. The oldest U-Pb date from detrital zircons in the lower Yellow Cat Member places the age on the boundary of the Berriasian and Valanginian stages. This quarry has previously yielded sauropods (*Mierasaurus*), polacanthine ankylosaurs, dromaeosaurs (*Yurgovuchia*), and styracosternan iguanodontians, which are described here.

At least six individuals have been found in the bonebed based on left ilia, which range in

length from 210mm to 574mm. Phylogenetic analysis (see below) recovers these specimens as styracosternan iguanodontians based on having maxillary tooth crowns that are narrower than dentary tooth crowns, and two to four ridges on the dentary teeth.

These specimens have several features that distinguish them from other iguanodontian taxa. An autapomorphic feature not described for any other taxon is a midline caudoventrally projecting process from the basisphenoid. This lies between the basiptyergoid processes and is distinct from them. The Doelling's Bowl specimens can be differentiated from other iguanodontians described from the lower Yellow Cat Member in having a prepubic process that is constricted proximally and expanded distally, unlike that of *Iguanacolossus*, and lacking a lateral process of the ilium as found in *Cedrorestes*. The Doelling's Bowl specimens also differ from *Hippodraco*, described from the upper Yellow Cat Member, in having a less well-developed deltoid ridge on the scapula and humeral head that is centered on the element, whereas that of *Hippodraco* is offset medially.

The new taxon was added to a phylogenetic data matrix with 323 characters and 71 taxa using Mesquite (version 3.1). Parsimony analysis was conducted in TNT (version 1.6) using new technology search with sectorial search, ratchet, drift, and tree fusing finding the best score 500 times. This produced 1506 most parsimonious trees. In the strict consensus tree, the Doelling's Bowl iguanodontian is recovered in a large polytomy at the base of Ankylopollexia. The majority rule consensus tree recovers *Dakotadon* as the earliest branching styracosternan, just outside a polytomy containing *Iguanacolossus*, *Theiophytalia*, *Owenodon*, and *Lanzhosaurus*. The next least inclusive node is the Doelling's Bowl iguanodontian, followed by a polytomy consisting of *Hippodraco*, *Xuwulong*, and all other styracosternans.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

The impact of sutures and ontogeny on mandibular mechanics in *Alligator mississippiensis*: implications for finite element modelling of fossil archosaurs

Porro, Laura B.¹, Galvez-Lopez, Eloy¹, Sellers, Kaleb², Ross, Callum²

¹Cell and Developmental Biology, University College London, London, United Kingdom, ²Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States

Previous studies utilising experimental and modelling approaches have attempted to characterize the impact of sutures on skull mechanics. Results suggest sutures have a complex role in mitigating and distributing forces within the skull, and their effect on overall skull performance may vary between taxa, during ontogeny, and across different regions of the skull. Thus, the degree to which including sutures in biomechanical models – a time-consuming task – affects the accuracy of model predictions is uncertain, particularly for models of fossil taxa that cannot be validated against experimental data. We used finite element analysis (FEA) to investigate the impact of sutures on the mechanical performance of an ontogenetic series of *Alligator* mandibles under simulated feeding loads. CT scans of a hatchling, subadult and large adult were segmented with the assistance of automation algorithms to separate the upper and lower jaws, as well as the individual bones of the lower jaw. Models were loaded using information obtained from gross dissection and scaled to the same muscle force: surface area ratio. In both models with and without sutures, peak Von Mises stress decreased from the smallest to largest specimens, suggesting changes in mandibular morphology during growth result

in increased strength under feeding loads. Larger differences in peak VM stress were observed between the scaled hatchling and subadult models than between the subadult and adult models, suggesting morphological changes between the hatchling and subadult growth stages result in more pronounced differences in mechanical performance. Unilateral bites always produced higher stresses than bilateral bites within the same model. For all ages and load cases, peak Von Mises stresses were higher in models with sutures than those without sutures, although bite forces were similar. During unilateral biting, the subadult and adult models deformed as described in previous FEA and experimental studies; however, the hatchling mandible behaved differently, with the area around the symphysis experiencing ventral rather than dorsal deformation. Our findings not only shed light on mandibular mechanics during growth in *Alligator*, but also suggest scenarios (unilateral biting, young ontogenetic stages) or desired output parameters (peak stress magnitudes) which may necessitate inclusion of sutures in models of fossil archosaurs such as dinosaurs.

Funding Sources This work was funded by a UKRI Future Leaders Fellowship MR/W011484/1 (Development, Diversity and Evolution of Reptilian Skull Shape)

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Possible sexual dimorphism in the Pleistocene Shasta Ground Sloth (*Nothrotheriops shastense*)

Potter, Tymbri K.

Geology, California State University, Long Beach, Long Beach, California, United States

Potential sexual dimorphism in extinct ground sloths has already been reported for the

gigantic *Eremotherium laurillardii* by Cartelle in 1982, and for the larger La Brea ground sloth *Paramylodon harlani* by McDonald in 2006. We examined the skulls of the smaller ground sloth, *Nothrotheriops shastense*, from Rancho La Brea, California, and from San Josecito Cave, Mexico. There is no real size distinction between the two morphs, as is evidenced by the total skull length measurements as well as by the sample of post-cranial bones such as astragali and patellae in the La Brea collections. However, like *P. harlani*, the skulls of *N. shastense* have a much more highly domed frontal region in the presumed male skull (HC 1800-5) versus the few other skulls which have flatter dorsal profiles and are presumed to represent females. In addition, the presumed male skull has a sharp transverse notch at the base of the anterior slope of the domed frontals, and in lateral view, the frontal and nasal bones of the rostrum slope much more steeply down toward the nares in the presumed male skull. The differences are not as extreme as those reported by McDonald in 2006 and by Cartelle in 1982, but are consistent with the fact that for most ground sloths that have been studied so far, there is at least some apparent sexual dimorphism in the skulls.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

A giant sea cow from the early Pleistocene of northern California: persistence of *Hydrodamalis* throughout the Pliocene-Pleistocene in the eastern North Pacific

Poust, Ashley W.^{1,2}, Boessenecker, Robert²

¹Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska, United States, ²University of California Museum of Paleontology, Berkeley, California, United States

Giant hydrodamaline sirenians were long-standing members of Pacific coastal

ecosystems and likely played a major role in kelp forest health through selective feeding. The extinction of *Hydrodamalis gigas* at the hands of 18th century sailors represents the final loss of a keystone species with a unique ecological role. Questions about the longevity, diversity, and ecology of these gentle giants of the Pacific remain, but lack of material, especially from the early and middle Pleistocene, hampers our ability to discern these answers. We report a large vertebra (VMS 19) of *Hydrodamalis* from the lower Pleistocene Falor Formation of Humboldt County, California (2.1-0.7 Ma). The specimen is one of the largest sirenian vertebrae ever discovered (centrum width = 200 mm), being approximately 15% larger than *H. gigas* and larger than all but two *Hydrodamalis cuestae* specimens from the Pliocene San Diego Formation. The similarity of the Falor *Hydrodamalis* in size to *H. cuestae* and its unique thinness in ratio of antero-posterior thickness to transverse width make a species level identification complicated, and we presently identify it as *Hydrodamalis* sp. Though Pleistocene occurrences of *Hydrodamalis* along the Pacific coast are fragmentary and difficult to date precisely, known examples seem to indicate that *Hydrodamalis* persisted until almost the Holocene, or at least ventured south often enough to be preserved, perhaps during cooler intervals. Though *H. gigas* historically inhabited cold temperate waters of the Bering sea, their sister-species *H. cuestae* lived in warm temperate waters as far south as Mexico. In concert with published paleoclimatic inferences from fossil mollusks, the hydrodamaline record is consistent with gradual cooling from 14 Ma to present. Serravallian and Tortonian hydrodamalines are found in association with inner and outer tropical mollusks (18-17°C mean temperature; sensu Hall), and Messinian through Piacenzian hydrodamalines with warm temperate and temperate mollusks (15-13°C). The Falor Formation specimen is the

geochronologically earliest hydrodamaline to be found in association with cold temperate mollusks (10-12°C); later Pleistocene records are associated with cold temperate and subpolar mollusks. *Hydrodamalis* likely continuously inhabited the eastern North Pacific, paralleling the record of hydrodamalines in Japan, and surviving dramatic Pliocene-Pleistocene marine vertebrate faunal turnover and/or extinction and marine cooling.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Madtsoiidae revisited: review of putative synapomorphies and their distribution to redefine the clade

Powers, Mark J.¹, Garberoglio, Fernando², Caldwell, Michael W.¹

¹Biological Sciences, University of Alberta Faculty of Science, Edmonton, Alberta, Canada, ²Universidad Maimónides, Hidalgo 775, 1405, CONICET - Fundación de Historia Natural Félix de Azara, Centro de Ciencias Naturales Ambientales y Antropológicas, Buenos Aires, Argentina

Madtsoiidae is an extinct clade of snakes united by several vertebral characters. The oldest specimens are from the Late Cretaceous of Gondwana. However, they reached a nearly global distribution by the Eocene, achieving large body sizes and are typically collected from fluvial and paralic sedimentary units. The first sets of vertebrae discovered were thought to belong to a large boid. However, recognition of several key features such as the absence of accessory prezygapophyseal processes, the presence of laterally expanded para-diapophyses and parazygantral foramina led to the proposal of a monophyletic Madtsoiidae, named after the type species *Madtsoia bai* from Chubut Province, Argentina. Due to cranial material being quite rare, most named taxa within

Madtsoiidae are described from isolated vertebrae, or segments of articulated vertebrae. Because relatively complete madtsoiids are rare, species diagnoses, and phylogenetic relationships are described primarily from vertebral characters. Snake vertebral columns can show considerable variation across the possible 150-400 vertebrae. Variability of madtsoiid synapomorphies across the vertebral column has not been critically assessed due to the relatively short series of articulated vertebrae and the scarcity of cervical (anterior trunk) and caudal (post-cloacal) vertebrae. Additionally, the putative synapomorphies of Madtsoiidae have not been systematically surveyed across other fossil lineages (e.g., Palaeophiidae). An articulated series of cervicals from upper Eocene deposits of the Divisadero Largo Formation in the Cuyo Basin of the Mendoza province, Argentina, are referred to *Madtsoia* sp. based on putative madtsoiid synapomorphies (e.g., parazygantral foramina), age (Mid-Late Eocene) and proximity to the holotype locality. We report here on the variability of these “synapomorphies” across a single vertebral series and see this as demonstrative of problematic degrees of within column variation as well as individual variation. This variability becomes more problematic when diagnosing isolated vertebrae as “madtsoiid”. Comparisons with palaeophiids, fossil taxa such as *Boavus*, and modern snake taxa demonstrate a much broader expression of putative madtsoiid synapomorphies. These observations reinforce the poor utility of vertebral characters alone in snake phylogenetics and stress the importance of relatively complete specimens in constructing taxonomic diagnoses to be used in subsequent analyses.

Funding Sources NSERC Discovery Grant - 2022-03164

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Comparative osteological re-evaluation of phylogenetically informative characters of the ornithopod dinosaur scapula

Prieto-Marquez, Albert¹, Lenoir, Briana², Wagner, Jonathan R.³

¹Dinosaur Ecosystems Research Group, Institut Català de Paleontologia Miquel Crusafont (ICP-CERCA), Sabadell, Barcelona, Spain, ²Facultat de Ciències i Biociències, Universitat Autònoma de Barcelona, Bellaterra, Barcelona, Spain, ³West William Canon Drive, Austin, Texas, United States

The scapula is the major element of the shoulder girdle in Ornithopoda, as is also the case in other dinosaurian clades. Ornithopods are among the most diverse clades of herbivorous dinosaurs, achieving as a whole a global distribution and spanning the middle Jurassic through the latest Cretaceous. Throughout their evolutionary history, the scapula was instrumental in anchoring the forelimb musculature, facilitating the movement of the shoulder joint, posture, and locomotor capabilities of these animals.

Here, we re-evaluate the patterns of intertaxonomic morphological variation of the ornithopod scapula, emphasizing its implication for phylogenetically informative characters. The latter are mostly concentrated in the proximal region of the scapula and include: the orientation of the supracoracoid eminence relative to the dorsal margin of the scapula leading to the coracoid facet, the position of the dorsomedial margin of the coracoid facet relative to the posterodorsal margin of supracoracoid eminence, the position of the ventralmost margin of the dorsolateral prominence (the pseudo-/acromion process of authors) relative to the ventral terminus of the glenoid process, the relative length of the supracoracoid lateral surface, the

development of the supracoracoid ridge that extends anterodorsally from the dorsolateral prominence, the orientation of the supracoracoid ridge relative to the dorsal margin of the scapula posterior to the supracoracoid eminence, the extent of production of the dorsolateral prominence over the deltoid fossa, the presence of a roughly textured and distinctly demarcated lateral facet on the dorsolateral prominence extending onto the supracoracoid ridge, the relative position of the ventral margin of the dorsolateral prominence, the development of a supracoracoid buttress, the presence of a supraglenoid fossa, the relative lengths of the lateral margins of the coracoid and glenoid facets, and the development and orientation of the deltoid ridge, among other characters.

Overall, the main modifications experienced by the ornithopod scapula during evolution are the relative anterior shift of the glenoid process to lie below (or even slightly anterior to) the dorsolateral prominence, the loss of the supraglenoid fossa, the reduction (and loss in some forms) of the supracoracoid ridge, the increased lateral protrusion and enlargement of the dorsolateral prominence, and the lengthening of the supracoracoid lateral surface.

Funding Sources Grant PID2020-119811GB-I00 funded by MCIN/AEI/10.13039/501100011033 and CERCA Programme funded by Generalitat de Catalunya.

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Extreme left-right asymmetry in the forelimb of a drepanosaur (Diapsida, Drepanosauromorpha) from the Upper Triassic of Utah

Pritchard, Adam C.¹, Britt, Brooks², Theurer, Brandon C.³, Engelmann, George⁴, Chure, Dan⁵

¹Paleontology, Virginia Museum of Natural History, Martinsville, Virginia, United States, ²Geological Sciences, Brigham Young University, Provo, Utah, United States, ³Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ⁴Geology, University of Nebraska Omaha, Omaha, Nebraska, United States, ⁵Dinosaur National Monument (retired), Jensen, Utah, United States

Left-right asymmetry of the limb skeleton occurs sporadically within tetrapods. Isolated examples have been reported in lepospondyls, marine diapsids, and some primates. Most studies of such asymmetry have focused on forelimb-dominated human athletes, in which the limb elements are slightly longer and more robust in the dominant limb. Here, we report an extreme case of left-right asymmetry in the arms of a Triassic reptile, specifically a drepanosaur.

Drepanosaurs are an enigmatic group of diapsid reptiles known from the Upper Triassic of North America and Europe. Superficially chameleon-like, drepanosaurs have been favorably compared to modern arboreal taxa. A subgroup within the clade, including the eponymous *Drepanosaurus*, possess a unique forelimb with hyperelongated carpals and a relatively massive second manual digit and accompanying ungual.

Here we report on an articulated skeleton (BYU 21952) of a *Drepanosaurus*-like taxon from the Saints & Sinners locality (Nugget Sandstone, Upper Triassic) of Utah that exhibits extreme left-right asymmetry in the morphology and proportions of its forelimb elements. Its right humerus, ulna, and proximal carpals are markedly more robust than those of the left while the right ulna, proximal carpals, and second manual phalanx are also absolutely longer. Most remarkably, the right second manual ungual is twice as long proximodistally and over three times as tall dorsoventrally relative to

its opposite. These two forelimbs are articulated with the pectoral girdle in BYU 21952, precluding the possibility that they belong to different individuals.

Multiple drepanosaur skeletons are known from the Saints & Sinners locality, but not all preserve both forelimbs nor do they exhibit the extreme asymmetry of BYU 21952. A second skeleton possess symmetrical elements, excepting a slightly more elongated right second manual ungual. Additional specimens from the Saints & Sinners and the Hayden Quarry localities illustrate similar proportional differences in their forelimb elements to BYU 21952, suggesting that this level of asymmetry is not unique to this individual. The functional or behavioral advantages of this condition are unclear, but the best analogs may be found among invertebrates such as decapods.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Systematics of the Late Oligocene-Miocene oreodonts (Mammalia: Artiodactyla: Merycoidodontidae)

Prothero, Donald R.¹, Cleaveland, Casey⁴, Welsh, Ed T.², Marriott, Katherine⁵, Balassa, Daniella³, Watmore, Kristin I.⁴, Olson, Sara³

¹Vertebrate Paleontology, Natural History Museum of LA County, La Crescenta, California, United States, ²Geological Sciences, California State Polytechnic University, Pomona, California, United States, ³Badlands National Park, Interior, South Dakota, United States, ⁴American Museum of Natural History, New York, New York, United States, ⁵Geological Sciences, California State University, Long Beach, California, United States

Oreodonts were a very common and diverse group of sheep-sized artiodactyls exclusive to North America from the late Eocene through

the late Miocene. Their rapid evolution and diversification, and great abundance of specimens have made them key index fossils for most of this interval. Yet their taxonomy has been a chaotic mess, largely due to a series of 8 monographs published between 1940 and 1968. This work included typological oversplitting and inability to recognize differences due to post-mortem deformation, and its failure to consider fossils as members of living populations, or use of any statistical methods. No thorough revision of the group was published until 1996, when Stevens and Stevens revised the Chadronian-Whitneyan oreodonts. Building on work from the 1970s, our new revision covers all the post-Whitneyan subfamilies of oreodonts, of which only seven are recognized. The invalid subfamilies Desmatochoerinae and Phenacocoelinae are disbanded and their contents dispersed to other groups, because they were based entirely on features due to post-mortem deformation. We recognize only 27 valid genera and 74 species of post-Whitneyan oreodonts, down from 39 genera and 169 species published by Schultz and Falkenbach. Oreodonts reached their maximum diversification in the late Arikareean, when 22 different species are recognized. They also became more disparate and distinctive, with small gracile running forms (*Merychys*) and short-legged tapir-like forms with retracted nasals that suggest the presence of a short proboscis (*Promerycochoerus*, *Brachycrus*, and *Merycochoerus*). Most of the oreodont lineages vanished after the early Barstovian, about 14.5 Ma. The very last of the oreodonts was the medium-sized taxon *Ustatochoerus*, which appears in just a handful of localities in the middle and early late Miocene (late Barstovian to early Hemphillian, or about 14-7 Ma) of North America, surviving about 7 m.y. after all the other oreodonts had vanished. The reason for their extinction is not known, but it does coincide with the expansion of C4 grasslands at 7 Ma, while oreodonts (with

their brachydont teeth) might not have been able to eat gritty grasses.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

The evolutionary significance of cerebral and endocranial volumetric increases on complex behavior across Dinosauria

Puetz, Emma¹, King, James L.²

¹Center for Functional Anatomy and Evolution, Johns Hopkins University, Rolla, Missouri, United States, ²Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Modern archosaurs display a wide array of complex behaviors such as gregariousness, parental care, increased sociality, and advanced predatory styles, yet our limited understanding of the degree to which neural tissue is represented in the cranial endocast makes it difficult to assess the potential for such behavioral patterns in fossil stem taxa like non-avian dinosaurs. Modern techniques for studying the endocranial cavity are continually emerging, providing us with new insights into non-avian dinosaur endocasts and how they have changed with time. Moreover, exceptionally well-preserved fossils of non-avian dinosaurs provide evidence of parental care, age-segregated gregariousness, and social or sexual displays. Here we test how complex behaviors correlate with cerebral volume and total endocranial volume across non-avian dinosaurs by sampling new and published cerebral relative volumes (CRV, $n_{\text{total}} = 30$) and encephalization quotients (EQ, $n_{\text{total}} = 53$). The volume of the cerebrum is of particular interest due to its informational processing and sensory data coalescing functionality within the brain, allowing questions to be postulated regarding how volumetric changes could be reflected in behavioral displays.

Furthermore, CRV and EQ data allow us to determine when the neural potential for complex behaviors may have arisen among non-avian dinosaurs. We also compared this volumetric data set of non-avian dinosaurs with values of extant crocodilians and avians to understand how changes in the CRV and EQ could alter the display of complex behaviors. Our analyses demonstrate a strong relationship between continual enlargement of the CRV and EQ through the Mesozoic and a greater likelihood for Late Mesozoic dinosaurs to display more complex actions. Specifically, Late Cretaceous hadrosaurs and theropods display the greatest CRV of 40–50% and EQ of 2.0–8.6; whereas Jurassic-Cretaceous stegosaurs, ankylosaurs, sauropods, and basal ornithomimids have the lowest CRV and EQ values of 19–30% and 0.35–0.85, respectively. Comparisons of these values with modern archosaurs demonstrate a significant increase in both the CRV and EQ for birds, while crocodilians exhibit similar values to the sampled non-avian dinosaur dataset (CRV, 31–43%; EQ, 0.67–1.65). These data support the hypothesis that a larger cerebrum and brain allow for more complex behaviors in dinosaurs and provide new techniques for investigating the acquisition of complex behaviors in deep time.

Technical Session 20: SVP Saturday Spectacular (Saturday, November 2, 2024, 1:45 PM)

A tale of loose teeth: using quantitative analyses for reconstructing phytosaur dentition

Pugh, Isaac, Stocker, Michelle R., Nesbitt, Sterling J.

Geosciences, Virginia Tech, Blacksburg, Virginia, United States

With some of the highest tooth counts among Triassic reptiles, phytosaurs and their teeth

are common in many Late Triassic fossil assemblages. At least four phytosaurs are known to have some degree of heterodonty, though this can be difficult to describe given most phytosaur skulls lack in situ teeth. Single teeth are generally unhelpful in diagnosing the species they are from or describing the animal's dental set, but abundant isolated teeth at many sites can fill in this information. Here we utilize in situ teeth of the phytosaurs *Diandongosuchus*, *Rutiodon*, *Machaeroprotopus*, and *Smilosuchus* to test methods for assigning jaw positions to isolated teeth and by proxy reconstructing complete dentition for each taxon. We have collected linear measurement data of teeth (mesiodistal basal width, labiolingual basal width, and crown height), discrete characters describing tooth shape, and 3D morphometric data for detailed shape comparison. We modify previous divisions of the jaw into five regions: the terminal rosette set (enlarged anterior teeth of the premaxilla and dentary), premaxillary, maxillary, anterior dentary, and posterior dentary (dentary divided by alveolar contact with the splenial). Scatter plots of the ratio of basal mesiodistal and labiolingual measurements provide some separation between maxillary and premaxillary positions and do not distinguish upper and lower jaw dentition and do not distinguish the enlarged anterior 'fangs' of the terminal rosette set from other premaxillary positions. PCA of basal and crown height measurements better distinguish tooth regions, but when measurements are size standardized the terminal rosette set plots with other premaxillary positions. Our character set does not provide more separation with nMDS than PCA of linear measurements. Linear discriminant analysis of linear measurements, while yielding similar tooth set separation to PCA, plots both *Diandongosuchus* and *Rutiodon* independently from leptosuchomorphs when grouped by taxa. Across all analyses, adjacent positions of the upper and lower jaw

are challenging to distinguish. We conclude that, within limits, quantitative analyses can distinguish tooth position for phytosaurs, and that a sufficient sample of isolated teeth may be able to represent a phytosaur's complete dentition. These analyses offer the first step in assessing paleoecology and taxon identification for microvertebrate sites where taxonomically informative skull material is unavailable.

Funding Sources NSF 1943286

NSF GRFP

VT Geosciences Department

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Analyzing reconstructions of the giant fossil shark *Otodus megalodon*, and proposing a new process behind "Megalodon" exhibit design

Quinn, Aleczandria E., Heckert, Andrew B.

Geological and Environmental Sciences, Appalachian State University, Holly Springs, North Carolina, United States

Reconstructions of *Otodus megalodon*, the extinct mega shark, are frequently displayed in museums. Investigating *O. megalodon* reveals that there are no known cartilage remains, only disarticulated *O. megalodon* tooth sets. Therefore, reconstructions of these sharks can be only based on *O. megalodon* teeth and on what is known from related shark species. This in turn reveals that many of these displays cannot be confidently declared as accurate representations of *O. megalodon*, potentially causing the public to gain a false picture of what is known on *O. megalodon*. New studies and advances in technology have helped modernize these displays.

We developed ways to emphasize what is known (and unknown) about *O. megalodon*,

and how this can be shown in museum reconstructions. This included creating public outreach displays that can be easily replicated. One display includes replicas of tooth whorls showing the growth and correct orientation of functional and replacement teeth. We compared molding and casting to 3D printing to generate replica teeth for outreach. A body size estimation display uses casts of various sizes of A1 and A2 (the two most mesial) *O. megalodon* teeth with matching notecards showing a solved published body size estimation equation. Each tooth then was paired with the equivalent length with string for public visualization. We used comparisons of modern tooth whorls of *O. megalodon* and *C. carcharias* to generate a 3D model of an upper left and right *O. megalodon* tooth whorl for museum and teaching use. These new forms of outreach display are to inform the public on the current view of *O. megalodon* and the science behind it.

Finally, we proposed and tested a new thought process behind exhibit design using *O. megalodon* as an example of how exhibits can show how science is constantly changing and advancing. To do this we conducted a case study with two different *O. megalodon* exhibit designs. The first design created represented current exhibits, and the other design represented our own design. These exhibits were tested among the public. There is much uncertainty and unknown about *O. megalodon* and often this has not been represented in exhibits. Therefore, the future of *O. megalodon* displays should aim to show the path humans took and continue to take to “crack the code” of these enormous sharks.

Funding Sources Office of Student Research at Appalachian State University

Quantifying wear in ornithopod and ceratopsian dental batteries

Radermacher, Viktor J., Makovicky, Peter

Earth and Environmental Sciences, University of Minnesota Twin Cities, Minneapolis, Minnesota, United States

In contrast to the other major dinosaur clades, Ornithischia was uniquely constrained to herbivory from the outset of its evolution. Two ornithischian lineages, Ornithopoda and Ceratopsia, would independently, and in gradual fashion, converge on a dental innovation termed the “dental battery”: a mosaic of hundreds of densely packed, constantly replacing and uniformly wearing teeth; with species like *Edmontosaurus* holding the record for highest tooth count among all terrestrial vertebrates. The perennial herbivory of Ornithischia means that the masticatory apparatus was responding solely to its ability to process vegetation. This means that the dental system provides a stable locus for evaluating the presence or absence of a ‘key innovation’ in Ornithischia: Did evolution of the dental battery “unlock” the ability for early hadrosaurs and ceratopsians to radiate into larger bodied, ecologically prominent forms? Or did large body sizes in these lineages provide the impetus to increase the efficiency of the dental system? How much more efficient were dental batteries than their simpler precursors? Is the dental battery even an efficient structure? With emphasis on the dental battery, here we present a novel method for quantifying the wear and efficiency of ornithischian dentition that we dub the Dinosaur Macrowear Metric (DMM), and present preliminary results for species that span the body mass ranges and evolutionary histories of ornithopods and ceratopsians. DMM is inspired by the qualitative mesowear analyses of mammalian dental systems but leverages reptilian polyphyodonty to acquire quantitative measurements. Specifically, we

quantify the amount of worn tooth material at each tooth position in a dentary by retrofitting an unworn crown to each erupted one and subtracting the non-overlapping volume. We then sum those values across the tooth row, dividing by the total surface area of wear facets to calculate the DMM score. Our preliminary data support a correlation between DMM values and increasing body size. We use this proxy to investigate the ability to consume bulk fodder, thought to be a prerequisite of evolving large body size, and to elucidate the role dentition may have had on shaping competition between and within ornithischian lineages like it did for mammals during the Cenozoic.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Ecomorphology and paleoecology of notosuchian crocodyliforms from the Late Cretaceous (Maastrichtian) Maevarano Formation, Madagascar

Rakotozafy, Bakoliarisoa¹, O'Connor, Patrick M.^{2,3}, Groenke, Joseph², Turner, Alan H.⁴, Sertich, Joseph J.⁵, Ranivoharimanana, Lovasoa¹

¹Mention Bassins Sédiments, Evolution Conservation, University of Antananarivo, Antananarivo, Madagascar, ²Biomedical Sciences, Ohio University, Athens, Ohio, United States, ³Earth Sciences, Denver Museum of Natural Science, Denver, Colorado, United States, ⁴Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ⁵Geosciences, Colorado State University, Fort Collins, Colorado, United States

The Late Cretaceous (Maastrichtian) Maevarano Formation of northwestern Madagascar hosts a rich assemblage of well-preserved fossil vertebrates, with ongoing efforts to characterize the paleoecology of

this terrestrial ecosystem. Notosuchian crocodyliforms are well represented in the fauna and include *Simosuchus clarki*, *Araripesuchus tsangatsangana*, *Miadasuchus oblita*, and *Mahajangasuchus insignis*. This assemblage spans a large range of body sizes and presumed habitat and feeding ecologies. To further explore the paleoecology of the Maevarano system, we examined several complete and partial skulls of the four notosuchians in our analysis. We used both qualitative and quantitative approaches based on first-hand specimen examination, digital photographs, and high-resolution renderings of CT/μCT reconstructions. The size, position, and orientation of the external nares, orbits, and choanae were characterized, with the relative position and size of temporal, suborbital, and external mandibular fenestrae noted for comparisons. The dentition (size, shape, number of teeth) of the four notosuchians were also included in this study, allowing direct insight into feeding ecology. The four forms can be divided between terrestrial and semi-aquatic lifestyles on the basis of cranial morphology. Within these habitat categories, estimated body size and tooth morphology allow for further differentiation of feeding ecologies. Among of the three carnivorous taxa (*Mahajangasuchus*, *Miadasuchus*, *Araripesuchus*), only *Miadasuchus* and *Araripesuchus* potentially overlapped ecologically as fully terrestrial predators. Estimated maximum adult body size differences between these two forms likely facilitated differences in prey choice, perhaps explaining coexistence in the same terrestrial environment. *Simosuchus* differs significantly from the others based on overall skull and dental morphology and occupied a primarily herbivorous niche. *Mahajangasuchus* is the lone semi-aquatic notosuchian in the assemblage and shared the aquatic environment with representative and smaller-bodied neosuchians. While other factors, including species-specific and

-WITHDRAWN-

ontogenetically-linked habitat and prey preferences, likely contributed to coexistence, the morphologic inferences from the rich crocodyliform fauna of the Maevarano Formation can be used as a case-study for comparison with other Cretaceous assemblages.

Funding Sources US National Science Foundation EAR_1525915, EAR_1664432, DBI_2242717, & DBI_2242716.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

An unusually complete *Cynodictis lacustris* from the Quercy Phosphorites and historical specimens of the Natural History Museum Denmark

Raun, Gorm S.¹, Cotton, Laura J.²

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Natural History Museum Denmark, Copenhagen, Denmark

Cynodictis Bravard & Pomel, 1850 is one of the earliest amphicyonids known from Europe, occurring in the late Eocene, and continuing until the early Oligocene. The genus has had a long and complex taxonomic history, with up to 20 species recognised in the past, however today only 7 are considered valid. The species are traditionally identified only by characters in the mandible and cranial material has rarely been described in detail and is not often found associated with mandible remains. Specimens where the mandible is preserved therefore provide an important holistic view of cranial anatomy and improved characterisation of complete skulls can lead to better identification of partial cranial remains. Here we describe two unusually complete skulls from the historical Quercy Phosphorites collection of the Natural History Museum of Denmark. Though collected in the early 19th century they have remained understudied. The first specimen

(NHMD 196096) consists of a skull with associated mandible. Here we both carry out standard taxonomic measurements and description, and image the specimen in three dimensions (surface and CT scanning and photogrammetry). CT scanning and reconstruction using Dragonfly software allowed for measurement of characters obscured by matrix. Tooth measurements were plotted against identified tooth/jaw fragments from NHMD collections and those within the study of Bonis (2020). The specimen was identified as *Cynodictis lacustris* Gervais, 1852.

The second specimen (NHMD 196092) was originally identified as *Cynodictis lacustris*, however, due to differences such as the low snout, deep midline of the nasal and the differences in temporal- and sagittal crest morphology, we could not affirm this taxonomic identity. Work on this specimen is ongoing but we tentatively identify this as a new but related taxon.

This study underlines the value of reassessing historical collections at scientific institutions, as the full description of the cranium is an important reference for the identification of additional specimens. Additionally, the identification of a new taxon increases our understanding of the evolution and distribution of early caniforms.

Funding Sources Funding for this project was received from the Danish State Educational Grant (SU).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Day Camp based education of geological and paleontological sites of the Dinosaur Ridge Fossil Area

Rea, Amanda S., LaCount, Erin, Atwater, Amy L.

Education, Friends of Dinosaur Ridge,
Morrison, Colorado, United States

Dinosaur Ridge, a National Natural Landmark in Morrison, Colorado, is tucked between the major city of Denver and the Rocky Mountains. The prime location and Dinosaur Ridge's robust camp programs have provided youth with increased access to our paleontological heritage. 80% of urban Denver students have never been west of Denver city limits, and this camp has opened an opportunity to help youth experience geoheritage by providing programs in outdoor and hands-on STEM-based lessons. Dinosaur Ridge Day Camps began in 1996 and were active until 2004, and re-introduced in 2012, with 16 participants. The camp program has grown to include over 400 campers in 2024. Camp grows each year as returning campers are joined by new campers to experience outdoor activities, visit paleontological and geological sites, access guest experts in their fields, and form community with fellow campers who share their passions. Camp has expanded to include winter, spring, and single-day camps to better provide for the needs of the communities served. Not only do these camps provide impactful STEM education, camp provides a safe place for children when they are not in school. Dinosaur Ridge Day Camps strive to break down barriers by providing scholarships aimed at underserved communities such as youth in foster care and youth experiencing socio-economic inequities. In 2023, this program awarded 8 scholarships to youth and in 2024, increased funding awarded 19 scholarships. These scholarships are a key component in the goal of increasing access to underserved youth. Campers ages range from 5 through 13, former campers have gone on to volunteer as counselors for the camp program, and some have become employed at Friends of Dinosaur Ridge. Camp has grown from serving local youth to families coming nationwide and on occasion internationally to attend camps. The goal is to

increase access not only to traditional campers, but to provide STEM experiences to participants from marginalized demographics. The camp program plans provide new camps aimed for youth of underserved communities to provide a safe and comfortable space with staff and campers of similar experiences to explore their passions in STEM. Capacity and resources to expand camp continues to be barriers, but passionate staff, volunteers, and donors have grown the program each year. Through exposure and education Dinosaur Ridge Day Camps increase the preservation of our paleontological heritage through public support.

Funding Sources Scholarships and camp expansion are funded by the organization Rocky Mountain Association of Geologists, private donors, and support from the Betty Rall Camp Fund.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Paleontology's heaviest airlift: The collection and transportation of a complete opisthotonic Judithian tyrannosaur in a calcite-cemented sandstone concretion

Reeves-Wolf, Destiny D.¹, Fowler, Denver¹, Freedman Fowler, Elizabeth^{2,1}, Clawson, Steven R.¹, Schoch, Tyler J.³

¹Paleontology, Badlands Dinosaur Museum, Dickinson, North Dakota, United States, ²Dickinson State University, Dickinson, North Dakota, United States, ³Badlands Dinosaur Museum, Dickinson, North Dakota, United States

In 2017 an articulated opisthotonic skeleton of a tyrannosaur was discovered in exposures of the Campanian Judith River Formation on

BLM public lands near Hinsdale, Montana. The skeleton was mostly preserved in a large iron-rich calcite-cemented sandstone concretion ~ 3 m by 2 m by 1 m located ~2 km from the nearest road, and surrounded by a number of narrow ravines which blocked overland travel in most directions. It would therefore have to be removed by helicopter. Density and volume calculations led to an estimate of 9000-13000 lb (4000-6000 kg), a substantial payload only liftable by a CH-47 Chinook, or an Erickson S-64 aircrane. Fitting the block through the doors into our preparation laboratory was an additional challenge. A novel total strategy was devised and fabricated by museum board members whereby the skeleton block would be suspended beneath a 1000 lb (450 kg) steel lifting frame and delivered by helicopter onto a receiving frame on a heavy-duty flatbed trailer. The lifting frame was constructed from five welded 3.2 m long beams and two 2.2 m end beams each of which were carried by hand over the difficult terrain by the field crew then bolted together over the fossil block. The lifting frame was necessarily wider and longer than the fossil block as this would prevent lateral compressive forces potentially snapping the block during the lift, instead the block was effectively suspended below the lifting frame like a hammock using heavy 12 m chains with ratchet straps for steadying. Four V-shaped feet were welded “nose-down” to the main frame, which corresponded with four V-shaped channels welded on to the receiving frame. The v-shape of the feet would be self-guided into the receiving channels, making lowering of the frame quicker and more precise. Four ropes hung down from the corners of the lifting frame. These would be grasped by the receiving crew and used to guide the lifting frame onto the receiving frame. The lift was completed in October 2021 by a privately operated CH-47 Chinook, then driven to Dickinson on a heavy-duty flatbed. In November 2021 the block was flipped over by a privately operated crane. One long beam was removed from the lifting

frame (making it narrower, but wide enough to support the block), and wheels were welded on. The frame was then placed underneath the block and wheeled through the preparation lab doors. The block is currently undergoing preparation and can be viewed by the public through the lab window.

Funding Sources Trans Canada Energy, Trans Canada Energy Employees, Conoco-Phillips, Loren Myran, Tyler Schoch, Stark County Historical Society, US Bureau of Land Management

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Taxonomic resolution to compare taphonomic processes in bonebeds: an example on a bonebed from the Lance Formation (Maastrichtian)

Regalado Fernandez, Omar Rafael, Sebralla, Alexander, Bückner, Niklas, Heidekorn, Sarah, Marutschke, Philipp, Mäurer, Denise, Uhe, Claudia, Watz, Flavius

Exhibition, Senckenberg Museum, Frankfurt am Main, Hesse, Germany

Between 2018 and 2019, the Senckenberg Museum organized an expedition to collect paleoecological data from outcrops near where Charles Sternberg found the now iconic Frankfurt *Edmontosaurus* mummy in 1910. The bonebed (P4 site) described in this work was discovered in 2019 and represents a deltaic, or other transitional environment, from the Lance Formation (Maastrichtian, Cretaceous). The bonebed was extracted and shipped to Germany, where it was part of a temporary exhibition that aimed to show guests how fieldwork is carried out. Paleontologists then worked on the bonebed *in situ*, and the material was stored in the museum depot. The second stage of this project is to create a new exhibition informed by research done on the bonebed and show

guests how paleoecological reconstructions are done.

Although bonebeds offer an opportunity to reconstruct paleoenvironments, taphonomic processes that affect taxonomic determination are often downplayed or understudied. Taphonomy can be a major source of uncertainty when describing the taxonomic composition of a vertebrate bonebed, where disarticulation, fragmentation and reworking of bones lead to loss of taxonomic resolution. The P4 site is represented by nine layers (alternate sandstone and mudstone) that show different levels of taxonomic resolution and preservation. The preliminary work on this bonebed was done during the excavation (exhibition) and was limited to a general identification of the material. During the second stage of the project, we attempted to assess how much the taxonomic resolution can be improved using data aggregators such as the Paleobiology Database. To compare our bonebed with others, we developed a scale of taxonomic confidence to assign it to the identifications of the material found. The scale considers four levels of confidence: I) when diagnostic features are found, II) when features are identified similar to the referred material, III) when the identification is made based on other lines of evidence, and IV) when the determination is done through a process of elimination. Given that taxonomic determination is a rigorous process that relies on comparing material with types, we explored the potential of using taxonomic resolution as a way to compare taphonomic processes between bonebeds. Our bonebed is described here as similar to Chris's bonebed (Hell Creek Fm., Montana), and it captures several stages of development of a complex riparian system.

Funding Sources Funding for this work was obtained from the Lipoid Foundation through a project-based donation.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

New tritylodontid specimen from Wucaiwan area of Xinjiang, China, and the revised phylogeny of Tritylodontidae

Ren, Jicheng, Mao, Fangyuan

Key Laboratory of Vertebrate Evolution and Human Origins, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

Tritylodontidae is a group of advanced and highly specialized cynodonts from the Mesozoic era, characterized by the three cusp rows on the upper postcanine teeth. Since the 1940s, plentiful tritylodontid fossils have been unearthed in various regions of Western China, including Sichuan, Chongqing, Xinjiang, and Yunnan. Here we described a well-preserved tritylodontid skull from the Upper Jurassic Shishugou Formation, Wucaiwan area of Junggar Basin, Xinjiang, China. The cranial anatomy of the specimen based on 3D reconstruction of computed tomography data shows the typical features characteristic of *Bienotheroides zigongensis*, such as the shortened snout, notably deepened zygomatic arch, significantly reduced maxilla bone, upper postcanine cusp formula of 2-3-3 and the quadrate with a mediodorsally directed stapedial process. Additionally, the virtual reconstructions of the inner ear endocast and maxillary canal system helped the understanding of the palaeoneurological diversity of tritylodontids.

Based on the detailed morphological study of this specimen and the comparison with some other cranial materials available, the diagnose characters of *Bienotheroides* have been reestablished. We also revised some characters and character states and expanded the character matrix of Tritylodontidae. The phylogenetic analyses based on 16 genera and 70 characters indicate that *Bienotheroides* have a closer phylogenetic relationship with five other

genera (*Stereognathus*, *Bocatherium*, *Yuanotherium*, *Nuurtherium* and *Shartegodon*) and are located at a comparatively derived position within Tritylodontidae. This analysis prompts a reevaluation of morphological transformations throughout the evolutionary trend of tritylodontids.

Funding Sources This work was supported by the National Natural Science Foundation of China (42122010, 42072002).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

From bobcats to sabercats: Dental (dis)similarity among modern and fossil felids in the Americas

Restrepo-Cortes, Esteban, Keller, Jonathan S., Smith, Felisa A.

Biology, University of New Mexico,
Albuquerque, New Mexico, United States

As humans spread across the Americas, mammalian megacarnivores experienced both the loss of their prey base and competition/persecution by humans, resulting in their extinction by the Terminal Pleistocene. Loss of apex predators such as *Smilodon fatalis*, *Homotherium serum*, and *Panthera (leo) atrox* generated a depauperate modern American assemblage composed of just two large felids: *Puma concolor* and *Panthera onca*. Among other extant felids, modern mesocarnivores include *Lynx rufus*, *Lynx canadensis*, and *Leopardus pardalis* — with greater diversity in South America. Since the Pleistocene, these surviving cats have faced anthropogenic pressures affecting their ecology and potentially modifying their morphology. Here, we examine 3D dental ecomorphospace occupied by *Smilodon fatalis*, *Puma concolor*, *Panthera onca*, *Leopardus pardalis*, *Lynx rufus*, and *Lynx canadensis* to assess their dental

ecomorphological niches and how they vary across time and space. We measured six primary dental ecomorphological variables (enamel crown ratio, occlusal convexity, volumetric relief index, carnassial proportion, stenodonty index, and Dirichlet normal energy — DNE) shown to correlate with dietary ecology across Mammalia from 3D scans of lower cheek tooth rows downloaded from Morphosource. Discriminant analysis revealed that our focal taxa occupy distinct ecomorphospace despite close phylogenetic affinities. Stenodonty index indicated longer, broader tooth rows for extant apex predators consistent with greater dietary breadth, while modern mesocarnivores possessed shorter, narrower tooth rows. DNE, a tooth curvature and sharpness measure, was greatest for specialist mesocarnivores with the most hypsodont and secodont crowns such as *Lynx canadensis*, relative to more bunodont, durophagous *Panthera onca* and *Puma concolor*. *Smilodon* occupied distinct dental ecospace with a unique, short, broad cheek tooth row and the second highest DNE values, consistent with its secodont carnassials. Broken tooth cusps dramatically increased DNE across taxa and efforts to standardize poly-face count may have been affected by differing initial scan resolutions. As we pursue our own scanning and sampling of museum collections, our continuing work couples stable isotope analyses, body size, tooth fracture frequency, and cranial robustness to holistically characterize hypercarnivore dietary ecology in the context of modern biogeographic patterns and comparison of modern and fossil felid communities.

Funding Sources UNM Biology graduate resource allocation committee research grant

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

***A priori* cladistic data comparison reveals the need for a revision of character data in macronarian evolution**

Reutter, Alexandra

Department of Earth and Environmental Sciences, Ludwig-Maximilians Universität München, Munich, Germany

The Macronaria is the only sauropodan clade that survived until the mass extinction at the end of the Cretaceous period. This successful clade includes the smallest and the largest representatives of Sauropoda known so far. Its origins can be traced back to the Middle Jurassic. However, the early evolutionary history of macronarian sauropods is obscured by incongruent phylogenetic results. Depending on the matrix used, putative non-somphospondyli macronarian taxa can take different positions across the tree, ranging from Turiasauria to Somphospondyli. Considering equal weights analysis only, the supposed early branching macronarians *Tehuelchesaurus benitezii*, *Bellusaurus sui* and *Janenschia robusta* have been recovered as turiasaurs; *Atlasaurus imelakei* as diplodocoid; *Euhelopus zdanskyi* and *Tastavinsaurus sanzi* within Somphospondyli.

Here we identify two of the most recent matrixes, with several putative non-titanosauriform macronarian taxa, and compare them for the first time. One matrix is composed of 85 taxa and 400 characters while the other includes 119 active taxa and 551 characters. One major obstacle when performing comparative cladistics is character delineation. Because of different wording and variations in character statements, the TNT implementation for comparative cladistics is not useful at first and requires an extra step. Direct comparison of characters had to be done manually. Here we use a previously proposed standardization for character statements. The Character Similarity Index (CSI) indicates that less than

40% of the overall character count is shared between analyses. Hence, the overall count of characters is 693, where the majority is relevant for early macronarian evolution. In this case, the Character State Similarity Index (CSSI) is heavily influenced by the addition of extra states and the imperfect overlap of states.

Even though these matrixes have greatly improved our understanding of eusauropod interrelationships, they highlight the need to implement a total evidence approach, in terms of taxa and character selection, if we want to understand the origins of Macronaria. Specifically, the imperfect overlap of character states between these analyses suggests that we are dealing with a much deeper problem, that is differences in character coding.

Funding Sources This project is funded by the DFG RA 1012/33-1.

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

Triassic babies? A cluster of small-bodied aetosaurs from the Upper Triassic Dockum Group (Otischalkian – latest Carnian?) of Texas

Reyes, William, Brown, Matthew

Jackson School of Geosciences, The University of Texas at Austin, Austin, Texas, United States

The fossil record of archosaurs currently extends into the Early Triassic. This clade exhibits a fossiliferous record across the entire Mesozoic, however the same cannot be said about young, skeletally immature juveniles within this group. In ovo embryos, nests, neonates, and hatchlings are represented within terrestrial Jurassic and Cretaceous strata, but mostly restricted to some dinosaur groups. In comparison, the fossil record of such young, skeletally

immature archosaurs is sparse in the Triassic Period. Currently, no egg-bearing archosaur nests or embryos are documented from this period. When present, neonates and hatchlings are typically documented based on limited fragmentary elements intermixed with larger specimens. Currently, the only reported exception is a cluster (n = 24) of articulated hatchlings (<1 years old) of the pseudosuchian aetosaur *Aetosaurus ferratus* (SMNS 5770) from the Upper Triassic (middle Norian) Lowenstein Formation in Germany. Here, we present a cluster of small, skeletally immature individuals (TMM 31100-1336) from the Otis Chalk fossil assemblage within the Upper Triassic Dockum Group of Texas. This cluster preserves at least three individuals, including a 3-dimensionally well-preserved skull and two partial skeletons. Skeletal proxies such as a small body size; a large skull that is proportionately longer than the femur; loosely articulated skulls with a large, elliptical orbit that is not enclosed by the postorbital bar and bears dorsally opened supratemporal fenestrae; un-coossified atlas-axis complex; un-coossified neurocentral sutures of the vertebrae; and porous nature of the bones suggest that these individuals are young, skeletally immature juveniles. Together, TMM 31100-1336 and SMNS 5770 indicate that aetosaurs exhibited a well ossified carapace early in their development, suggesting that their osteoderms may have been partially ossified to some degree at birth, which is unlike the condition observed in extant crocodilians. Although the specimens preserved within TMM 31100-1336 are skeletally immature, the morphology of their dentition, mandible, basicranium, dorsal and ventral osteoderms support their referral to the co-occurring pseudosuchian aetosaur *Coahomoasuchus kahleorum*. Comparison of TMM 31100-1336 to other skeletally mature specimens of *C. kahleorum*, highlight characters that are subject to intraspecific variation within the Aetosauria, which are also incorporated within broader analyses of archosaurs.

Funding Sources NSF Graduate Student Research Fellowship (Grant No. 2137420)

NSF (EAR-2223808)

Jackson School of Geosciences

Lundelius Endowment in Vertebrate Paleontology

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Paleoenvironmental patterns in mammal fossil localities of the Fort Union and Willwood Formations, Bighorn Basin, Wyoming, USA

Reynolds, Sydney, Foreman, Brady Z.

Geology, Western Washington University, Bellingham, Washington, United States

Ancient fluvial systems, including their floodplains, provide researchers the ability to interpret past environmental changes. Integrating sedimentologic data with paleobiologic data may yield insights into habitat preference, taphonomic history, and time-averaging. The Bighorn Basin in northwestern Wyoming, USA, hosts an early Paleogene stratigraphic succession that contains the Paleocene-Eocene Thermal Maximum (PETM), an extreme global warming event ca. 56 Ma. The two early Paleogene formations that crop out in the basin are the Fort Union Formation and the Willwood Formation, both are dominated by alluvial lithofacies. Strata of the Fort Union and Willwood Formations can be categorized into three major lithofacies associations: large fluvial sandstone bodies, variegated paleosol mudrocks, and heterolithic intervals, the latter often called crevasse splays or avulsion deposits. Over three hundred fossil localities within the northern basin document biotic responses to the PETM and later hyperthermal events. The aforementioned paleosol mudrocks are the specific interest of

this study and commonly host the fossil localities. These fossil-bearing paleosols range from drab to red bed overbank deposits, often interbedded with sand layers, and frequently contain rhizoliths, soil nodules, bioturbation, and clay cutans, amongst other features. Paleosol chroma, along with the presence of carbonate nodules, and yellow-brown nodules can be semi-quantitatively summarized into a soil morphology index (SMI) that captures the degree of floodplain drainage. Fossil localities were characterized using this established index of relative drainage. Numerous sections were trenched and measured, and analyzed using the SMI. Sedimentologic data was collected at fossil localities from stratigraphic heights ranging from 680 meters to 2065 meters above the K/Pg boundary and spanning the PETM. Preliminary findings indicate fossil localities consist of interbedded mudstones, silty mudstones, and siltstones generally 5 cm to 1.5 m thick with variable pedogenic modification and gradational contacts. The calculated SMI show a range of values on a 0-20 point scale from 0 to 9.95. These represent very poorly drained swamp-like conditions to well-drained and aerated floodplains. Initial patterns suggest shifts consistent with broader paleoclimatic trends.

Funding Sources Funding for this research was provided by the David B. Jones Foundation and Western Washington University.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

An anachronistic assemblage of omomyid primates from the early Eocene Wasatch Formation, Great Divide Basin, Wyoming, U.S.A.

Rhinehart, Parker D.¹, Beard, K. Christopher¹, Anemone, Robert L.²

¹Ecology and Evolutionary Biology, University of Kansas, Lawrence, Kansas, United States, ²Anthropology, University of North Carolina at Greensboro, Greensboro, North Carolina, United States

Omomyidae (Mammalia: Primates) is a family of small-bodied Eocene primates known from North America, Asia, and Europe. Here we report the co-occurrence of three species of omomyids from the Smiley Draw local fauna in the Great Divide Basin, Sweetwater County, southern Wyoming. Two of the omomyids known from Smiley Draw, *Arapahovius gazini* and *Anemorhysis savagei*, have been described previously from the Wasatchian (Lysitean) *Arapahovius* paleofaunule in the nearby Washakie Basin. The third omomyid from Smiley Draw is a new species of *Tetonius*. Previously *Tetonius* has only been reported from older (early Wasatchian) strata of the Bighorn Basin and the Four Mile local fauna of northern Colorado. In the Bighorn Basin a well-documented anagenetic lineage including *Tetonius matthewi* and *Pseudotetonius ambiguous* documents a progressive alteration of the lower anterior dentition including the loss of p2 and the transformation of p3 from double-rooted to single-rooted. The anterior dentary also becomes progressively compacted in this lineage, reflected primarily in the mesiodistal compression of i2, c1, and p3. Conversely, the i1 is enlarged during this transformation. *Tetonius* sp. nov. has lost p2 while retaining a double-rooted p3, combined with a hypertrophied i1 and mesiodistal compaction of the anterior dentition comparable to *Pseudotetonius ambiguus*. This unique dental morphology does not match any stage of the documented morphological transformation from the Bighorn Basin. Furthermore, *Tetonius* is not known to co-occur with *Arapahovius* or *Anemorhysis* in the well sampled faunas of the Bighorn Basin. Anachronism, the co-occurrence of taxa previously known from different intervals, can be caused by sampling biases, time-

averaging, paleoenvironmental heterogeneity, or cladogenesis. Cladogenesis early in the *Tetonius* lineage could have resulted in the anachronism observed among Smiley Draw omomyids, leading to a species of *Tetonius* that persisted outside the Bighorn Basin long enough to occur alongside later Wasatchian omomyids.

Funding Sources Fossils collected under BLM permit 287-WY-PA95. Partially funded by NSF-BCS1227329, David B. Jones Foundation, and University of Kansas Biodiversity Institute grants

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Locate, assess, support, move, repeat: planning considerations when moving collections of specimens and archives time after time

Rhue, Vanessa R.

Yale Peabody Museum, Yale University, New Haven, Connecticut, United States

The Yale Peabody Museum embarked on a four-year renovation project, which necessitated a complete building evacuation and re-installation of all exhibits, collections, libraries, archives, laboratories, and offices. Planning the workflow, staffing, and resources for collection moves of any scope can be a challenge to align with administrative timelines and budget constraints. Yet, as collection stewards our goal is to make a series of choices that advocates for the long-term preservation of the objects and associated data we hold in public trust. To accomplish this, we are deeply interested and invested in the materials, tools, and methods we use to handle, support, transport, track, and label collections, as well as consideration of the

environment in which collections are stored, including climate, integrative pest management, ease of access, and security. In review, three aspects contributed to an efficient and safe relocation of all objects during recent moves: 1) use of a physical location field in our EMu database to inventory and track object level movement, 2) use of condition assessments to improve the archival housing and stability of specimens prior to movement, and 3) imparting operational procedures to team members and ensuring access to move equipment resources. Cataloged specimens were assigned a four-part physical storage location string in our database and printed barcodes were placed in specimen trays and affixed to storage units to allow for the rapid relocation of groups of objects. Assessing the condition of mounted skeletons and isolate elements allowed for improvements to specimen housings, such as use of closed-cell polyethylene foam liners and wedges for immobilization, as well as fabrication of custom support bases, pallets, and A-frame carts for larger specimens. Lastly, directing and motivating move team personnel was achieved by reviewing the sequence of move phase objectives, imparting a daily workflow pull list, providing maps of building unit locations, and availing use of mechanical and electrical lifts, pallet jacks, drawer carts, rolling shelving units, and supplies. Daily digital and physical documentation of collection move progress informed weekly check-in meetings, which facilitated procedure debriefs, reporting, and milestone celebrations. In the end, meticulous space mapping, logistical planning, and resource allocation were paramount to the success of multiple specimen and archive collection moves time after time.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

The fossil record of worm-lizards (Squamata, Amphisbaenia) across the Paleocene-Eocene Thermal Maximum of the Bighorn Basin, Wyoming

Riegler, Mitchell¹, Morse, Paul E.^{2,1}, Vitek, Natasha S.^{3,1}, Houde, Peter⁴, Bloch, Jonathan I.¹

¹Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States, ²Cell & Developmental Biology, University of Colorado School of Medicine, Aurora, Colorado, United States, ³Ecology & Evolution, Stony Brook University, Stony Brook, New York, United States, ⁴Biology, New Mexico State University, Las Cruces, New Mexico, United States

The Paleocene-Eocene Thermal Maximum (PETM, 56 Ma) is an interval of global warming with temperatures rising ~5 °C. The record of amphisbaenians, a group of limbless and mostly fossorial lizards, from the Big Horn Basin (BHB), Wyoming has been limited to few fragmentary fossils from the early Paleocene and one locality in the PETM (Wa-0). Fossils from this Wa-0 locality were derived from a single screenwashed site (Castle Gardens) in the southern BHB and were referred to a new small amphisbaenian species *Anniealexandria gansi*. This taxon had been assigned to Bipedidae, however a more recent study describing a complete *Anniealexandria sp.* dentary from the Ypresian of France compared it more favorably to the European lineage Blanidae. To better understand squamate diversity across the PETM, we studied 9 new lizard fossil assemblages from the BHB derived from intensive screenwashing efforts in strata just underlying, during, and overlaying the PETM. No amphisbaenians have been recovered from the pre-PETM microsite from the latest Paleocene (upper Cf-3). Four PETM microsites from Wa-M, lower Wa-0 (similar level as Castle Gardens) and later Wa-0 produced an abundance of small-bodied amphisbaenian fossils. The sample includes

a nearly complete dentary of a new taxon with an open Meckel's canal and homodont, unicuspid, pleurodont dentition, and reduced tooth counts (<8), all characteristic of amphisbaenians. The tooth count (7) is different from that of *A. gansi* (9) and the coronoid articulation is similar to that of the *Anniealexandria sp.* dentary from the Ypresian of France. The dentary from Wa-0 is consistent with the assignment to Blanidae, suggesting a dispersal of this group from Europe into the BHB by the earliest PETM (Wa-M). Post-PETM (Wa-1) localities include this smaller taxon, although less abundant. A freshwater limestone collected in the same locality as one of the low Wa-1 microsites yielded a remarkably complete amphisbaenian skull and associated vertebrae of a larger rhineurid here referred to *Spathorhynchus sp.* The specimen is the oldest relatively complete skull of an amphisbaenian with plesiomorphic characters not seen in modern amphisbaenians, including: a bony orbital rim, no compound bone, and paired orbitosphenoids. In contrast, this specimen has marked heterodonty, recurved dentition, reduced nostril ridge, and is more elongate/gracile than other species of *Spathorhynchus* and is likely a new post-PETM immigrant taxon.

Funding Sources Supported by National Science Foundation Grants: DGE-1315138, BCS-1440558, BCS-1440742, EAR-0640076, EAR-0719941, DEB-020828, and BCS-1552848

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Morris Skinner and the dispossession of vertebrate fossils on Lakota Treaty Lands

Rieppel, Lukas¹, Bradley, Lawrence²

¹History, Brown University, Boston, Massachusetts, United

States, ²Geography/Geology Department, university of Nebraska, Omaha, Nebraska, United States

During the late 1930s, Morris Skinner of the Childs Frick Laboratory at the American Museum of Natural History (AMNH) visited the Pine Ridge Indian Reservation in South Dakota numerous times to collect vertebrate fossils. As the correspondence between Skinner and Frick in the AMNH archives reveals, the museum was unable to secure a permit to collect fossils from the Department of the Interior. After passage of the Indian Reorganization Act in 1934, the Oglala Sioux Tribe formed a federally recognized Tribal Council that, among other things, had sovereign jurisdiction over the management of natural resources on the reservation, including the collection of natural history specimens. Realizing that he was unlikely to secure permission from the Oglala Sioux Tribal Council, Skinner wrote to tell Frick that he had decided to collect specimens on the reservation in secrecy, without securing the necessary permits. Furthermore, Skinner also complained about the tribe's authority over fossils, even while he used subterfuge to collect thousands of specimens from Lakota lands well into the 1960s. In this presentation, we will use the history of Skinner's collections from the Pine Ridge Reservation to motivate a broader discussion about the ethics and politics of conducting paleontological research on tribal lands. In addition to asking how museums could use their collections to begin repairing relationships with Indigenous people, we will also offer thoughts on how paleontologist can go about forging more respectful, ethical, and reciprocal relationships with indigenous collaborators when working on tribal lands.

Funding Sources The Mellon Foundation

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A new species of zygodactylid bird from the late Eocene Florissant Formation, Colorado

Rivera-Molina, Israel J.¹, Field, Daniel J.³, Tarailo, David A.², Wilson, Laura E.¹

¹Geosciences, Fort Hays State University, Hays, Kansas, United States, ²Earth Sciences, University of Cambridge, Cambridgeshire, United Kingdom, ³Biological Sciences, Fort Hays State University, Hays, Kansas, United States

The late Eocene Florissant Formation has yielded thousands of excellently preserved fossil plants and insects since the 1870s. Vertebrate fossils are rarer, with bird remains being especially scarce. To date, only four birds from the Florissant Formation have been described in detail, and only three of these have been identified to species: *Eocuculus cherpinae* and *Yalavis tenuipes* (both of uncertain higher-order phylogenetic affinities), and the Pan-coliiform *Palaeospiza bella*. Here, we examine a previously undescribed bird from the Florissant Formation, FLFO 9661. This specimen is distinct from previously identified Florissant taxa, with preliminary phylogenetic analyses supporting a position within Zygodactylidae (Pan-Passeriformes). Features supporting this referral include an elongate tarsometatarsus with a well-developed accessory trochlea for the fourth pedal digit, and a prominent intermetacarpal process. Currently, only two zygodactylid species are known from North America, yet both of these (*Eozygodactylus americanus* and *Zygodactylus ochlurus*) differ from FLFO 9661 in size and proportions. FLFO 9661 lacks a dorsal supracondylar process on the distal end of its humerus, a character state that is present in most other zygodactylids, including *E. americanus* and *Z. ochlurus*. FLFO 9661 is also distinct as its overall size is markedly smaller than all but one known zygodactylid, *Z. ochlurus*. Pending further study, we expect FLFO 9661 to provide new

insight into the evolution of stem passerines in the late Eocene of North America.

Funding Sources Funding for this work was received from the Graduate Scholarly Experience (GSE) Grant from Fort Hays State University.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Ouchies and boo boos: A survey of northern Laramidian pathologies using differential diagnoses for a quantitative dataset

Robinson, Jeremiah

Montana State University, Bozeman, Montana, United States

An effective way to better understand an extinct animal's lifestyle and behavior is to study the diseases and injuries it accrues over its lifetime. This information can give context to not only an individual taxon or group of taxa, but to overarching phylogenetic trends. One such group is that of the fearsome tyrannosaurids which dominated Campanian and Maastrichtian North America. Though other research has done work on tyrannosaurid pathologies, much of that work has been qualitative and/or focused towards one aspect of pathologies. The goal of this survey is to create a well-defined quantitative dataset of northern Laramidian tyrannosaurids. A novel approach to this data collection employed a veterinary primary survey to measure and compare pathological elements with non-pathological elements to form differential diagnoses. The types of pathologies used in the differential diagnoses could be broken up into 6 major categories: Trauma (injuries such as fractures), Infection/idiopathy, Neoplasia (cancer), Metabolic (such as gout), Degenerative (osteoarthritis), and Congenital. Data was collected and categorized by skeletal

element for pathology type and frequency. A total of 542 tyrannosaurid skeletal elements were used in the survey comprising albertosaurines and tyrannosaurines with the majority of specimens belonging to *Tyrannosaurus rex*. The data show trends in the frequency of pathologies within different areas of the skeleton. Results show the highest frequency of pathologies are in the mandible, humeri and fibulae, and ribs and gastralia in respect to the cranial, appendicular, and axial parts of the skeleton. Injuries and infections have the greatest frequency of primary diagnoses, whereas congenital birth defects are the least likely. Pathological frequency is remarkably similar across the genera and through ontogeny. These observed patterns give insight into the lifestyle and behavior of Tyrannosauridae. This work also gives greater insight into trends in virology and immunology from a macroevolutionary standpoint.

Funding Sources Graduate School at Montana State University
Jack Horner Paleontology Scholarship

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

The good, the bad, and the weird: A new hypothesis of tylopod (*Artiodactyla*) relationships based on data from the auditory region

Robson, Selina Viktor¹, Mourlam, Mickaël J.², Orliac, Maeva J.³, Ruf, Irina², Gegner, Jay¹, Ludtke, Josh A.⁴, Bertrand, Ornella C.⁵, Smith, Thierry⁶, Theodor, Jessica¹

¹Biological Sciences, University of Calgary, Calgary, Alberta, Canada, ²Abteilung Messelforschung und Mammalogie, Senckenberg Forschungsinstitut und Naturmuseum, Frankfurt/Main, Germany, ³Institut des Sciences de l'Evolution, Université de Montpellier, Montpellier, France, ⁴MiraCosta College,

Oceanside, California, United States, ⁵Institut Català de Paleontologia Miquel Crusafont, Universitat Autònoma de Barcelona, Barcelona, Spain, ⁶Royal Belgian Institute of Natural Sciences, Brussels, Belgium

The composition and position of the artiodactyl suborder Tylopoda is a long-standing area of debate. Camelids are the only living tylopods, but members of over a dozen extinct North American and European families have been referred to the group. Furthermore, although camelids are traditionally thought to be sister to ruminants, the results of molecular phylogenetic analyses suggest that they may be a much earlier branching group within Artiodactyla. However, phylogenetic hypotheses about the suborder have yet to be directly tested using modern morphological phylogenetic methods. There is a great deal of convergent evolution within Artiodactyla, so we used morphological data from the auditory region, which is thought to be a slower evolving system. We used CT scanning to image the petrosal of 32 purported tylopods, a broad sampling of other artiodactyls, and select condylarths. Based on these data, we constructed a matrix with 115 characters and conducted a parsimony analysis to test hypothesized tylopod relationships.

The analysis produced 150 equally parsimonious trees. Several groups are monophyletic in the majority consensus tree, including Camelidae, Hypertragulidae, Amphimerycidae, Cainotheriidae, Cebrochoeridae, and Suoidea. *Eotylopus*, an oromerycid thought to be closely related to camelids, is sister to Camelidae. These taxa are united by several petrosal features including the presence of a rostral tympanic process, a flat plate of bone lateral to the internal acoustic meatus, and a small wedge-shaped mastoid region; at its most restrictive, Tylopoda reasonably includes camelids and *Eotylopus*. *Protylopus* was not recovered in the same clade, rendering Oromerycidae polyphyletic. *Agriochoerus* and all

merycoidodontids were recovered close to Camelidae, supporting the hypothesis that oreodonts are tylopods. Surprisingly, anthracotheres were consistently nested within the oreodonts and not recovered close to other cetancodontomorphs. *Mixtotherium* (Mixtotheriidae) was sister to the clade including camelids, *Eotylopus*, anthracotheres, and oreodonts, and *Trigenicus* (Protoceratidae) was sister to that larger group. The topology may change with additional characters, but our current results support the hypothesis that oromerycids and oreodonts belong in Tylopoda, with more tentative support for the inclusion of protoceratids. The most unexpected outcome is the placement of anthracotheres within the clade, a result that bears further investigation.

Funding Sources This project was partially funded by an ABS Grant and Paleo. Society Research Award awarded to S. V. Robson, and an NSERC Discovery Grant awarded to J. M. Theodor.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A comparison of Miocene faunas from East Texas

Rock, Andrew A., Godwin, William, Lewis, Patrick J.

Biological Sciences, Sam Houston State University, Conroe, Texas, United States

The Push Creek Locality (PCL) is a Miocene locality in Tyler County, Texas, north of the Big Thicket National Preserve and east of Woodville, Texas. Push Creek cuts through a fossiliferous stratum of the Lagarto Formation (LF) eroding out fossils and creating the PCL. The LF is a subdivision of the Fleming Group dating to ca. 14-12 mya. Little work has been done on the PCL fauna, and here we compare the PCL fauna to faunas from other localities

in the region of similar age to better understand the distribution of the taxa in the PCL fauna. Families identified from PCL are compared to specimens from the Toledo Bend Reservoir Locality, the Coldspring Locality, and Lapara Creek Locality using published descriptions and specimens housed in The Texas Vertebrate Paleontology Collections at The University of Texas at Austin. These localities represent the early and late depositional environments of the LF. Of the 40 vertebrate families recovered at the Toledo Bend Reservoir, the Coldspring, and Lapara Creek Localities, 11 are also recovered at the PCL, (Alligatoridae, Emydidae, Trionychidae, Moschidae, Protoceratidae, Camelidae, Castoridae, Gomphotheriidae, Equidae, Rhinocerotidae, and Lepisosteidae). A one-way ANOVA, a Tukey Test, and two indices were used to test the taxonomic diversity of these faunas. An alpha of 0.05 was used for all tests. The ANOVA found the differences insignificant ($p=0.05$), while the Tukey Test shows that each faunal list is statistically different from the others. A Jaccard Index measures the differences in diversity between two sites, and the Sørensen Index measures the similarities between two sites. Six pairwise comparisons were made using each index. The indices suggest that PCL faunal list is most like the Lapara Creek fauna and most different from the Toledo Bend fauna. The analysis's results are mixed; while key taxa are shared among the regional localities, there is also significant variation. Likewise, the tests do not account for potential biases, such as collection bias, preservation bias, or time averaging. Affiliations for taxa at the PCL cannot be discerned below the family level, in most cases, which further obscures potential variation at the genus and species level. Nevertheless, continued analyses of the east Texas Miocene faunas will help clarify the regional distribution of taxa.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A new genus of cylindrodontid rodent from the Middle Eocene Devil's Graveyard and Laredo Formations in Texas

Rodwell, Ben¹, Kirk, Edward C.^{1,2}

¹Department of Anthropology, The University of Texas at Austin, Austin, Texas, United States, ²Texas Vertebrate Paleontology Collections, Jackson School Museum of Earth History, Austin, Texas, United States

The rodent fauna of the Tornillo Basin of Trans-Pecos Texas is largely dominated by the family Ischyromyidae during the Uintan NALMA. In contrast, cylindrodontids and eomyids are much more abundant and diverse in the Tornillo Basin during the Duschesnean and Chadronian NALMAs. The only currently described non-ischyromyid rodents from the Uintan of the Tornillo Basin are the cylindrodontid *Mysops boskeyi* and the sciuravids *Prolapsus* and *Pauromys*. Here we add to the record of cylindrodontids from the Uintan of Texas. Recent fieldwork in the Devil's Graveyard Formation of the Tornillo Basin has confirmed the presence of a new genus and species of cylindrodontid rodent. The new rodent was also present in the similar-aged Laredo Formation of the Texas Gulf coastal plain and is only known from dentognathic material. The upper dentition is largely represented by isolated teeth, but two maxillary fragments reveal that unlike other cylindrodontids except *Cylindrodon*, the new taxon lacks a P³. The upper dentition is characterized by moderate unilateral lingual hypsodonty and upper molars with distinct protoconules and metaconules, with metaconules often twinned on unworn M¹⁻³. M¹⁻² differ from all known cylindrodontids except for *Orientocylindrodon* and *Jaywilsonomys* in having distinct mesostyles. The lower dentition is characterized by very large metaconids and complete hypolophids, ectolophids, and metalophid I, though these

lophids are not as well defined as in *Mysops*, *Ardynomys*, *Pseudocylindrodon*, *Jaywilsonomys*, and *Cylindrodon*. The new taxon differs from all cylindrodontids except for *Tuscahomys* and *Jaywilsonomys* in having a discontinuous metalophid II on lower molars. A phylogenetic analysis of all known cylindrodontid genera recovers the Early and Middle Eocene *Tuscahomys*, *Mysops*, *Gobiocylindrodon*, and *Proardynomys* as the most basal members of the Cylindrodontidae. The new taxon and the Middle Eocene *Orientocylindrodon* from Asia are recovered as sister taxa, and together are sister taxa to a clade comprising the Middle to Late Eocene *Pareumys* and all other Late Eocene to Oligocene cylindrodontids. The new taxon adds further evidence of continued faunal interchange between North America and Asia in the Middle to Late Eocene, echoing similar trends in contemporary primate communities.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Unique pathology on a pedal claw of *Gorgosaurus* sp. (TCM 2001.89.1)

Rooney, Laura A.¹, Anné, Jennifer², Donnelly, Kevin B.³

¹Collections, The Children's Museum of Indianapolis, Indianapolis, Indiana, United States, ²The North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States, ³Toxicology/Pathology, Eli Lilly and Company, Indianapolis, Indiana, United States

TCM 2001.89.1, a *Gorgosaurus* sp. from The Children's Museum of Indianapolis, is recognized for possessing a wide range of pathologies throughout its skeleton. Due to continued advancements in the field of paleopathology, we have been able to identify yet another distinctive abnormality on this specimen. The claw on right pedal digit I is

deeply bifurcated at the distal end. Upon gross inspection, the condition appeared to bear similarities to preaxial polydactyly type 1 (PPD1). Through advanced imaging techniques (SEM/EDS and CT), several deep cavities in the region of the deformity were revealed. These appear to be consistent with a traumatic and infectious origin, possibly osteomyelitis. Further study is needed to interpret potential causes for this unusually symmetrical bifurcated claw and the prevalence of this type of injury in theropod dinosaurs.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Microvertebrate ichthyofauna of the Upper Triassic (Norian) Homestead Site at Garita Creek in east-central New Mexico, USA

Rose, Luke J.¹, Crothers, Joel P.², Pugh, Isaac³, Heckert, Andrew B.^{1,4}, Nesbitt, Sterling J.³, Stocker, Michelle R.³, Lauer, Bruce H.⁴, Lauer, Rene⁴

¹Department of Geological and Environmental Sciences, Appalachian State University, Boone, North Carolina, United States, ²University of Colorado Museum of Natural History, Boulder, Colorado, United States, ³Department of Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ⁴Lauer Foundation for Paleontology, Science and Education, Wheaton, Illinois, United States

The Homestead Site at Garita Creek preserves a highly diverse microvertebrate assemblage that has yielded thousands of fossils from several vertebrate lineages, making it the most fossiliferous site of the Garita Creek Formation. Homestead is located in east-central New Mexico and is Revueltian (early-mid Norian) in age, part of the Upper Triassic Chinle Group. Homestead represents a freshwater environment, characterized by the presence of aquatic

reptiles and amphibians, as well as various types of fish. Fish body fossils include scales, teeth, dentigerous plates, skull bones, and vertebrae. Only a single chondrichthyan is reported, *Reticulodus synergus*, a durophagous hybodont represented by dozens of superficially batoid-like teeth. This species is an index fossil for Revueltian strata and is found primarily in the American Southwest. Sarcopterygians include both dipnoans and actinistians. The lungfish *Arganodus* and *Ptychoceratodus* are known from a series of tooth plates and plate fragments. Homestead is the first occurrence of *Ptychoceratodus* on mainland North America (NA) during the Triassic, showing that there were two lungfish taxa in NA at this time. Some fragments of what appear to be elasmoid scales are also present, which we interpret to be dipnoan. Coelacanths are represented by jaw bones with acrodont teeth, a quadrate, a potential sphenoid condyle, and a dentigerous plate similar to *Quayia zideki*. Actinopterygians are the most abundant with dozens of body fossils assigned to this group, although many of them are not diagnostic beyond this class. Ganoid scales are assigned to semionotids, redfieldiids, and palaeoniscoids based on differences in their shape and ornamentation. Certain ridged scales may represent turseodids, potentially *Turseodis dolorensis*, or perleidids, which are also characterized by dentigerous plates with randomly arranged pustular denticles. Some ornamented skull bones appear similar to redfieldiids, such as *Lasalichthys* or *Synornichthys*, and include four jaw fragments with conical teeth. So far, Homestead contains at least six orders of fish across three different classes, preserving a uniquely diverse freshwater fauna. The Late Triassic is well-known for the diversification of reptiles and origin of both dinosaurs and mammals, thus, other vertebrates such as fish are often left understudied. The Homestead site provides a new point of reference for the diversity of the Chinle Group and freshwater ichthyofauna of Pangea.

Funding Sources We acknowledge an undergraduate research assistantship (URA) to the senior author. Additional funding was provided by the Lauer Foundation.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

The first glimpse into the trabecular bone of a stem primate: use of the Regularized Deep Network (RDN) for segmentation of a 55 Ma femur (*Microsyops latidens*; Wasatchian NALMA, Southern Bighorn Basin, Wyoming)

Rose, Madison¹, Kuo, Sharon^{3,4}, Ryan, Timothy M.², Silcox, Mary T.¹

¹Anthropology, University of Toronto, Scarborough, Scarborough, Ontario, Canada, ²Biomedical Science, University of Minnesota Duluth, Duluth, Minnesota, United States, ³Technological Primate Research Group, Max Planck Institute for Evolutionary Anthropology, Leipzig, Germany, ⁴Anthropology, Pennsylvania State University, State College, Pennsylvania, United States

Over the last two decades the use of microCT scanning has revolutionized researchers' ability to identify functionally informative patterns in fossil trabecular bone. This work has demonstrated meaningful differences related to reconstructing locomotion. However, there have been challenges associated with segmenting fossil material including poor quality due to taphonomic processes, sediment infill, and bias in manual segmentation. Here we present the first trabecular observations for a stem primate from a well preserved femoral head of a 55 Ma fossil (*Microsyops latidens*), part of the first dentally associated partial skeleton for Microsyopidae. Using the new machine learning based domain enriched regularized

deep network (RDN) model, we segmented high resolution microCT scans (resolution of 15.5 - 20 μm) of the femoral heads of *M. latidens*, as well as 2 extant primates (*Galago senegalensis*, *Callithrix argentata*). Employing the unique relearning capabilities of RDN and training data from 5 slices of manually segmented data from the *Microsyops* fossil per plane, we fine tuned the segmentation to overcome the challenges of segmenting trabecular bone as old, small, and complex as that of a plesiadapiform. In doing so we are able to make preliminary qualitative comparisons of the *M. latidens* femoral head internal morphology to that of two diverse comparative extant taxa (*G. senegalensis* and *C. argentata*), demonstrating the validity of this method to produce a segmentation comparable to that for modern specimens. We conclude that the use of RDN will allow for the most accurate functional comparisons of trabecular variables when applied to both ancient fossil and extant materials. This study is the first to use microCT segmentation methods to explore plesiadapiform trabecular anatomy and therefore is key to the continuing studies of the earliest members of the primate clade. Using RDN's advanced segmentation capabilities opens the doors to a wealth of trabecular data to be explored within ancient fossil materials in the future.

Funding Sources NSERC Discovery Grant to Mary T. Silcox

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A saurolophine hadrosaur (Dinosauria: Ornithischia) from the marine Claggett Formation (Campanian) of northern Montana

Rossi, Rory E.¹, Horner, John R.², Scannella, John¹

¹Museum of the Rockies & Department of Earth Sciences, Montana State University, Bozeman, Montana, United States, ², Schmid College of Science and Technology, Chapman University, Orange, California, United States

The Cretaceous Western Interior Seaway produced the marine deposits of the Bearpaw Formation and the geologically older (~ 81 Ma) Claggett Formation in Montana and surrounding regions. Whereas marine invertebrates and occasional vertebrate fossils have been recovered from the Claggett Formation, remains of non-avian dinosaurs are relatively rare. In 1998, a new Claggett dinosaur locality was discovered near Malta, Montana; the site represents the northernmost recorded occurrence of dinosaur remains within the formation. Recovered fossils (MOR 1121) are all consistent in morphology with hadrosauridae and include a left humerus, partial right ilium, left astragalus, partial rib, chevron, two dorsal vertebrae, and associated fragments. The fossils were encrusted in gypsum, complicating assessment of the bone surfaces. The humerus is relatively small (total length, 37.8 cm) compared to known Campanian hadrosaurs, suggesting a subadult individual. The moderately expanded deltopectoral crest is consistent with the condition observed in saurolophine hadrosaurs. Some bones from the site are relatively large compared with the humerus (e.g. preserved length of the preacetabular process of the ilium, 85.42 cm), suggesting the possibility of multiple individuals being preserved. The ilium shows signs of the preacetabular process being slightly deflected (>150°), consistent with observations in other saurolophine hadrosaurs. The identification of saurolophine fossils in the Claggett Formation is consistent with previous studies noting that these animals are more commonly recovered from marine deposits than the coeval lambeosaurines. This may reflect differences in habitat preferences

between these groups, with saurolophines inhabiting areas closer to the coast and thus more likely to be preserved in the Western Interior Seaway.

Funding Sources Funding for field collection of MOR 1121 provided by NSF grant #EAR-9211542

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Eye of the beholder: Role of vascular plexuses in ocular thermoregulation in upper level vertebrates

Rothschild, Bruce M.^{1,2}, Mayle, El³, Argyros, George C.⁴

¹Vertebrate Paleontology, Carnegie Museum, Muncie, Indiana, United States, ²Medicine, Indiana University Health, Muncie, Indiana, United States, ³Zoology, Ohio Wesleyan University, Delaware, Ohio, United States, ⁴Biology, Emory & Henry University, Emory, Virginia, United States

Orbital roof phenomena in humans, once mistaken as marrow hyperplasia-exposed trabeculae, have been revealed to represent not only vascular channel, but also vascular plexuses. The same orbital roof imprints of vascular structures, recognized across mammalian phylogeny, is now described in birds. Given the likely role of such plexuses for maintenance of ocular thermal balance, the brain itself and the greater range of hostile temperatures encountered by birds, modern and fossil avian orders were surveyed for plexus presence. Birds occupy a remarkable myriad of ecological niches, ranging from terrestrial to high altitude, desert heat to sub-zero temperatures, thus providing an opportunity to assess the potential significance of vascular plexuses for protection of the contents of the orbit against environmental extremes.

The orbital surfaces of bird skulls were examined by epi-microscopy at 50 to 200x magnification in the collections of the Carnegie Museum of Natural History, Ohio History Center, Ohio Wesleyan University and University of Michigan Museum of Natural History. We tested whether prevalence of orbital plexus correlates with what is known with regards to species geography, habitat, flight altitude, climate, routine temperature exposure, position in the food chain (prey versus predator) and character of diet, body mass, length and width of beaks, tibiotarsal, femoral, wing and tail parameters, life history (maximum longevity female and male maturity, clutch size and number per year, ontogeny (egg mass, width and length, incubation time, hatching and fledging weight, and susceptibility to osteoarthritis.

Preliminary results suggest the osseous correlate of vascular plexuses is phylogenetically diverse, as well as unrelated to geography, habitat, dietary choices, size. Hypothetically, the role of an orbital plexus is likely modulate circa-orbital temperatures for protection of and perhaps for optimization of ocular function. Given the lack of correlation with environmental parameters and the apparent inverse relationship to osteoarthritis, it is suspected that a behavioral exploration is likely and a subject for future investigation.

Funding Sources No outside funding was involved

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Redescription of a Miocene Colubrid from West-Central Nevada using Micro-CT

Rourke, Declan, Powers, Mark J., Caldwell, Michael W.

Biological Sciences, University of Alberta, Edmonton, Alberta, Canada

Colubridae is the largest clade of snakes with a fossil record beginning in the Miocene. Despite large-scale molecular analyses with robust taxon sampling, the phylogenetic relationships of this clade remain uncertain. This is in large part due to a lack of well-preserved fossil material. In particular, articulated fossil colubrids are rare and poorly described. Here we provide a redescription of a partially articulated fossil snake from the middle member of the Truckee Formation in west-central Nevada (UNMSM 0001). This specimen was found in the summer of 1969 and was initially described by Ruben (1971), but not given a proper name. UNMSM 001 was initially thought to be early-mid Pliocene in age. However, a radiometric date of 9.8mya is currently well supported for the middle member of the Truckee formation. The specimen is preserved in a diatomite slab, dorsoventrally compressed with a partly articulated cranium and 76 anterior vertebrae. Most of the ribs and/or impressions are present and associated with their corresponding vertebrae. The cranium exhibits significant breakage and lateral displacement of bony elements. Micro computed tomography (μ CT) scanning identified maxillary, dentary, pterygoid, ectopterygoid, palatine, and compound bone elements that are relatively well-preserved and close to anatomical position. Components of the frontal, nasal, braincase and anteriormost cervical vertebrae are identifiable but fragmented. The remains of three ray-finned fish are present within the body cavity and suggests that the specimen lived near a significant body of water. UNMSM 0001 shares many morphological traits associated with *Coluber* sp. and other closely related genera. Maximum parsimony using a modified morphological character matrix from Garberoglio et al. (2019) supports this specimen within the superfamily Colubroidea. Maximum parsimony and Bayesian inference using the matrix by Zaher and Smith (2020) reconstructs UNMSM 0001

with strong affinities within Colubridae as well as a sister taxon to *Coluber constrictor*. Biogeographically, UNMSM 001 likely represents an early radiation of the family Colubridae into western North America and a probable new species. As a transitional fossil this may help resolve phylogenetic conflicts within Colubridae in conjunction with molecular data and development of a morphological character matrix for this family.

Funding Sources This project was done as part of an undergraduate research project Biol 499 at the University of Alberta.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Quantitative and qualitative analyses of dental morphology in an anaptomorphine (Omomyidae) lineage reveal patterns of mosaic evolution in early primates

Rust, Kathleen L., Tietjen, Kristen, Beard, K. Christopher

Biodiversity Institute & Ecology and Evolutionary Biology, University of Kansas, Lawrence, Kansas, United States

Anaptomorphine omomyids from the Willwood Formation (early Eocene) in the Bighorn Basin of Wyoming have been known to researchers since the late 19th century. Given the virtually uninterrupted fossil record of the Willwood Formation, paleontologists have documented fine details of evolutionary changes characterizing anaptomorphine lineages. Earlier studies have found patterns of gradual morphological change in the lower dentition of the *Tetonius-Pseudotetonius* lineage that span 1.5 million years, resulting in the progressive compaction of antemolar teeth and loss of p2 in later taxa. From these findings, researchers established a stage-based system of gradual morphological change in the lower dentition associated with

specific meter-levels from the Willwood Formation. These previous studies, however, lacked sufficient maxillary fossils to permit formal analysis of the upper dentition. Additional fossil maxillae from this lineage have been recovered and are studied here.

We present results of quantitative and qualitative morphological analyses to test whether coordinated changes in the upper dentition match modifications previously documented in the lower dentition. Results from qualitative analyses document morphological changes in the upper dentition through time, but these transformations do not evolve in tandem with those in the lower dentition. While dentaries of *Tetonius* from higher meter levels demonstrate evolutionary loss of p2, several partial *Tetonius* fossil maxillae from the same strata maintain P2. In p4, a gradual reduction of the paraconid and metaconid represents a morphocline. However, P4 does not appear to undergo cusp reduction or simplification. Quantitative analyses used three-dimensional geometric morphometric (3DGM) methods to quantify shape changes through time. Our results show that upper and lower antemolar dentition undergo mesiodistal compression. Our results also indicate that the shape changes found in the lower dentition in our sample do not strictly conform to the previously established stage-based gradient of morphological change associated with meter level, as considerable overlap of p4 specimens from disparate meter levels occurs within the morphospace. In P4, we found a weaker pattern of mesiodistal compression compared to p4. Collectively, our findings suggest that the upper dentition in the *Tetonius*-*Pseudotetonius* lineage evolve at a disparate rate relative to the lower dentition, demonstrating a case of mosaic evolution.

Funding Sources Financial support offered by the Association of Earth Science Clubs of Greater Kansas City, the University of Kansas, and the David B. Jones Foundation.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Love's labor's lost: Texas type, figured and forgotten specimens lost to neglect. Notes on keeping your research associates close and their data closer

Sagebiel, James C.

Jackson School Museum of Earth History, The University of Texas at Austin, Austin, Texas, United States

Recent specimen losses suffered by the Texas Vertebrate Paleontology Collections (TMM) have occurred through the most insidious agent of deterioration - neglect. The classic definition of curatorial neglect includes dissociation of objects and documentation, or deterioration through lack of conservation effort. However, our recent experience with curatorial neglect was through poor management of researcher relationships. Despite strong personal relationships with recently departed researchers (possibly because of it), the quality of professional relationships to their collections deteriorated over time, ultimately resulting in lost collection objects. Had these missteps followed a pattern, more recent losses might have been prevented, but each collection, collector, and curatorial relationship is different. The intention of this abstract and presentation is to provide examples of pitfalls with these associations, provide guidelines to remedy them, and plea for assistance in recovering the lost fossils. Most fossil repositories build collections through affiliated researchers through donations and agreements such as MOUs and repository agreements. The researchers usually retain the specimens for a period of time so that they can complete research projects. These relationships can last decades, and the flow of specimens and

related documentation is typically episodic. Recently, the Texas collections lost a handful of research associates who died before their collections could be transferred. Despite permit reports and publications listing TMM as repository, when researchers perish, so too can the knowledge of the whereabouts of those collections. Even when an understanding between researcher and repository is firm, if plans for retrieving collections do not include family and institutional administration, those plans can be thwarted.

Close review of collection transfers over the past 40 years - notably Lamar University (Stevens and Westgate), Midwestern State University (Dalquest and Stangl), the Texas A&M system (Baskin, Echols, Francis, Hesse), and individual collectors, revealed successes and pitfalls. Lessons learned from those experiences informed our development of research associate policies and protocols that include loss prevention. This includes: (1) designating personal and professional contacts to help manage transfers, (2) managing third-party loans, (3) including documentation with transfers, (4) reviewing research associate agreements.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Exceptional preservation of integumental structures in hadrosaur ‘mummies’ via clay templating

Saitta, Evan T.¹, Sereno, Paul C.¹, Ciudad Real Ballester, María², Vidal, Daniel^{1,2}, Keillor, Tyler¹, Baumgart, Stephanie L.³, Myhrvold, Nathan P.⁴, Burdick, Aidan⁵, Kaye, Thomas G.⁶, Erikson, Marcus⁷

¹Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States, ²Grupo de Biología Evolutiva, Departamento de Física Matemática y de

Fluidos, UNED, Madrid, Spain, ³Department of Physiological Sciences, University of Florida College of Veterinary Medicine, Gainesville, Florida, United States, ⁴Intellectual Ventures, Bellevue, Washington, United States, ⁵Department of Earth & Planetary Sciences, Northwestern University, Evanston, Illinois, United States, ⁶Foundation for Scientific Advancement, Sierra Vista, Arizona, United States, ⁷Ventura County Science Center, Santa Paula, California, United States

Exceptionally fossilized dinosaur ‘mummies’ preserve 3-D integument renderings over articulated skeletal remains. Explanations for such renderings have ranged from simple impressions in sediment to a mélange containing traces of original proteins. Two new *Edmontosaurus annectens* ‘mummies’ with novel integumental features were discovered near the sites of the American Museum and Senckenberg ‘mummies.’ They preserve the fleshy midline including a cervicodorsal crest grading over the hips into a row of imbricate keratinous spikes over the entire length of the tail. Also preserved are wedge-shaped ‘hooves’ surrounding the terminal phalanges of the three pedal digits. High-energy fluvial sandstone rapidly buried the mummies with thin intercalated layers of carbonized plant matter.

Microscopy, spectroscopy, and mass spectrometry suggest the originally keratinous integument fossilized via clay templating, leaving a thin (<1 mm) clay layer preserving fine external details. Kaolinite is the predominant clay, dark minerals (iron sulfides, iron/manganese oxides) occur in places, and an iron-rich concretion formed around the tail tip. We find no evidence of original organic molecules, which our maturation experiments suggest are diagenetically unstable. Clay templating, often described in much older marine fossils, may be a more general means to soft structure preservation than previously realized.

We support Osborn's 1912 hypothesis for the initial taphonomic stages of *E. annectens* 'mummies' including (1) *carcass decay with desiccation of the cornified epidermis* followed by (2) *sudden short-distance, fluvial transport and burial*. Subaerial desiccation is clearly shown by shrink-wrapped, wrinkled skin renderings over the torso and tail, while long-distance transport is unlikely given the completeness of skeletal preservation. A third stage, (3) *rapid carcass infilling*, occurred during or shortly after burial via breaches in the integument, given near-identical sediment outside and within the mummy. A final stage, (4) *integument templating*, began during sub-aqueous sediment entombment, driven by microbial decay of the keratinous integument. Kaolinite accumulated at an external biofilm at the interface of the integument, generating high-fidelity renderings of original scales, spikes, and pedal hooves with patchy precipitation of iron-rich minerals atop the clay. Decay experiments closely approximate this taphonomic motif.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

**'Synthetic fossils': experiments make
taphonomy a better science**

Saitta, Evan T.¹, Kaye, Thomas G.²

¹Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States, ²Foundation for Scientific Advancement, Sierra Vista, Arizona, United States

Fossilization is a black box. This statement emphasizes uncertainty inherent over millions of years of a fossil's history and the emergent properties of biogeochemistry compared to simpler sciences (e.g. math, physics). Still, predictable processes of fossilization exist, otherwise scientific study is impossible.

Modern analytical equipment (e.g. microscopy, spectroscopy, mass spectrometry) can improve the study of fossil structure and composition. Analysis only goes so far however, so experimentation is needed. It is reasonable to assume that key taphonomic processes are understood well enough to be simulated to a sufficient approximation. Controlling some variables and altering others offers a way to disentangle complex biogeochemistry.

Taphonomy experiments simulate diverse processes (e.g. burial, microbial/autolytic decay, diagenesis). Laboratory decay can even authigenically mineralize carcasses. By combining observations of fossils with experiments, taphonomic hypotheses can be tested with more confidence. Fossils help to close the loop and calibrate experimental treatments, which in turn provide powerful support for taphonomic models.

We simulate deep-burial, long-term diagenesis over laboratory timescales using heat and pressure in compacted sediment. Sediment pores filter thermally stable compounds from labile ones, predicting diagenetic stability of organisms' *in vivo* components. Sediment-encased maturation makes 'synthetic fossils' of vertebrate bones/integument, plant leaves/resin, and arthropods that macro- and microscopically resemble carbonaceous compression fossils and copal/amber. Key chemical pathways are simulated, as in feather 'keratin' decomposition and melanin polymerization. Ongoing improvements will combine decay and maturation into a single experimental design, simulating more complex preservation.

Experimental taphonomy can also be applied to conditions on other planets and moons to guide hunts for extraterrestrial fossils in astrobiology. If synthetic diamonds and gemstones can be produced and solar fusion can even be replicated on Earth's surface, then vertebrate paleontologists should take

seriously the possibility that ‘synthetic fossils’ can, to a degree, be realistically produced in the lab.

Funding Sources Geological Soc. of London Daniel Pidgeon Fund, U. Bristol Bob Savage memorial fund, Palaeontological Assoc. PA-RG202202, Paleontological Soc. Norman Newell Grant

Technical Session 18: Carnivora & Co
(Saturday, November 2, 2024, 8:00 AM)

Evolutionary lag between changes in diet and changes in jaw function in Cenozoic carnivores

Salcido, Charles J.

Earth and Atmospheric Sciences, Indiana University, Bloomington, Indiana, United States

There are instances in the evolution of organisms into newly opened niches in which one phenotypic trait evolves noticeably faster than another to which it is functionally linked in a form-function complex, creating an apparent stagger between the two. This phenomenon can be described as an evolutionary lag between two correlated features in which one has yet to be optimized for an environment or role based on changes in a behavior. A clear example of what this lag should look like regarding changes in behavior and functional morphological features are changes in diet, dentition, and mandibles. The fossil record of Carnivoraformes provides a dataset in which to analyze whether this evolutionary lag between diet and mandible functional morphology is present in the evolution from generalist mesocarnivorous taxa to specialized hypercarnivorous taxa across different clades and evolutionary history. This study analyzes evolutionary lag using dental topographic analysis as a proxy for dietary behavior and geometric morphometrics and

finite element analysis of the mandible to quantify changes in mandible shape and functional performance.

Dental topographic analysis of extant carnivoraform species shows that orientation patch count rotation (OPCR) of the carnassial is the best way to diagnose the dietary categories relevant to this study and was applied to extinct fossil taxa. To measure whether the parts of the masticatory form-function complex have changed during carnivoraform evolution, OPCR of the carnassial, Procrustes distances of the mandible, and stress on the mandible recorded from finite element analysis underwent ancestral state reconstruction to detect instances of evolutionary lag. Results show that at the base of Hesperocyoninae, *Metatomarctus* + Borophagini, and Hyaenidae, morphological changes in the teeth (and thus diet) were faster than functional morphological changes in the mandible and then switches later in clade history. It appears that evolutionary lag in which behavioral dietary changes occurs initially at faster rates at the family or subfamily cladistic level that have clear mesocarnivores with functional morphological changes becoming faster later in the clade toward the hypercarnivore or bone-cracking hypercarnivore end.

Funding Sources AmericCorps Education Award, Indiana University Galloway/Perry/Horowitz Fund, Indiana University Norman R. King Graduate Field Research Fellowship

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

A new long-snouted dyrosaurid (Crocodyliformes, Mesoeucrocodylia) from the Campanian of Egypt

Salem, Belal S.^{1,2}, Saber, Sara^{1,3}, Ouda, Khaled³, Gohar, Abdullah S.^{1,4}, El-Sayed, Sanaa^{1,5}, Sallam, Hesham^{1,6}

¹Mansoura University Vertebrate Paleontology Center (MUVP), Mansoura University, Mansoura, Egypt, ²Department of Biological Sciences, Ohio University, Athens, Ohio, United States, ³Department of Geology, Faculty of Science, Assiut University, Assiut, Egypt, ⁴Department of Anatomy and Cell Biology, Oklahoma State University Center for Health Sciences, Tulsa, Oklahoma, United States, ⁵Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ⁶Institute of Global Health and Human Ecology (I-GHHE) School of Sciences and Engineering, American University in Cairo, New Cairo, Egypt

Dyrosauridae, a clade of neosuchian crocodyliforms, is a significant component in terrestrial and aquatic ecosystems across the latest Cretaceous to Paleogene in North Africa. Here, we report a newly discovered dyrosaurid specimen from the late-middle Campanian Quseir Formation in the southern Western Desert of Egypt. The partial mandible (MUVP 635), which including dentaries and splenials, was recovered *in situ* near Kharga Oasis, assigned to Dyrosauridae based on its dental pattern, size, and the shape of the splenial in the symphysis. MUVP 635 exhibits a mandible substantially wider than its height, with alveolar diameters shorter than the interalveolar distances within the same row. Notably, the seventh dentary alveolus is significantly large, comparable in size to the fourth dentary alveolus, while the sixth dentary alveolus is positioned close to the seventh dentary alveolus and is as small as the eighth dentary alveolus, which is adjacent to the ninth dentary alveolus. The phylogenetic analysis places MUVP 635 as an early-diverging member of Dyrosauridae, aligning with its geological age in the middle-upper Campanian. It clusters with a soft polytomy, with *Chenanisuchus lateroculi* and

Anthracosuchus balrogus identified as the most basal members of Dyrosauridae. The discovery of this new dyrosaurid in the Quseir Formation extends the temporal range of Dyrosauridae to the middle Campanian, highlighting the taxonomic richness of the dyrosaurid clade across North Africa and supporting hypotheses of an African origin for this family. Additionally, the stratigraphic horizon of the Quseir Formation offers opportunities to enhance our understanding of the Late Cretaceous terrestrial vertebrate assemblages in northern Africa, particularly when compared to coeval sedimentary units in Sudan. The notably increased abundance of associated skeletal remains within the Quseir Formation suggests potential taphonomic disparities between this region and north-central Sudanese deposits, likely influenced by differences in paleoenvironmental settings.

Funding Sources This research received support from Mansoura University, the American University in Cairo, and the Science and Technology Development Fund (STDF), project 38284.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A new late Pleistocene fossil *Crocodylus* from Sudan

Salih, Khalafallah^{1,2}, Müller, Johannes¹, Eisawi, Ali², Bibi, Faysal¹

¹Museum für Naturkunde Berlin, Berlin, Germany, ²Faculty of Petroleum and Minerals, Al Neelain University,, Khartoum, Sudan

African *Crocodylus* is common in Miocene to Plio-Pleistocene deposits, but remains poorly studied. Here we report on a complete cranium of a new fossil *Crocodylus* from the middle Atbara River, eastern Sudan, dated to around 130 ka. Cranial morphology overall resembles the Plio-Pleistocene Paleoafican

Crocodylus (*C. thorbjarnarsoni* and *C. anthropophagus*) in having upturned squamosals, though not as prominently developed as in these species. The cranium differs from previously described *Crocodylus*, as well as from extant *C. niloticus/suchus* in having four premaxillary teeth, a prominent sagittal boss on the dorsal surface of the rostrum and the absence of the supraoccipital exposure on the dorsal skull table. Phylogenetic analysis suggests the Atbara *Crocodylus* represents a new species and is more closely related to the fossil Paleoafrican species than to the extant forms.

Funding Sources This work was supported by the German Research Foundation (DFG, grant no. 387794796) and European Research Council (ERC, PALEONILE Project)

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Oldest record of Cenozoic terrestrial vertebrates (Chiroptera) from Madagascar

Samonds, Karen E.¹, Simmons, Nancy B.², Goodman, Steven M.³, Alumbaugh, Jamie L.⁴, Hand, Suzanne J.⁵, Irwin, Mitchell T.⁶, Rasolofomanana, Nadia⁷, Gunnell, Gregg F.⁸

¹Department of Biological Sciences, Northern Illinois University, DeKalb, Illinois, United States, ²American Museum of Natural History, New York, New York, United States, ³Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States, ⁴Department of Geography, University of Tennessee, Knoxville, Tennessee, United States, ⁵School of Biological Sciences, University of New South Wales, Sydney, New South Wales, Australia, ⁶Department of Anthropology, Northern Illinois University, DeKalb, Illinois, United States, ⁷Mention Bassins sédimentaires, Évolution, Conservation, Université d'Antananarivo, Antananarivo,

Madagascar, ⁸Division of Fossil Primates, Duke University Lemur Center, Durham, North Carolina, United States

Madagascar's world-renowned endemic biota has been shaped by the island's complex geological history and isolation from other land masses in deep geological time (~88 million years). Molecular data suggest that ancestors of most living native species successfully colonized asynchronously throughout the Cenozoic, well after the island was isolated, requiring crossing of considerable oceanic barriers. However, the paucity of the Cenozoic fossil record of Madagascar has inhibited direct testing of biogeographic hypotheses, as until now the oldest non-marine Cenozoic Malagasy vertebrate fossils date to only 80,000 years ago. Here we report the first terrestrial fossils described from this time: a Late Miocene bat fossil assemblage from a nearshore island in northwestern Madagascar, which extends the non-marine Cenozoic fossil vertebrate record back to the Miocene (early Tortonian, ~10 Ma). Fossils recovered include cranial, dental, and postcranial elements representing the families Hipposideridae (Old World Leaf-nosed Bats) and Miniopteridae (Bent/Long-winged Bats), including a new species of *Macronycteris*. This new material represents at the genus level the earliest fossil record of land mammals on Madagascar that are still represented in the extant fauna, and indicates that some bat lineages have at least a 10-million-year history on the island. These fossils also represent the earliest record of fossil bats in Madagascar and the oldest non-marine fossils from within the island's profound fossil gap, helping elucidate the colonization and diversification history of groups represented in the island's modern animal fauna.

Funding Sources Funding for this work was received from National Geographic Grants 9662-15 and NGS-161R-18.

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

A new cranium of early Pleistocene *Elephas recki atavus* from Koobi Fora, Kenya, and evaluation of phylogenetic and taxonomic hypotheses of the “*Elephas recki* complex”

Sanders, William J.^{1,4}, Leakey, Louise N.^{2,3}, Gichunge Ibui, Timothy², Kirinya Muthuri, Martin²

¹Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States, ²Department of Anthropology, University of Michigan, Ann Arbor, Michigan, United States, ³Turkana Basin Institute, Nairobi, Kenya, ⁴Stony Brook University, Stony Brook, New York, United States

The orthodox hypothesis of the dominant elephants of the African Plio-Pleistocene, supported primarily by morphometric analyses of molars, is that they belong to a single, anagenetically-evolved, >3 Myr species lineage, “*Elephas recki*.” Progressive increases of molar lamellae, crown height, frequency and amplitude of enamel folding, lamellar frequency, and abundance of cementum, with concomitant thinning of enamel, were used to subdivide the lineage into sequential subspecies *E. recki brumpti*, *E. r. shungurensis*, *E. r. atavus*, *E. r. ileretensis*, and *E. r. recki*, with temporal boundaries of subspecies subjectively established at tuff horizons in stratigraphic sequences of the greater Turkana Basin. Metric aspects of “*E. recki*” overlap extensively between successive subspecies. This hypothesis was challenged as a misuse of the subspecies concept, and the construction of the lineage as a single species evolving via anagenesis was disputed. Studies of “*Elephas recki*” crania suggested alternatively that either *E. r. recki* belongs in *Palaeoloxodon*, a group widely successful in late Pleistocene Eurasia, or that

a split between *Elephas* and *Palaeoloxodon* is evidenced in older, early Pleistocene *E. r. atavus*. Paleogenomic investigations further complicated these competing phylogenetic hypotheses by indicating that *Palaeoloxodon* shares a deep common ancestry with African elephants (*Loxodonta*) rather than *Elephas*. Comprehensive morphometric examination of “*E. recki*” fossils, notably including a new cranium of *E. r. atavus* from Area 104 at Koobi Fora, Kenya (KNM-ER 103170), from 1.9 Ma sediments of the Upper Burgi Mb., Koobi Fora Fm., was undertaken to evaluate the merits of these hypotheses. The results sustain hypotheses that subdivide the “*E. recki*” lineage into separate species, and possibly genera: a primitive Pliocene-aged “*brumpti*” group with similarities to South Asian *E. planifrons*; an early Pleistocene “*atavus*” group with abundant modern *Elephas* features but also with occipital advancement onto the frontoparietal vertex of the cranium clearly seen in ER 103170 (characteristic of *Palaeoloxodon*); and an early-middle Pleistocene “*recki*” group that belongs in *Palaeoloxodon*. Paleontological evidence supports ancestry of both *Elephas* and *Palaeoloxodon* in the “*E. recki*” complex but fails to verify genomic hypotheses of common ancestry between *Palaeoloxodon* and *Loxodonta*.

Funding Sources National Geographic Society; Turkana Basin Institute Research Fund.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Allometric change in the limbs of the Pliocene goat-like camel *Capricamelus gettyi*

Santos, Sunshyne M.¹, Prothero, Donald R.²

¹Geological Sciences, Cal Poly Pomona, Pomona, California, United States, ²Vertebrate Paleontology, Natural

History Museum of LA County, Los Angeles, California, United States

The goat-like miolabine camelid *Capricamelus gettyi*, described in 2005 by Whistler and Webb from the Pliocene beds of Tecopa Lake, California, is remarkable in how short and stumpy its limbs were, especially the more distal elements, with limb proportions much like that of a mountain goat. How did its limbs scale as they got shorter and stumper? We remeasured all the limb elements from the original sample of *C. gettyi*, and compared them to the limbs of its sister-taxon, the middle Miocene miolabine camel *Paramiolabis tenuis*, to see if there were any allometric size changes as they shrank in size and developed stumpy distal limb elements. The more proximal limb elements, such as the humerus, femur, and tibia, showed some negative allometry and increased robustness compared to *Paramiolabis tenuis*, with an allometric slope of about 0.8. But the metapodials are extremely short and thick compared to *Paramiolabis tenuis*, with an allometric slope of 0.2. This extreme allometric shape change results from *C. gettyi* evolving from a more “normal” camel with the typical long slender limbs. Such extreme allometric shortening is comparable to that of the extinct goat *Myotragus balaericus* of Mallorca, which also has extremely short broad metapodials, and evolved from goats with relatively longer distal limb elements.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Paleontological resource inventory strategies developed and implemented by the U.S. National Park Service

Santucci, Vincent, Tweet, Justin

Paleontology Program, National Park Service, Gettysburg, Pennsylvania, United States

The U.S. National Park Service (NPS) has developed and implemented several strategies to enhance the management and stewardship of non-renewable paleontological resources. The compilation of comprehensive baseline paleontological resource data is recognized as a fundamental best practice to help inform park managers about fossils and the considerations associated with their management. This perspective is reinforced within the Paleontological Resources Preservation Act (2009), which specifically mandates the use of inventory and monitoring of fossils by five federal agencies: the Bureau of Land Management, Bureau of Reclamation, U.S. Fish and Wildlife Service, National Park Service, and U.S. Forest Service. Through the design and coordination of paleontological resource inventories, the NPS has been able to better document the scope, significance, and distribution (both geospatially and temporally) of park fossils and to understand the management issues associated with these resources. These inventories have yielded new and important scientific and resource management information about the fossil record preserved throughout the parks, monuments, and other areas administered by the National Park Service. The NPS fossil record is documented in at least 286 different NPS areas and represents at least 1.4 billion years of Earth’s history. The rich and diverse paleontological resources of the NPS are available for scientific research and public education. Park fossils represent important, sometimes globally significant, and iconic components of the history of North American paleontology and America’s paleontological heritage. Our knowledge of the fossil record within the national parks continuously expands based on new paleontological discoveries every year gained through fossil inventories, scientific research and other management practices undertaken by NPS paleontologists and staff.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Ready-to-apply adhesive patches for efficient fossil preparation

Sato, Tetsuya

Division of Paleontology, American Museum of Natural History, New York, New York, United States

The preparation of pseudosuchian and dinosaur fossils from the Elliott Formation in South Africa poses a significant challenge, particularly in avoiding the continuous appearance of parallel breaks during matrix removal and handling. To address the issue, a method is proposed, involving ready-to-apply patches composed of solution adhesives and conservation-purpose tissues. Initially, the tissue is immersed in an adhesive solution and subsequently dried on a silicone-laminated Mylar film sheet. It is then cut according to size and shape to create a suitable patch. The application of the patch is simplified by either tapping it onto a designated area with brushes wet with acetone or by swiftly soaking it in acetone or ethanol before pasting. In this case, Tengujo, an extremely-thin acid-free kozo paper (5 grams per square meter), immersed in a solution of Paraloid B-72 at a concentration of 20% wt/vol in acetone, was primarily utilized. The patches are customized to different thicknesses and material compositions to meet specific fossil preparation needs. Fiberglass veils are used to replace kozo tissues for stiff joints, while Butvar B-76 replaces Paraloid B-72 for weaker bonds.

This approach simplifies decision-making and preparation processes, offering an efficient solution for joining and reinforcement. Additionally, the patches serve as pressure adhesives, securely holding pieces in place both temporarily and permanently. Not only does this method address current challenges in fossil preparation, but it also introduces a practical

approach to field excavation and paleontological conservation.

Technical Session 21: Cenozoic & Modern Herpetology (Saturday, November 2, 2024, 1:45 PM)

Paleopathologic examination of the eusuchian crocodyliforms *Borealosuchus formidabilis* and *Wannaganosuchus brachymanus*, as well as the choristodere *Champsosaurus gigas*, from the Paleocene Wannagan Creek Site in western North Dakota, USA

Schaberg, Mark, Hastings, Alex K., DeVault, Grace

Paleontology, Science Museum of Minnesota, Saint Paul, Minnesota, United States

The Wannagan Creek quarry, and surrounding area, produced an incredible quantity and diversity of fossil remains, including reptiles, amphibians, fish, mammals, birds, invertebrates, flora, and fungi. Of added significance is the superior lagerstätten-like preservation conditions, allowing one to discern taphonomic effects from pathologies incurred during an individual's lifetime. Over 100 individuals of the 14-foot-long crocodyliform *Borealosuchus formidabilis* lived in and around Fossil Lake Wannagan, along with approximately 20–30 individuals of the smaller *Champsosaurus gigas* and about 4 individuals of the much smaller *Wannaganosuchus brachymanus*; with *Champsosaurus* and *Wannaganosuchus* showing greater distribution outside the quarry than *Borealosuchus*. Gastralia, osteoderms, and limb bones from each of the 3 taxa were examined for abnormalities, and categorized into: periosteopathy (outer surface growth), osteomyelitis (infection including channels and drainage pores), fractures, and bitemarks. Osteoderm and limb elements were included if >50% of the bone was intact. Gastralia fragments longer

than 25mm were included (10mm for *Wannaganosuchus*).

Of 296 *Borealosuchus* gastralia examined, 62 abnormalities were present, including 53 healed fractures. An examination of 3,727 *Borealosuchus* osteoderms found 105 total abnormalities, including 51 bitemarks and fractures. Of 157 *Borealosuchus* limb bones, 20 showed abnormalities, including 4 fractures. Of 712 podials, 54 abnormalities were found, including 12 fractures. In *Wannaganosuchus*, 1 fractured gastralia and 1 podial with periosteopathy were present in 250 total samples. In 282 total samples of these elements in *Champsosaurus*, 6 gastralia abnormalities were found, including 1 healed fracture and 1 toothmark.

Given the high population density of *Borealosuchus*, and the high frequency of fractures and bitemarks in gastralia, limb bones, and osteoderms, relative to its reptilian neighbors, a likely cause for many of these injuries seems to be from other individuals of the species. Toothmarks preserved in *Borealosuchus* specimens were consistent with tooth morphology of this taxon. This examination supports the presence of social aggression in extinct crocodyliforms, especially for *Borealosuchus*, and suggests anatomical patterns of intraspecific injury.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Divergence of pneumatizing pulmonary tissues in five extant avian taxa: implications for reconstructions of respiratory biology across Ornithodira

Schachner, Emma R.¹, Martinez, Aracely⁴, Baumgart, Stephanie L.¹, Lawson, Adam B.², Diaz, Jr., Raul E.⁵, Skorka, Tautis⁶, Hedrick, Brandon P.⁷, Moore, Andrew³

¹Physiological Sciences, University of Florida, Gainesville, Florida, United States, ²Louisiana State University Health Sciences Center, New Orleans, Louisiana, United States, ³Tulane University, New Orleans, Louisiana, United States, ⁴California State University Los Angeles, Los Angeles, California, United States, ⁵University of Southern California, Los Angeles, California, United States, ⁶Cornell University, Ithaca, New York, United States, ⁷Stony Brook University, Stony Brook, New York, United States

Paleontologists have long been interested in reconstructing the anatomy and evolution of an ‘avian-style lung’ in the extinct ancestors of birds. Such reconstructions have relied on putatively universal ‘rules’ of skeletal pneumatization, whereby certain components of the avian pulmonary system invade the postcranial skeleton in invariant ways. However, the universality of these rules was recently challenged by the discovery of highly heterodox pneumatization patterns in the Common ostrich (*Struthio camelus*). To further explore pneumatization patterns, five species of phylogenetically disparate birds – the Common ostrich, Mallard, Red-tailed hawk, African grey parrot, and Zebra finch – were evaluated using micro-computed tomography (μCT) and 3D anatomical modeling to determine which specific pulmonary tissues were pneumatizing the adjacent skeletal structures. The birds were intubated, inflated, checked for disease/decay, and then regions where respiratory epithelia invade the skeleton were tracked using the MPR module of OsiriX for each taxon (n = 5). This method was then validated through the segmentation of 3D surface models of the lower respiratory system in Avizo for each species (n = 2). Contrary to published reports, all taxa (except for the entirely apneumatic Zebra finch) show strongly divergent pneumatization patterns. In hawks, the femora are pneumatized by the abdominal sac, while the pelvic and synsacral elements are pneumatized by

pelvic diverticula emerging from the gas-exchanging lung. In the ostriches, the pelvis and femora are pneumatized entirely by pelvic diverticula. The ducks mostly followed the previously established pattern, except that the synsacral region is pneumatized by lung-derived pelvic diverticula. The parrots are similar to ducks, albeit more pneumatized, and with contributions from the cranial thoracic sac to the ribs and supramedullary diverticula to thoracic vertebrae. Our analysis also demonstrates that the location of the pneumatic foramina varies both intra- and interspecifically.

Collectively, these data show that the specific pulmonary tissues pneumatizing different parts of the postcranial skeleton are far more variable than previously recognized. Our results challenge previous reconstructions of the respiratory system in extinct pterosaurs and non-avian dinosaurs that were based solely on which skeletal elements are pneumatized, and indicate that pulmonary reconstructions should be much more conservative.

Funding Sources This work was funded by a Jurassic Foundation grant to Aracely Martinez and a University of Florida Gatorade Allocation Award to Emma R. Schachner.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Integrating paleobiological insights to evaluate climate impacts on small mammal communities

Schap, Julia

Biological Sciences, Georgia Institute of Technology, Atlanta, Georgia, United States

Throughout the late Quaternary, ecosystems moved and reconfigured as glaciers retreated, climates changed, and humans expanded globally. Small mammals, here rodents and lagomorphs, are central to the

function of these ecosystems, with close associations with environmental conditions, yet their responses to climate change are understudied. My dissertation examines the effects of changing climate, particularly precipitation, on small mammal community composition and ecological function across spatiotemporal scales, exploring the interplay between modern and fossil communities. In North America and Africa, I have found that community-level hypsodonty, a measure of tooth-crown height, correlates to climate. I build a maximum likelihood model using modern community-averaged hypsodonty and annual precipitation for communities across Africa. Finding strong correlations, I then generate trait-based paleoprecipitation estimates for 26 fossil localities over 5.7 Ma in eastern Africa, creating some of the first quantitative estimates of paleoprecipitation for these important sites. Given this close association between functional traits and climate, I then evaluate small mammal functional traits at a single site, Natural Trap Cave (NTC; 23-2.5 ka), Wyoming, which contains a rich microvertebrate record. By aligning multiple paleoenvironmental proxies, including small mammal functional traits, pollen, carbon isotopes, and nearby lake-level data, I demonstrate shifts from wetter, more closed environments to drier, more open habitats. These paleoenvironmental shifts align with anticipated shifts in microvertebrate community evenness at NTC. Higher evenness during times of aridification allows more species, particularly rare species, to coexist during resource-poor conditions. Finally, I expand my study region and test the ecological hypotheses of whether competition or coexistence processes dominate small mammal communities when resources are sparse. Using 11 U.S. fossil sites, I evaluate how environmental change affects different diversity metrics across spatial scales. Competition is supported at the continental scale and coexistence at the biome scale when the habitat is more constrained. My

research highlights the strong relationship between ecological function, traits, and small mammal community composition and evaluates ecological hypotheses that will be crucial for predicting ecological responses to impending drought as changing climates progress.

Funding Sources NSF # 2124770, NSF-CAREER #1945013

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Using modern variation to inform species-level taxonomy of *Brachycrus* (Family Merycoidodontidae)

Scharpf, Jessica L.¹, Wetherell, Meaghan²

¹Geology, Central Washington University, Ellensburg, Washington, United States, ²School of Information, University of Arizona, Tucson, Arizona, United States

In order for two or more fossils to be considered different species, they should display differences on par with the skeletal differences found in modern animals.

Understanding the variation in modern animals is an important step for rejecting the null hypothesis of a single species. We used cranial measurements of *Camelus*, *Madoqua*, and *Tapirus* to establish the level of variation expected in a single and multiple-species samples, then compared this to the variation found in 57 skulls of *Brachycrus*. These skulls represented eight different species from six different states.

We used coefficients of variation (CVs) to establish modern parameters for cranial variation. Multiple characteristics like the length of the nasals, premolar tooth rows, malar bones, width of the orbit, and breadth of the zygomatic arches had high intraspecific variation (>20%) in several of our modern animals. When treated as a single-species group, our sample of *Brachycrus* fell lower

than 20% for most characteristics. However, the nasal bone lengths for *Brachycrus* had a coefficient of variation of 31%. This was substantially larger than the percentage found in camels (24.1% for *C. dromedarius* and 20% for *C. bactrianus*). However, we found similarly high measurements in *T. terrestris* (36.5%) and *Madoqua kirkii* (35.8%), two modern species that also exhibit nasal retraction. Our sample sizes of *T. terrestris* and *M. kirkii* are quite small and contains juveniles, which may be inflating the modern coefficients of variation excessively.

We conducted a multivariate and several univariate finite mixture analyses on both our modern and fossil samples. No univariate or multivariate combination of characteristics was statistically significant for *Brachycrus* ($p > 0.05$), suggesting no evidence for more than one group. Univariate finite mixture analyses rejected a null hypothesis of a single species of *Camelus* for multiple characters. However, a multivariate mixture analysis found no evidence for more than one species of camel, suggesting this may be too conservative of a test.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Use of musculoskeletal models to estimate optimal postures and potential functions of tyrannosaur forelimbs

Schirrmacher, Kurt W.¹, Scotti, Alexandria^{2,1}, Makovicky, Peter⁴, Hutchinson, John R.³, Yao, Xi⁵, Xu, Xing^{6,5}, Burch, Sara H.¹

¹Biology, SUNY Geneseo, Geneseo, New York, United States, ²Anatomical Sciences, University at Buffalo, Buffalo, New York, United States, ³Department of Earth and Environmental Sciences, University of Minnesota, Minneapolis, Minnesota, United States, ⁴Royal Veterinary College, Hatfield, United Kingdom, ⁵Yunnan University, Kunming, China, ⁶Institute of Vertebrate

Paleontology and Paleoanthropology, Beijing, China

The potential function of the unique reduced forelimbs of *Tyrannosaurus rex* has generated much discussion, but few concrete answers have been established. By using three-dimensional (3D) musculoskeletal models, we can estimate muscle moment arms to better understand the most optimal forelimb postures in this taxon in terms of muscle leverage. In this study, we obtained CT scans of the pectoral girdle and forelimb of *Tyrannosaurus* and created a 3D musculoskeletal model following standard procedures. Individual elements were rearticulated, joint axes were defined, and muscle lines of action were reconstructed. Muscle moment arms were automatically calculated by the modeling software for each muscle and joint (shoulder, elbow, wrist, and first digit) across a range of potential positions, then summed, normalized, and graphed, allowing identification of primary function around a joint, how this function changes with position, and the position with the greatest moment arm. The summed moment arms in the *Tyrannosaurus* shoulder were overall positive, indicating an emphasis on protraction, elevation, and internal rotation, and the joint was most effective when held in a highly protracted and elevated position. At the elbow, flexion and pronation were emphasized, and the joint would have been most effective when flexed and pronated. We then repeated the entire process for *Guanlong wucaii*, a Late Jurassic tyrannosauroid. Unlike *Tyrannosaurus*, it had long, gracile forelimbs, a stark contrast that points to functional differences and evolutionary change. The *Guanlong* shoulder showed largely opposite trends from the *Tyrannosaurus* shoulder, and was most effective when held in a depressed and retracted position. However, the patterns of the summed moment arms at the elbow were more similar between the two taxa. Different shoulder functions and maximal leverage at

different positions suggests that tyrannosauroid forelimbs did undergo changes in function as the clade evolved. The patterns are consistent with the inference that *Tyrannosaurus* may have used its forelimb to grasp and stabilize prey, while *Guanlong* used its forelimb to slash at prey. These musculoskeletal models will also allow further investigation of shifts in individual muscle function, as well as serve as a reference for future studies of the function and evolution of forelimbs in Tyrannosauroidea.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Multi-level paleontology outreach:
Instilling the value of science outreach at
the undergraduate level**

Schmeisser McKean, Rebecca

Earth Science, St. Norbert College, De Pere,
Wisconsin, United States

The benefits of science outreach are extensive, including increasing trust in science, increasing enthusiasm for science, making science more accessible to underrepresented groups, and changing perceptions of who scientists are and what they look like. Vertebrate paleontology is an outstanding topic for science outreach, often seen as a “gateway science” for young kids. However, outreach is often undervalued in career paths and is rarely taught as a skill for young scientists at the undergraduate level. The Earth Science discipline at St. Norbert College, a liberal-arts institution in Wisconsin, placed outreach as a top goal in its most recent assessment plan. The course designated for teaching that skill is Introduction to Paleontology, an upper-level course for earth science majors. In the final project for the course, students are asked to design, implement, and assess an outreach project. The assignment is scaffolded,

beginning with a class discussion on the types, benefits, and challenges of outreach followed by clearly outlined assignments. Students are graded on scientific accuracy, engagement with their audience, delivery of information, length and reach of the project. This past fall, a local elementary school brought 48 fourth graders on a field trip to campus to participate in paleontology activities designed by students in the class. Students designed activities around fourth-grade earth science benchmarks provided by the teachers. Following the event, the effectiveness of the multi-level outreach (undergraduates teaching elementary students) was evaluated through student grades using a rubric as well as qualitative surveys of the undergraduates and the fourth-grade teachers. While all the undergraduates stated they were very or extremely interested in science outreach, only 33% had done outreach previously. All the undergraduates marked that they were more or much more interested in doing outreach as part of job responsibilities in a future career after completing the outreach project. Both teachers surveyed felt the field trip helped fill a gap in their earth science curriculum, and that their students were engaged and learning during the activities. The teachers also noted that the fourth graders were more enthusiastic about geology and paleontology after the field trip. This project highlights the value of teaching scientific outreach skills using paleontology to an undergraduate audience while benefiting local elementary school-age kids.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Feeding without jaws: diversity of heterostracan oral structures

Schnetz, Lisa¹, Lanzetti, Agnese^{2,1}, Dearden, Richard^{3,1}, Jones, Andrew S.¹, Giles, Sam^{1,2},

Johanson, Zerina², Lautenschlager, Stephan¹, Randle, Emma¹, Sansom, Ivan J.¹

¹Earth Sciences, University of Birmingham, Birmingham, United Kingdom, ²Natural History Museum, London, United Kingdom, ³Naturalis Biodiversity Center, Leiden, Netherlands

The dominance of vertebrates in past and present ecosystems has long been attributed to the evolution of jaws and resulting re-engineering of the head to support feeding and ventilation. In contrast, the extant jawless vertebrates, represented by parasitic lampreys and scavenging hagfish (the cyclostomes), comprise a minuscule proportion of vertebrate diversity. Assumed to be 'primitive', jawless vertebrates had a much greater significance prior to the end-Devonian when a broad array of jawless taxa, generally referred to as the ostracoderms, were highly successful and co-existed with jawed vertebrates for over 100 million years. They are known from a wide range of body types and diversified into a range of marine and fluvial environments. The reasons for their initial success are poorly understood: the temporal and phylogenetic distance between the ostracoderms and the extant cyclostomes makes comparisons of feeding mechanisms problematic. Here, we present an ongoing study exploring the diverse array of feeding structures in pteraspid and cyathaspid heterostracans (one of the most diverse and abundant ostracoderm groups) using computed tomography imaging and 3D visualisation methods. In this, we reveal several hitherto undescribed features of the heterostracan oral region, which, together with previously published work, provide insight and constraints on the functional models for these feeding apparatuses. We show that the 'classic' pteraspid oral apparatus presents a consistent morphology of hooked plates, which showed very limited plate movement. In contrast, we find a wider range of plate morphologies in the cyathaspid specimens, which lack any obvious

homologies to the pteraspid plates. Re-examination of the earliest-known articulated heterostracan *Athenaegis* from the Silurian, previously thought to be pteraspid-like, reveals an oral morphology lacking the hooks and posterior sulcus seen in pteraspids, suggesting a more limited plate movement. Across the range of taxa studied, movement of the oral plates and hence opening of the mouth appears to have been limited, moderating the oral gape. This finding rules out a number of feeding scenarios, most notably a pseudo-bite function, and lends support to previous interpretations that at least some heterostracans were predominately suspension feeders.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

The ^{13}C isotope record of 30 million years of mosasaur evolution

Schulp, Anne S.^{1,2}, Polcyn, Michael^{3,2}, Robbins, John³, Jacobs, Louis³

¹Naturalis Biodiversity Center, Leiden, Netherlands, ²Geosciences, Utrecht University, Utrecht, Netherlands, ³Southern Methodist University, Dallas, Texas, United States

In the final c. 30 million years of the Cretaceous, mosasaurs evolved to occupy a wide range of niches in the world's marine ecosystems. Various avenues of research have been employed to infer the feeding ecologies of these successful marine lizards. Lines of evidence include tooth morphology, dental microwear, biomechanical considerations, gut content and evidence from damage to prey items. In recent years, ^{13}C values of mosasaur tooth enamel from various Cretaceous ecosystems have been evaluated to add another independent line of evidence towards our understanding of mosasaur feeding adaptations as well as

their foraging area along the nearshore-offshore gradient.

Differentiation of body size and tooth morphology are good indicators of segregation by prey preferences, but do not reflect foraging area preferences. The timing and direction of morphological changes seen in the evolution of mosasaurs, leads us to hypothesize there will be accompanying shifts in foraging area reflected in the ^{13}C signature preserved in tooth enamel. To test that hypothesis, we compiled a comprehensive geographic, temporal and body-size coverage of the mosasaur ^{13}C record. Our data set now spans 93-66 Ma, covers body sizes from diminutive meter-long mosasaurs through taxa exceeding 15 m in length, and explores a full range of dental morphologies.

Mososaurine taxa are found to occupy a broader range of foraging areas versus most tylosaurines, pliolatecarpines, and halisaurines, which is consistent with the diversity of tooth morphologies seen in that clade. Tylosaurines exhibit range expansion correlated with increase in body size and robustness of their feeding apparatus, and the largest tylosaurines are replaced in the most offshore foraging area by *Mosasaurus*, with which it shares large body size and similar dentition. Moderately sized pliolatecarpin pliolatecarpines occupy a relatively narrow foraging area for their existence, while *Ectenosaurus* and selmasaurin pliolatecarpines exhibit a variety of foraging areas, reflecting disparity in their feeding morphology. Simultaneous niche and foraging area occupation by multiple taxa suggest factors of prey acquisition beyond size and dental apparatus allowed finer partitioning of resources.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Isotope-based assessment of trophic relationships amongst Early Permian vertebrate fauna from Baylor County, Texas

Schulte, Cody^{1,2}, Tabor, Neil J.¹, Flis, Chris²

¹Department of Geology, Southern Methodist University, Dallas, Texas, United States, ²Whiteside Museum of Natural History, Seymour, Texas, United States

The Texas redbeds, famous for their Early Permian vertebrate fossil assemblages, are located in Baylor County as part of the Midland Basin. At the time of deposition, the Clear Fork Group was located along the western equatorial Pangea, characterized by warm and increasingly arid climate. The fossils, notably teeth, within the Clear Fork Group include the extinct reptilian group called the pelycosaurs (*Dimetrodon*, *Diadectes*, and *Secodontosaurus*). The trophic relationships amongst these extinct Permian taxa has yet to be characterized, particularly in terms of stable carbon isotopic signals between carnivores (i.e. *Dimetrodon* and *Secodontosaurus*) and the earliest true herbivores (i.e. *Diadectes*). Tooth enamel is an ideal source of paleoecological information in this context, due to its stability, high density, and relative resilience to diagenetic overprinting when compared to other fossil elements such as dentin or bone. This study's objective will be to evaluate the trophic relationships of *Dimetrodon* ($n = 15$), *Diadectes* ($n = 11$), and *Secodontosaurus* ($n = 13$) within the Clear Fork Group by analyzing stable carbon isotope differences across these taxa derived from the teeth enamel bioapatite. Analytical methods include petrographic characterization of representative examples from each taxa a minimum of two analyses of fossil tooth powder each fossil element. Amongst herbivores (denoted as prey), $\delta^{13}\text{C}$ values gathered from tooth enamel bioapatite align with the $\delta^{13}\text{C}$ values observed in plant material targeted for foraging, with isotopic enrichment related to vertebrate enrichment.

In contrast, $\delta^{13}\text{C}$ values from carnivore tooth enamel bioapatite likely reflect trophic enrichment observed today in between prey-predator compositions. This work will help to interrogate the antiquity of typical modern prey-predator relationships.

Funding Sources Funding for this work was received from the Institute for the Study of Earth and Man.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Dental microwear texture analysis suggests differing responses to Paleocene-Eocene Thermal Maximum in phylogenetically dwarf basal ungulates

Schwartz, Andrew F.¹, DeSantis, Larisa²

¹Anthropology, Rutgers The State University of New Jersey, New Brunswick, New Jersey, United States, ²Department of Biological Sciences, Vanderbilt University, Nashville, Tennessee, United States

The Paleocene-Eocene Thermal Maximum (PETM) is a geologically recent period of rapid-onset climate change that occurred 56 million years ago, with elevated global temperatures of 5-8 degrees Celsius lasting nearly 200,000 years. Increased aridity and seasonality shifted flora and fauna in places such as western North America. Closed mesophytic forests became drier and more open, dominated by thermophilic flora, particularly of the family Fabaceae. Notably, numerous mammal species exhibit body mass reduction in correlation with the increased temperatures of the PETM, a potential example of Bergman's rule. This is quite evident in the native phenacodontid *Ectocion*, as well as the immigrant basal perissodactyl *Sifrhippus*. Despite these well-established body mass trends, dietary change across the PETM has received little attention. Experiments have shown that many

plants become less nutritious and provide lesser yields when grown under supra-optimal conditions. We investigated dietary trends within *Ectocion* and *Sifrhippus* from the latest Paleocene to the early Eocene through dental microwear texture analysis. Dental microwear suggests a browsing/frugivore lifestyle for both taxa. While *Ectocion* exhibits significantly higher complexity during the PETM compared to the latest Clarkforkian, we recover no significant differences in *Sifrhippus* between the PETM and the early Wasatchian. Additionally, we recover no significant trends across the PETM for *Sifrhippus*, despite a well-established trend of body mass reduction through the duration of the event. These results suggest two distinct dietary trends across the PETM: 1) Body mass reduction in *Ectocion* coincided with increased consumption of hard object (seeds/nuts); 2) *Sifrhippus* body mass change not coupled with any significant dietary shift. This implies divergent responses to the PETM between immigrant and native taxa. While Bergman's rule is likely partially responsible for body mass reduction in *Ectocion*, increased reliance on hard plant objects that became less abundant and nutritious may have selected for reduced mature body size. Immigrant taxa such as *Sifrhippus* did not undergo dietary change in response to environmental change, suggesting increased temperature as the most likely cause of body mass reduction. These results are important towards understanding how mammals adapt to global warming, helping us predict mammalian response to modern climate change.

Funding Sources Funding for this work was provided by the Albert Fellows award from the Center for Human Evolutionary Studies at Rutgers University.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Cretaceous combat: Identifying trends in mosasaur cranial injury pathologies

Scott, Maximilian J.¹, Brink, Kirstin^{1,3}, Brown, Caleb M.^{2,1}

¹Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba, Canada, ²Canadian Fossil Discovery Centre, Morden, Manitoba, Canada, ³Royal Tyrrell Museum of Paleontology, Drumheller, Alberta, Canada

Mosasaurids, marine reptiles that inhabited Late Cretaceous oceans, are thought to have engaged in intraspecific combat due to the presence of healed bite marks on their skulls. Evidence for combat has been reported sporadically in the literature, however, no study has summarized the frequency of occurrences, trends, or types of evidence preserved in the fossil record. Therefore, it is difficult to determine the causes of these bite marks, particularly whether they are due to intraspecific aggression (possibly sexual selection), or interspecific aggression due to other types of competition. To address this, we performed a survey of the literature to compile all documented instances of facial bite marks in mosasaurs.

The dataset of 18 published specimens contains information on species occurrences, size (likely correlating to age) of specimens, stratigraphic occurrence, location(s) of bite marks on the skull, and the degree of healing. Across these 18 published specimens, a total of 64 healed marks and 18 unhealed marks are reported. Results show that, taxonomically, attacks on the face are significantly most common in Mosasaurinae, followed in succession by Tylosaurinae, Plioplatecarpinae, and Halisaurinae, with no published occurrences in the Tethysaurinae or Yaguarasaurinae. There is a strong bias in favor of bites on the anterior bones of the skull, as well as dorsally on the frontal and premaxilla. The bite marks are oriented sagittally on the maxillae, surangulars,

prefrontals, and dentaries, and transversely on the frontal and premaxilla. While skull material in these publications is equal between the left and right sides of the skull, there is a slight bias in favor of healed marks on the right-lateral faces of the skulls as opposed to the left.

The pattern of distribution and orientation of observed markings by other mosasaurs suggests a preference for attack from the anterior and lateral sides of the head, especially to the right. Bite marks that do not show any healing are interpreted as dubious, as these may also be due to feeding traces that formed post-mortem during scavenging. This study shows that trends in mosasaur pathologies are quantifiable and interpretable, and that some published interpretations of mosasaur-on-mosasaur violence may need further justification and reassessment. This leads to establishing an improved standard in what researchers confidently identify as an injury pathology.

Funding Sources Dr. Malcolm Heaton
Student Research Program

University of Manitoba

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Paleoenvironments across the onset of the Early Eocene Climatic Optimum in the Wind River and Bighorn basins, Wyoming, USA – inferences from stable carbon isotopes in fossil mammals

Secord, Ross^{1,2}, Chew, Amy E.³, Gilbert, Christopher C.^{4,6}, Chester, Stephen G.^{5,6}, Rose, Kenneth D.⁷

¹Earth & Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, Nebraska, United States, ²Division of Vertebrate Paleontology, University of Nebraska State Museum, Lincoln, Nebraska, United States, ³Warren Alpert Medical School, Brown University,

Providence, Rhode Island, United States, ⁴Department of Anthropology, Hunter College, New York, New York, United States, ⁵PhD Programs in Anthropology and Biology, City University of New York, New York, New York, United States, ⁶Department of Anthropology, Brooklyn College, Brooklyn, New York, United States, ⁷Center for Functional Anatomy & Evolution, Johns Hopkins University School of Medicine, Baltimore, Maryland, United States

We investigate environmental change across the onset of the Early Eocene Climatic Optimum (EECO) in two Wyoming basins. The EECO saw the warmest temperatures of the Cenozoic when paratropical climate prevailed at mid-latitudes. In the Rocky Mountains, mammalian species richness peaked at this time. A diversity of arboreal mammals indicates the common presence of trees but whether these were dry open forests, humid closed forests, or something in between, remains unresolved. Here we use stable carbon isotopes in mammalian tooth enamel to infer forest structure across the onset of the EECO in the Wind River (WRB) and Bighorn (BHB) basins.

Paleobotanical records indicate an increase of ~5° C from Wasatchian biozone Wa-6 to Wa-7, marking the onset of the EECO. We use a carbon isotope model to predict mean enamel $\delta^{13}\text{C}$ values for early Eocene environments based on isotopes in modern C_3 plants. The model adjusts for diet-to-enamel enrichment, latitude, altitude, and temporal changes in atmospheric $\delta^{13}\text{C}$ values.

In all biozones in both basins, semi-aquatic *Coryphodon* (Pantodonta) has the most negative mean $\delta^{13}\text{C}$ values while mean equid values are consistently higher, indicating the preservation of primary $\delta^{13}\text{C}$ enamel values. In both basins, results indicate that pre-EECO (Wa-6) mean $\delta^{13}\text{C}$ faunal values are consistent with open forests, such as the deciduous forests of western Madagascar. In

the BHB, mean values increase by 1.0‰ in the EECO (Wa-7), indicating a shift to drier, more open habitats. In contrast, mean values in the WRB do not significantly change in the EECO. However, in the WRB all mean values are consistently higher, indicating drier, more open habitats than in the BHB, equivalent to the driest parts of Madagascar's deciduous forests. In Wa-6 and Wa-7 of the WRB, mean faunal values are 2.6‰ and 1.8‰ higher, respectively, than in the BHB. Previous regional work found an increase in arboreal taxa in Wa-7 and our preliminary analyses in both basins support that finding. Although one may expect a loss of arboreal taxa as forests opened in the BHB, many arboreal taxa appear to have been adapted to open habitats before the EECO, as evidenced by high $\delta^{13}\text{C}$ values in the WRB. This study shows that the environmental response to EECO warming varied considerably, even in adjacent depositional basins, and it demonstrates the importance of comparing records from different areas.

Funding Sources Funding was provided by NSF grants EAR 2124939 (RS), 2124757 (AEC), 2124864 (CCG), and 2124926 (SC).

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Expanding comparative collections at The Mammoth Site of Hot Springs, SD: overcoming constraints and constructing a comparative skeletal framework for use in vertebrate paleontology

Self, Alanna G., Berenyi-Tonesi, Ariel C.

Research, The Mammoth Site of Hot Springs,
SD, Hot Springs, South Dakota, United States

Comparative collections in vertebrate paleontology are essential for museums that engage in active paleontological research. These collections, composed of skeletal material from modern vertebrates, provide a

way to extrapolate the functional traits and taxonomic markers from fossil material through comparisons with modern analogs. In some cases, this may be the only way to interpret skeletal elements retrieved from the fossil record. However, the cost and spatial requirements of establishing modern, skeletal, specimen collections may prove problematic to institutions with limited space and budgets. The Mammoth Site (TMS) of Hot Springs, South Dakota, is a mid-sized regional paleontological research museum whose mission is to study, curate, and exhibit Pleistocene paleontological resources for the public good. In late 2022, TMS established a skeletonization laboratory to expand its modern skeletal comparative collections. This came with two significant challenges: a limited working space of 120 square feet and a limited, initial budget of \$800 USD. By using maceration as the preferred skeletonization method, and by recycling glass jars provided by museum staff, TMS was able to reduce recurring costs such that the project budget was almost entirely devoted to purchasing safety and documentation equipment. Furthermore, by reclaiming shelving not suitable for collections spaces, TMS staff increased the available working space in the laboratory. In the summer of 2023, the TMS skeletonization lab was first utilized for full-time skeleton production. Full-time laboratory operations introduced new challenges to be addressed, including how to process partially skeletonized and mummified specimens, pest management in the lab space, and the establishment of a data documentation workflow in preparation for a new collections database. Standardization of specimen data formatting for binomials, notes, biometrics, and specimen photographs ensures that data collected during laboratory operation can be readily integrated into the new database. The creation of the lab provided additional intern learning opportunities and led to a significant increase in comparative specimens. In 12 weeks, we documented and macerated 448

specimens and completed skeletonization for 127.

Funding Sources Funding for this project was provided by The Mammoth Site of Hot Springs, South Dakota, Inc.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Scimitar-crested species of *Spinosaurus* discovered in riparian habitat in Niger (Farak Formation, Cenomanian)

Sereno, Paul C.¹, Vidal, Daniel^{1,2}, Myhrvold, Nathan P.³, Ciudad Real Ballester, María⁴, Saitta, Evan T.⁵, Fontela, Noelia S.⁹, Johnson-Ransom, Evan D.⁵, Baumgart, Stephanie L.⁶, Gascó Lluna, Francesc^{7,8}, Simarro Cano, Álvaro²

¹Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States, ²Grupo de Biología Evolutiva, UNED, Madrid, Spain, ³Intellectual Ventures, Bellevue, Washington, United States, ⁴Universidad Nacional de Educación a Distancia (UNED), València, Valencia, Spain, ⁵Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States, ⁶Independent Researcher, Madrid, Spain, ⁷Department of Physiological Sciences, University of Florida, Gainesville, Florida, United States, ⁸Facultad de Humanidades y Ciencias Sociales, Universidad Internacional Isabel I de Castilla, Burgos, Spain, ⁹Museo de Benagéber, Benagéber, Spain

Partial remains of a new species of *Spinosaurus* were discovered in fluvial deposits in the Farak Formation (Cenomanian; central Niger). The skull is similar to *S. aegyptiacus* in size and bears a similar dentition of subconical, interdigitating teeth, terminating anteriorly in a rosette. The snout is proportionately lower and longer with greater separation between the same number

of maxillary and dentary teeth. A dramatic difference between these species, however, is the form of the median nasal crest. In the new species, it rises posterodorsally as a solid, scimitar-shaped process. In lateral view, the crest equals in height the depth of the cranium below it. Postcranial bones indicate the presence of a stout dorsal sail, although its contour and height remain unknown. Portions of the femur and a complete tibia suggest that this species may have had somewhat longer hind limbs than in *S. aegyptiacus*.

The morphology of the crest and the variation in its proportions among three individuals from the same locality resemble variation in the casques in modern birds (e.g., helmeted guineafowl). Striations on the surface of the crest and internal vascular canals suggest that the crest was extended by a keratinous casque, which may have added significantly to its height in life. Evidence for an ornamental crest in the new species adds to evidence that the sails over the torso and tail in *Spinosaurus* and other spinosaurids functioned in sociosexual display, rather than as fins or paddles for underwater locomotion.

Multiple specimens of the new *Spinosaurus* species were found at a single fossiliferous locality in close association with a partial skull of the large-bodied predator *Carcharodontosaurus* and partial skeletons of new titanosaurian and rebbachisaurid sauropods. The fluvial sediments at the locality and in local section clearly show that the new spinosaurine flourished in an inland riparian habitat distant from any maritime coastline. The coterie of large-bodied predators and herbivores that characterizes Cretaceous-age terrestrial faunas on Africa undermines the proposition that *Spinosaurus* was an aquatic, diving pursuit predator. The new species also adds to growing evidence of latitudinal faunal differentiation on Africa during the Cenomanian. Shared genera in faunas from the northern coast of Africa (Morocco to Egypt) and those to the south in

the continental interior (Niger) differ at the species level.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Skull morphology and histology indicate the presence of an unexpected buccal soft tissue structure in dinosaurs

Sharpe, Henry S.¹, Wang, Yan-yin¹, Dudgeon, Thomas^{3,4}, Powers, Mark J.¹, Whitebone, Amber², Coppock, Colton¹, Dyer, Aaron D.^{3,4}, Sullivan, Corwin¹

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada, ³Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada, ⁴Palaeoscience Research Centre, University of New England, Armidale, New South Wales, Australia

Unlike mammals, reptiles typically lack large muscles and ligaments that connect the zygoma and mandible. Dinosaur craniomandibular soft tissue reconstructions, often based on the rationale of Extant Phylogenetic Bracketing, follow this general rule. However, descending flanges from the zygomata of hadrosaurs, heterodontosaurids, and psittacosaurids have been used to argue for a masseter-like muscle in these dinosaur taxa. We examined dinosauriform skulls for osteological indicators of connective tissue entheses on the zygoma and mandible, and subsequently sectioned 9 specimens for histological evidence. Osteological indicators were found on the zygoma in most sampled dinosauriforms, which ranged from rugosities to large descending processes, and morphologically resemble known muscular and ligamentous entheses. Similarly, rugose features oriented towards the zygoma were found on the mandible of sampled

dinosauriforms, many of which have previously been interpreted as entheses for the adductor mandibulae muscle group. Serial histological sectioning of ceratopsid, hadrosaurid, and tyrannosaurid jugal and surangular rugosities reveals an external cortex rich in collagen fibres, strongly resembling enthesal fibres. Jugal enthesal fibres are usually oriented ventrally towards the surangular, which in hadrosaurids and tyrannosaurids are macroscopically parallel to striations on the surfaces of the jugal flange. Histological sections of extant chicken buccal regions show similar enthesal fibres in insertions of the jugomandibular ligament on the jugal, and the adductor musculature on the mandible. We hypothesize a strong connective tissue bridging the zygoma and mandible in dinosaurs. This structure's size and proximity to the craniomandibular joint would be advantageous in stabilizing the mandible relative to the cranium during jaw movement, particularly in dinosaurs thought to masticate. A ligamentous or muscular identity for this tissue cannot be determined with the available data, but the size and shape of the zygomatic entheses in many dinosauriforms are more consistent with a muscular attachment. Possible antecedents in non-dinosauriform archosaurs and derivations in modern birds may exist, but the homology of this tissue is currently unknown. These results highlight the complex soft tissue evolution of dinosauriforms, and caution against simplified phylogenetic model-based approaches to tissue reconstruction that ignore contrasting osteological signals.

Funding Sources National Science and Engineering Research Council of Canada

Technical Session 14: Paleobiology: Evolution, Ecosystems, Taphonomy, & Traces (Friday, November 1, 2024, 1:45 PM)

Relative abundance of macrovertebrates from the early Danian of Colorado shows evidence for niche partitioning just after the end-Cretaceous mass extinction

Sherman, Sadie M., Petermann, Holger, Lyson, Tyler

Earth Sciences, Denver Museum of Nature and Science, Aurora, Colorado, United States

The Corral Bluffs study area east of Colorado Springs, CO, USA contains a diverse macrovertebrate fauna of mammals, crocodilians, turtles, and fish in the D1 sequence of the Denver Formation that records the first ~1 million years after the end-Cretaceous mass extinction. The quantity of post-extinction macrovertebrates, ~150 turtles, ~120 mammals, ~70 crocodilians, 7 fish, and 3 champsosaurs, preserved at Corral Bluffs presents a unique opportunity to determine relative abundance and associated depositional environments of large-bodied taxa (>10kg) from a single study area. We used the total sample of fossils from the North American Land Mammal 'age' ranges Puercan I through III from Corral Bluffs, and their inferred depositional environment to calculate relative abundance and associated depositional environments. Of identifiable macrovertebrate taxa, most abundant are the periptychid mammals *Carsioptychus coarctatus* and *Ectoconus ditrigonus* and the multituberculate mammal *Taeniolabis taoensis*, the turtles *Hoplochelys clarki*, *Axestemys infernalis*, and *Compsemys victa*, and the crocodilian *Wannaganosuchus* sp. *Carsioptychus* is the most abundant taxon by total number of elements found. *Hoplochelys* and *Axestemys* are the most common turtles in the field area. We also identified depositional environments of each of those taxa: 1) overbank/floodplain; 2) river channel; 3) ponded water. *Carsioptychus* is most commonly found in overbank/floodplain environments, whereas the turtles *Axestemys* and *Compsemys* and the multituberculate mammal *Taeniolabis* are better represented

in river channel environments. Within ponded water facies, *Hoplochelys* and *Axestemys* are the most common taxa. Relative abundance of these early Paleocene large-bodied taxa within depositional environments suggests turtles are partly separated into two distinct niches – *Compsemys* and baenid turtles dominate riverine environments and *Hoplochelys* and plastronid soft-shelled turtles are preferentially found in ponded-water environments. The much larger soft-shelled trionychid turtle *Axestemys* appears to occupy both niches equally. The crocodilian *Wannaganosuchus* is most common in overbank/floodplains and river channels. Application of this principal also suggests that large-bodied mammals avoided inter-specific competition for resources through niche partitioning: *Taeniolabis* is preferentially found in riverbanks whereas the periptychids *Carsioptychus* and *Ectoconus* are found within floodplains.

Funding Sources Lyda Hill Philanthropies
National Science Foundation (NSF-FRES-2317666)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

How large was the Neogene megatooth shark, *Otodus megalodon* (Lamniformes: Otodontidae)?

Shimada, Kenshu¹, Wood, Jake J.², Sternes, Phillip C.³, Siverson, Mikael⁴

¹Department of Environmental Science and Studies & Department of Biological Sciences, DePaul University, Chicago, Illinois, United States, ²Department of Biological Sciences, Florida Atlantic University, Boca Raton, Florida, United States, ³Department of Evolution, Ecology, and Organismal Biology, University of California at Riverside, Riverside, California, United States, ⁴Department of Earth & Planetary Sciences, Western

Australian Museum, Welshpool, Western Australia, Australia

Otodus megalodon (Lamniformes: Otodontidae) is an iconic late Neogene shark. Because no complete skeleton of the species is known to date, its total length (TL) has traditionally been estimated based on comparisons with the teeth or vertebrae of the extant white shark, *Carcharodon carcharias*. Recently, previous TL estimates based on *C. carcharias* have been called into question by recognizing that the length of an incomplete vertebral column of *O. megalodon* from the Miocene of Belgium (IRSNB P 9893: Royal Belgian Institute of Natural Sciences, Brussels) measures about 11.1 m without the neurocranium or caudal fin, which is considerably greater than the previous TL estimate made for the individual based on *C. carcharias*. However, no further TL assessment of *O. megalodon* has been made since then. To determine the TL of *O. megalodon* based on IRSNB P 9893, we surveyed the proportional relationships of the neurocranial length and caudal fin length compared to the trunk length (= precaudal vertebral column length) across diverse extinct and extant neoselachian sharks comprising ten orders, 45 families, 119 genera, and 164 species. Whereas the median neurocranial length and caudal fin length are, respectively, 18.3% and 33.5% of the trunk length for all examined 164 species combined, they are 16.6% and 41.8%, respectively, in Lamniformes comprising four extinct genera and all 15 extant species in the dataset. If goblin sharks (mitsukurinids) and thresher sharks (alopiiids) with a uniquely elongated neurocranium or caudal fin are excluded from the dataset of Lamniformes, those percentages are 16.6% and 32.6%, respectively. Because IRSNB P 9893 is considered to include a few caudal vertebrae and to have likely gently arched in life, we tentatively considered the vertebral column length consisting only of trunk vertebrae to be about 11 m. If the percentages attained from

the ‘non-mitsukurinid/non-alopiid lamniforms’ are used to calculate the possible neurocranial length and caudal fin length for IRSNB P 9893, they would have been 1.8 m and 3.6 m, respectively, making the *O. megalodon* individual to have measured about 16.4 m TL. Whereas the largest vertebral centrum in IRSNB P 9893 measures 15.5 cm in diameter, the largest known putative vertebra of *O. megalodon* ever reported is photographic evidence from the Miocene of Denmark measuring about 23 cm in diameter. If the evidence is taken at face value, that *O. megalodon* individual would have measured around 24 m TL.

Colbert Prize Session

Insights into the diversification dynamics of Mesozoic dinosaurs

Shimizu, Shuhei¹, Kobayashi, Yoshitsugu²

¹Department of science, Hokkaido University, Sapporo, Hokkaido, Japan, ²Museum, Hokkaido University, Sapporo, Hokkaido, Japan

The mass extinction event at the K/Pg boundary is one of the most catastrophic events in Earth’s history. There have been ongoing debates about whether the high diversity of non-avian dinosaurs persisted until the mass extinction or experienced a gradual decline. Additionally, the question of which factors influenced diversification dynamics and how these dynamics varied among different dinosaur clades remains unresolved. Although fossil records provide direct evidence of paleodiversity, they are far from complete. Moreover, species share an evolutionary history and cannot be treated as independent data points. Therefore, phylogenetic comparative methods that control the phylogenetic relationship and uncertainties in fossil data are indispensable.

In this study, a Bayesian model-averaging approach was performed based on the fossilized-birth-death process. Our results show upward trajectories in the speciation and extinction rates of all dinosaur clades toward the K/Pg boundary. However, the increase in extinction rate surpassed that of the speciation rate, resulting in a decline in the diversification rate. Ornithischians show similar trends to dinosaurs as a whole, whereas sauropodomorphs and theropods display increasing net diversification rates. Ceratopsians and hadrosauroids emerged with higher speciation rates compared to other clades. Hadrosauroids have high extinction rates, contributing to a negative shift in net diversification rates. In contrast, ceratopsians maintained high net diversification rates until the mass extinction event. These results imply that the attenuation of the net diversification rates of dominant mega-herbivores, exemplified by hadrosauroids, weakened the dinosaur ecosystem.

Furthermore, our study extended to a time-series analysis to test the correlation between non-avian dinosaur speciation rates and three environmental proxies: pCO_2 , $\delta^{18}O$, and sea levels. Our result revealed an association between dinosaur speciation rates and sea level fluctuations, suggesting active speciation during periods of high sea level. In contrast, fluctuations in pCO_2 and $\delta^{18}O$ did not explain speciation fluctuations. These suggest that dinosaur speciation may have been a passive phenomenon, influenced by the emergence of new ecological niches through land shrinkage and fragmentation, rather than a direct response to climate change, as represented by paleotemperature changes.

Funding Sources This work was supported by the Sasakawa Scientific Research Grant from The Japan Science Society.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

A new, large-bodied species of *Dicynodontoides* (Synapsida: Anomodontia: Emydopoidea) from the base of the Usili Formation (Ruhuhu Basin, Tanzania) with comments on tetrapod biozonation in the formation

Shipps, Brenlee^{1,2}, Sidor, Christian A.^{1,2}, Angielczyk, Kenneth D.³

¹Biological Sciences, University of Washington, Seattle, Washington, United States, ²Burke Museum of Natural History, Seattle, Washington, United States, ³Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States

Approximately forty percent of the vertebrate species recorded from the upper Permian Usili Formation are dicynodonts, ranging in size from *Kawingasaurus* (humerus length = 29.2 mm) to *Rhachiocephalus magnus* (humerus length = 335 mm). Among these are several members, including *Dicynodontoides*, of the Emydopoidea subclade, a group of small to medium-sized dicynodonts (maximum humerus length = 90 mm), several of which possess adaptations for fossoriality. Here, we describe a new species of emydopoid from the basal conglomerate of the Usili Formation of Tanzania. This horizon contains endemic taxa and taxa very rare in Africa, including the enigmatic temnospondyl *Peltobatrachus*, the burnetiamorph *Pembacephalus*, the giant gorgonopsian *Inostrancevia*, and now a new species of *Dicynodontoides*.

Like other emydopoids, the anterior dentary of *Dicynodontoides* sp. nov. is shovel-shaped, lacks postcanine dentition, and the humerus bears an ectepicondylar foramen. Within the Emydopoidea, we can refer this material to *Dicynodontoides* by a suite of characters including a wide lateral dentary shelf with a deep dorsal depression, a lack of

both dentary table and dentary sulcus, and a plate-like outgrowth on the distal shaft of the fibula. *Dicynodontoides* sp. nov. is distinguished from the other members of the genus primarily by its size: every element of this material is at least twice as large as the same element from *D. nowacki* or *D. recurvidens*, making it the largest emydopoid recognized to date. Perhaps as a result of this difference in size, many elements of *D. sp. nov.* are also markedly robust, especially the humerus and femur. Other clear distinctions between *D. sp. nov.* and both *D. nowacki* and *D. recurvidens* include perpendicular grooves on the lateral edges of the anterior dentary, a deep pit along the midline of the fused splenials, a low ratio of major trochanter length to total femoral length, and a medio-laterally thin, elongate ilium.

The recognition of a new species of *Dicynodontoides* adds important detail to our understanding of the enigmatic basal conglomerate layer and how its fossil assemblage relates to tetrapod horizons higher in the Usili section. The unique characteristics of *D. sp. nov.* may indicate convergent evolution of traits not seen in other dicynodonts until the Triassic kannemeyeriiformes, including a well-developed femoral head and anteroposterior expansions on both articular ends of the humerus.

Funding Sources University of Washington

Iuvo Award, University of Washington
Department of Biology

Technical Session 4: Mesozoic Mammals,
Xenarthra, & Afrotheria (Wednesday, October
30, 2024, 1:45 PM)

**Forwarding the understanding of
proboscidean behavior and diagenesis with
chemical analysis of dentin**

Shirley, Ethan A.

Earth and Environmental Sciences, University
of Michigan, Ann Arbor, Michigan, United
States

Analysis of growth rates and chemical composition of teeth coupled with careful examination of archeological and stratigraphic contexts informs our understanding of the extinction process in fossil proboscideans. However, diagenesis affects the composition of fossil dentin, the material that provides the longest record of these animals' growth. The study of fossil proboscidean life histories depends not only on measuring sequential growth increments in dentin to understand growth rate, but also associating these increments with specific times of year. Confident inferences about aspects of life history such as reproduction, changes in diet, and cause of death, require alignment of multiple analytical proxies to differentiate life history signals from natural variability and diagenetic overprinting. Laser ablation inductively coupled plasma mass spectrometry (LA-ICP-MS) offers a promising avenue to address these concerns by measuring the abundance of multiple trace elements along transects corresponding to time spans constrained by growth increments. Specimens of mammoth, mastodon, and gomphothere dental material from fluvial and lacustrine settings show reduced Mg and its replacement with Ba and Sr, along with impregnation by exogenous Fe and Mn; conversely, dentin in mammoth fossils from permafrost settings is chemically indistinguishable from modern elephant ivory. In some poorly preserved fossils, Sr overprinting prevents inference of movement across landscapes using Sr isotopes. Meanwhile, well-preserved specimens show seasonal fluctuation in Cu and Zn that is tied to plant productivity. Coupled Cu and Zn ratios along with serial isotope systems can indicate growing season to constrain timing of specific intervals in growth increments. Cu and Zn abundance excursions that are out of phase with seasonally-fluctuating isotopes

and coincident with other isotope excursions could provide a new proxy for reproductive behavior. The LA-ICP-MS methods demonstrated here in Pleistocene proboscideans provide a structure for assessment of diagenetic alteration of dentin along with independent proxies for seasonality more generally. The utility of well-preserved dentin to make inferences about behavioral ecology of fossil animals likely extends beyond the Pleistocene and outside of Proboscidea—LA-ICP-MS analyses may open doors to study dentin in well-preserved Pliocene, Miocene, and even earlier fossil dental material in a wide variety of taxa.

Funding Sources This study was funded by a University of Michigan Department of Earth and Environmental Sciences Scott Turner grant.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

The most posed burial in prehistory: Capturing and reconstructing its story in multiple dimensions

Shonk, Robert¹, Eckstein, Nina², Sereno, Paul C.¹, Keillor, Tyler¹, Connelly-Smolenc, Nena¹, Ciudad Real Ballester, María³, Fitzgerald, Erin¹

¹Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States, ²Dept. Biomedical and Health Information Sciences, University of Illinois, CHICAGO, Illinois, United States, ³Universidad Nacional de Educación a Distancia (UNED), València, Valencia, Spain

We used a combination of field and laboratory techniques from archaeology and paleontology to collect intact a triple burial of mid Holocene age (~5,300 BP) from Gobero, the largest and richest site in the Ténéré Desert in central Niger that documents cultures from Africa's Humid Period (Green

Sahara). The burial preserves an adult female and two children buried in an intimate pose facing each other with hands intertwined. Evident at the start of excavation and mapping were pristine lithic points (arrowheads) added to the grave at the time of burial. Buried in soft paleodune sand, we excavated the triple burial using a combination of archaeological (sieving matrix, photography, drawing) and paleontological (stereophotogrammetry, stabilizing, field jacketing) techniques to collect the burial intact for microscope preparation back in the laboratory.

Preparation in the laboratory resulted in the discovery of unseen artifacts and faunal remains while preserving skeletal elements in their original positions. The skeletons were CT-scanned, segmented and repositioned in standing anatomical pose, allowing a complete set of measurements and the calculation of stature without losing the integrity of the burial. Pollen clusters discovered in the matrix document the presence of flowerheads of the angiosperm *Celosia*. Thin sections of permanent molars from the two children clarify their ages and the absence of stress at the time of death. Casts of the burial were mounted on a vertical slab that allows observation of the burial and included lithic artifacts in top and bottom views for exhibition purposes. The burial became the centerpiece of a story in *National Geographic* magazine on the Gobero site and development of archaeological exhibitions in its home country of Niger.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Different mammals, same structure: co-occurrence structure of North American mammal paleocommunities across the Plio-Pleistocene transition

Shupinski, Alexandria¹, Craffey, Matthew¹,
Smith, Felisa A.², Lyons, Kate¹

¹Biological Sciences, University of Nebraska-
Lincoln, Lincoln, Nebraska, United
States, ²Biological Sciences, University of
New Mexico, Albuquerque, New Mexico,
United States

Understanding the structure and function of biological communities is a central goal in ecology. One promising line of inquiry is using co-occurrence analyses to examine how species traits mediate co-existence and how major ecological, climatic, and environmental disturbances can affect this relationship, and underlying mechanisms. However, modern communities have been heavily modified by humans. Here, we use the North American fossil record to evaluate co-occurrence of mammals across the Plio-Pleistocene transition at the intensification of the Great American Biotic Interchange and onset of northern hemisphere glaciation. We compiled 88 paleocommunities from two time periods: late Pliocene (4–2.5 Ma) and early Pleistocene (2.5–1 Ma). We calculated co-occurrence to identify significantly aggregating (co-occur more than expected) and segregating (co-occur less than expected) genus pairs, as well as association strength. Four traits were used to quantify functional distance between genus pairs to evaluate the effect of functional role on association type and strength. The distribution of association types and strengths does not significantly change across the transition, even with different genera forming the associations and a larger abundance of South American immigrants. However, significantly associated pairs become more functionally similar. We show that mammal communities can remain stable across major perturbations prior to human disturbance. Furthermore, we suggest that mammals have fundamental ways of assembling that may have been altered by humans.

Funding Sources Support for this research was provided by NSF-DEB 1257625 and 2051255 (E6 RCN, ETE RCN)

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Victims of the “Big 5” and modeling threats of the sixth extinction: Science communication by upcycling waste into art

Shuster, Finn J.¹, Visaggi, Christy¹, Spears, Rick²

¹Geosciences, Georgia State University, Atlanta, Georgia, United States, ²Fernbank Museum of Natural History, Atlanta, Georgia, United States

The sixth extinction is a problem our planet faces and communicating the all encompassing impacts of such a disaster on biodiversity can be difficult. This project uses an alternative medium to communicate an important message and exemplifies the integration of art into science as promoted by STEAM. Models of charismatic species from previous extinctions were created using plastic and other waste prevalent in our environment, as a means to tell stories about ancient life and modern biota at risk due to current human impacts. By constructing representations of past species using modern-day single-use materials, connections are made between historical extinction events and present-day threats to biodiversity. Five models were created representing each of the major mass extinctions in the fossil record with all examples connected to modern fauna and relevant threats to these groups. The models developed include a trilobite, *Dunkleosteus*, *Dimetrodon*, coral reefs, and Velociraptor; all made from plastic containers symbolizing environmental dangers faced by their living descendants, and speaks to the impacts of pollution, habitat destruction, and climate change. These models, alongside fossils,

were highlighted in pop-up exhibits in collaboration with Fernbank Science Center for Earth Day and in Atlanta Science Festival outreach events. Audience engagement included facilitating and promoting awareness of both paleontological history and contemporary environmental challenges as well as by providing activities for kids to guide their learning. The project evokes a vivid portrayal of the interconnectedness between past and present extinctions through this multi-faceted approach, and highlights the urgent need for conservation and sustainable practices to mitigate the effects of the ongoing sixth extinction. Ultimately, it aims to foster a deeper understanding of the complex dynamics driving biodiversity loss and inspire action towards safeguarding Earth's ecosystems for future generations. The project was received well as an engaging and effective method of science communication. The next step is to provide a digital portfolio of these models and materials for expanded reach. This will be done by 3D scanning models and uploading supplemental material online used for the exhibit with the ultimate goal of linking NGSS standards to this project to promote use in K-12 settings.

Funding Sources This project was funded by Georgia State University's Sustainability Fellowship Program.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

New craniodental remains of the suine *Propotamochoerus palaeochoerus* from the Late Miocene of Hostalets de Pierola (Vallès-Penedès Basin, NE Iberian Peninsula): biochronological implications

Siarabi, Souzanna¹, Kostopoulos, Dimitris S.², G. Arranz, Sara¹, Robles, Josep M.¹, Alba, David M.¹

¹Institut Català de Paleontologia Miquel Crusafont (ICP-CERCA), Universitat

Autònoma de Barcelona, Cerdanyola del Vallès, Barcelona, Spain, ²School of Geology, Aristotle University of Thessaloniki, Thessaloniki, Greece

Suines originated in Asia during the Middle Miocene and dispersed into Europe by the early Late Miocene. Their first European record by *Propotamochoerus palaeochoerus* was formerly dated to the latest Middle Miocene (late Aragonian, MN7+8) but recent data suggest a later, earliest Vallesian (MN9, 11.2 Ma) age. While the presence of *P. palaeochoerus* in the fossiliferous area of els Hostalets de Pierola (Vallès-Penedès Basin, NE Iberian Peninsula) has been known for decades, dating inaccuracies, due to the lack of stratigraphic control, have previously precluded ascertaining the species' earliest record. In contrast, the abundant suid remains from the stratigraphic sequence of Abocador de Can Mata (ACM; Hostalets de Pierola) are precisely dated through litho-, bio-, and magnetostratigraphic correlations, allowing us to determine when the species is first recorded. Here we describe all the currently available material of *P. palaeochoerus* from the Hostalets area, including abundant unpublished ACM remains that comprise 72 isolated teeth, 21 dentognathic fragments, and two (a male and a female) crania. Both qualitative and metrical comparisons support an attribution to *P. palaeochoerus*. All the ACM material has an estimated age between 11.2 and 11.1 Ma, even though the ACM sequence spans from 12.6 to 11.1 Ma and yielded abundant remains of other suid subfamilies throughout. The oldest ACM record of *P. palaeochoerus* is correlated to C5Ar.2r (11.26–11.18 Ma), with an interpolated age of 11.23 Ma. Interpreted literally, our results would suggest that *P. palaeochoerus* dispersed into Western Europe ~50 kyr before hipparionin horses, whose first appearance datum marks the beginning of the Vallesian Land Mammal Age and is currently correlated to the base of C5r.1n (11.18 Ma). Nevertheless, when

potential sampling biases and age interpolation errors are considered, it is more reasonable to conclude that both taxa (along with giraffids) dispersed roughly synchronously ~11.2 Ma (roughly coinciding with the C5Ar.2r/C5r.1n boundary). Further research is required to more precisely date the various dispersal events that took place around the Aragonian/Vallesian transition, after which *P. palaeochoerus* became established as one of the most common suids during the early Vallesian (MN9) of Europe.

Funding Sources PID2020-117289GB-I00/AEI/10.13039/50110001103, Generalitat de Catalunya/CERCA Programme, and AGAUR 2022 SGR 00620 and 2023 FI-1 00396 to S.S.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

A new species of *Arctops* (Therapsida: Gorgonopsia) from the upper Madumabisa Mudstone Formation of Zambia, with new information on gorgonopsian postcranial anatomy

Sidor, Christian A.¹, Mann, Arjan²

¹University of Washington, Seattle, Washington, United States, ²Geology, Field Museum of Natural History, Chicago, Illinois, United States

The fossil record of Zambian gorgonopsians has recently been demonstrated to be more extensive and diverse than previously recognized. In the Mid-Zambezi Basin, gorgonopsian fossils have been reported from the Guadalupian and lower Lopingian rocks of the Madumabisa Mudstone Formation, with the latter referred to *Gorgonops*. Despite a longer history of collection, previous reports of gorgonopsians from the Luangwa Basin have been restricted to taxonomic lists, with little in the way of voucher specimens or

diagnostic features referenced. However, recent work suggests the presence of an endemic species of *Lycaenops* and here we introduce a previously undescribed species of *Arctops*.

The holotype of the new species comprises a nearly complete skull with lower jaws, as well as a large portion of the appendicular skeleton and several vertebrae, all exceptionally well preserved. The skull shares with *Arctops willistoni* from South Africa a robust and broad-snout, with three maxillary postcanine teeth, a median vomerine ridge that is displaced anteriorly relative to the lateral ridges, and reduced dentition on the palatal and pterygoid bosses. Uniquely the new species bears a strong interorbital ridge otherwise only seen on some rubidgeines, three teeth on the pterygoid transverse flange surrounded by raised rim of bone, and a thin and elongate diminutive preparietal, among other features. Limb proportions suggest a stocky, strongly built carnivore and potentially diagnostic postcranial features include: atlas intercentrum substantially wider than atlas pleurocentrum, at least one accessory ectepicondylar foramen, and ungual phalanx of pedal digit five very reduced. Our phylogenetic analysis builds on previous work and finds the two *Arctops* species most closely related to *Smilesaurus*, with *Lycaenops* spp. as the immediate outgroup. These three genera form a clade that is the sister taxon to a larger clade including rubidgeines + *Arctognathus*.

Despite a much less intensive sampling history, the upper Madumabisa Mudstone Formation of Zambia hosts a gorgonopsian diversity approaching that of the *Cistecephalus* and parts of the *Daptocephalus* assemblage zones of South Africa, with most of the same genera represented. Continued detailed anatomical work will further refine the tetrapod biogeography of southern Pangea as well as shed light on ecomorphological differences

permitting niche partitioning among coexisting gorgonopsian species.

Funding Sources NSF EAR-1337569

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Revisions to our understanding of the endocranial anatomy of *Carcinella sigei* (Apatemyidae, Euarchontoglires)

Silcox, Mary T.¹, Gawlak, Dana S.¹, Lang, Madlen¹, Ruf, Irina^{2,3}

¹Anthropology, University of Toronto, Scarborough, Toronto, Ontario, Canada, ²Abteilung Messelforschung und Mammalogie, Senckenberg Forschungsinstitut und Naturmuseum Frankfurt, Frankfurt am Main, Germany, ³Institut für Geowissenschaften, Goethe-Universität Frankfurt, Frankfurt am Main, Germany

Apatemyidae is a family of extinct mammals thought to be a member of Euarchontoglires. Known from the Paleocene and Eocene of Europe, and the Paleocene to Oligocene of North America, specimens from both sides of the Atlantic show that apatemyids engaged in specialized extractive foraging behavior. They had enlarged central incisors and long fingers that would have allowed them to gouge into woody substrates and extract burrowing insects. This distinctive suite of traits also independently evolved in extant primates (*Daubentonia madagascarensis*) and marsupials (*Dactylopsila* spp.). Apatemyid cranial endocasts have previously been described for *Labidolemur kayi* (late Paleocene-early Eocene of North America) and *Carcinella sigei* (Late Eocene of France) based on μ CT data, and may elucidate the sensory adaptations associated with this unique foraging behavior. However, the published endocast for *C. sigei* lacked diagnostic surface features, and was not

assessed quantitatively beyond overall volume. Using up-to-date segmentation techniques, we re-segmented the *C. sigei* dataset, which produced a new version of the endocast that allows for a greater range of quantitative comparisons. In agreement with previous assessment of relative size, the encephalization quotient of *C. sigei* is large for a Paleogene mammal (Eisenberg EQ = 1.51 using a body mass based on cranial length) and notably higher than *L. kayi* (Eisenberg EQ = 0.42-0.50). However, this relatively large brain size does not come from an enlarged neocortex. That region only accounts for 25.4% of the overall endocranial surface area, which is approximately what would be predicted for a late Eocene taxon, and only slightly higher than values from stem primates and primitive rodents. Like *L. kayi*, *C. sigei* had large olfactory bulbs compared to other fossil euarchontoglires, accounting for 8.16% of the overall volume; this is a similarity to *D. madagascarensis*, which had larger olfactory bulbs than reconstructed for its ancestor. However, *C. sigei* differs from *D. madagascarensis* in having large petrosal lobules (accounting for 1.99% of overall volume), larger than is typical for a Paleogene mammal, which might suggest that it was more dependent on visually tracking moving prey. In all, the endocast allows for a refinement of our understanding of the suite of sensory adaptations of this distinctive group of Paleogene mammals.

Funding Sources Supported by an NSERC Discovery grant to MTS

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

An exceptional mammal locality from the first ~28 Kyrs after the Cretaceous-Paleogene mass extinction in northeastern Montana with Lancian-aspect taxa

Silviria, Jacqueline S.^{1,2}, Ausmus, David A.^{1,2}, Renne, Paul R.^{4,5}, Tholt, Andrew J.^{5,4}, Sprain, Courtney⁶, Wilson Mantilla, Gregory^{3,2}

¹Department of Earth & Space Science, University of Washington, Seattle, Washington, United States, ²Burke Museum of Natural History & Culture, University of Washington, Seattle, Washington, United States, ³Berkeley Geochronology Center, Berkeley, California, United States, ⁴Department of Earth & Planetary Science, University of California, Berkeley, California, United States, ⁵Department of Geological Sciences, University of Florida, Gainesville, Florida, United States, ⁶Department of Biology, University of Washington, Seattle, Washington, United States

The impact of the Cretaceous/Paleogene (K/Pg) mass extinction event (66.052 Ma) on mammalian evolution is best known from the Western Interior of North America, particularly the Fort Union Fm (Tullock Mbr) of the Hell Creek region in the western Williston Basin, northeastern Montana. The 'early disaster' subphase of faunal recovery, spanning the first ~28 kyr after the K/Pg event, is well-sampled but remains poorly understood due to the 'Bug Creek Problem', which prevents geochronological correlation of channel deposits with reworked Cretaceous fossils from the upper Hell Creek Fm.

Here we provide updated biostratigraphic and lithostratigraphic context for Constenius Locality, an extremely productive vertebrate microfossil site within a lowermost Tullock Mbr. sandstone channel. We hypothesize that the channel was deposited between equivalents of the Iridium Z coal (IrZ) at the K/Pg boundary and the McGuire Creek coal (MCZ; 66.024 Ma).

The Constenius local fauna (>500 specimens from ~16 morphospecies) includes multituberculates (*Cimexomys minor*,

Mesodma thompsoni, *Stygimys kuszmauli*, *Valenopsalis* sp.), metatherians (*Thylacodon montanensis*), and eutherians (*Baioconodon (Ragnarok) nordicum*, *Mimatuta minial*, *M. morgoth*, *Procerberus formicarum*, *Protungulatum donnae*, *Oxyprimus erikseni*) typical of the Pu1 interval-zone of the Puercan NALMA. We have also identified metatherian 'dead clades walking' (e.g., Alphadontidae sp. indet., *Pedimys elegans*) characteristic of the preceding Lancian NALMA, as well as new cimolestid and leptictid morphs resembling Lancian taxa.

Constenius resembles Z-Line Quarry, another Williston Basin 'early disaster' local fauna putatively constrained between an IrZ equivalent and the MCZ coal, in being depauperate and uneven compared to pre-extinction and 'recovery' faunas, and in bearing metatherian 'dead clades walking.' However, it is richer than Z-Line and represented by more complete elements (e.g., dentulous jaws) of multituberculate and eutherian 'immigrant taxa' common in 'late disaster' Pu1 local faunas.

Additional geochronological work is underway to further bracket the age of Constenius and to rule out reworking as explanation for Lancian-aspect taxa. Phylogenetic morphometric analyses are also underway to clarify taxonomic identifications. Still, available evidence from Constenius corroborates previously hypotheses of post-K/Pg mammalian faunal recovery in North America.

Funding Sources National Science Foundation (NSF EAR 2321341), Myhrvold & Havranek Charitable Family Fund, University of Washington, Colorado Scientific Society

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

The pervasiveness of constructive radiations during evolutionary transitions across deep time and space

Simoes, Tiago R.

Dpt. Ecology and Evolutionary Biology,
Princeton University, Princeton, New Jersey,
United States

Evolutionary (adaptive) radiations have been historically used to explain the origin of major animal clades and recovery from mass extinctions across the history of life. However, this idea was first developed and subsequently supported for decades based mostly on small-scale datasets, generalizations of local patterns, or ontological discrepancies over definitions of what represents an ‘adaptive radiation’. Crucially, there is also a discrepancy between expectations of how to detect evolutionary radiations between ontological and paleontological research programs. Fortunately, over the past two decades substantial advances in data acquisition, phylogenetics, and phylogenetic comparative methods have provided much improved quantitative tools that directly incorporate the fossil record to empirically test predictions from adaptive radiation theory in deep time.

Here, I have compiled and revised the results from 67 paleobiological studies testing macroevolutionary dynamics across major transitions in the fossil record of various animal clades across different time and geographical scales. I find that, in the vast majority of cases, the classical concept of adaptive radiation as the driving mechanism behind the origin of major clades or their recovery after mass extinctions can be refuted. Most parameters that are central to the concept of evolutionary radiations—diversification rates, phenotypic rates, and phenotypic disparity—when taken together, do not indicate a single evolutionary pattern occurring during those key evolutionary transitions. However, a more recently

proposed theory—constructive radiations—is the most common pattern (characterized by a strong decoupling of diversification and phenotypic evolutionary trajectories). Furthermore, I revisit the conceptual pillars of evolutionary/adaptive radiations, proposing a unifying terminology that discriminates between patterns and processes of evolution related to such events. I conclude by discussing candidate ecological and genetic mechanisms driving constructive radiations in the deep past, and how they are part of an ongoing expansion of macroevolutionary thought.

Technical Session 22: Paleontological
Practices: Education & Outreach (Saturday,
November 2, 2024, 1:45 PM)

Changing expectations and perceptions in emerging paleontologists: introducing high schoolers to scientific excavation

Simpson, Emily M.³, Bornheim, Sierra^{3,1},
Levering, David^{2,3}, Trevethan, Ian³

¹Sternberg Museum of Natural History, Hayes, Kansas, United States, ²Brown University, Providence, Rhode Island, United States, ³Fort Hays State University, Hayes, Kansas, United States

The Sternberg Science Camps are designed to provide students with access to hands-on science education, including experience in paleontological field work, before college. In the summer of 2024, two sets of approximately ten high school students in this program were involved in the excavation of the Minium quarry in Graham County, Kansas in the late Miocene Ash Hollow Formation. Remains of a diversity of plants and animals have been found at this site.

The two groups were presented with paleontological concepts following slightly different styles of teaching. We compare the experiences of these two groups of students,

including how their perceptions of paleontology and their expectations about how field work is done changed from the beginning to the end of their two-week experience.

At the beginning of their camp experiences, students were asked to rank how well statements about field work, the Miocene, anatomy, and paleontological methods reflected their expectations. They were also asked to describe what they thought Kansas looked like during the Miocene and to illustrate how much of the field site they expected to see excavated in the two weeks that they were present. Students were presented with these questions again at the end of their two-week experiences. We compare their answers from the beginning and end of their experiences to see how their expectations about the field and understanding of paleontology changed. We also compare the amount of change seen between the two groups of students, as material was presented in marginally different ways. The first group was given the opportunity to explore and engage with materials and questions independently prior to being presented with deeper instruction, while the second group was given more in-depth information prior to being given the chance to explore on their own. Our data show the potential differences between an inquiry based, constructivist approach to teaching paleontology and field methods versus a more traditional instructional approach. We also had the opportunity to test how students view the field early on in their learning careers, and discuss how these perceptions have the potential to change as they grow as scientists.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Phylogeny constrains distal propodial cross-sectional shape in plesiosaurs

Singh, Veronica, DeBlois, Mark

Earth and Planetary Sciences, UC Davis,
Davis, California, United States

Plesiosaurs are a diverse, globally distributed group of Mesozoic marine reptiles characterized by large, sub-equal fore- and hind flippers. Although previous studies have linked flipper planform shape and proportion to specific ecomorphotypes, it is unclear if the cross-sectional shape follows the same trend. Plesiosauromorphs, those with relatively long necks and small heads, tend to have drag-reducing features in their flippers such as higher aspect ratio while pliosauromorphs, those with relatively short necks and large heads, tend to have features associated with greater maneuverability such as lower aspect ratio. Since air- and hydrofoil cross-sectional shape is strongly related to performance, we hypothesized that drag-reducing features like camber are more pronounced in plesiosauromorphs than pliosauromorphs. We compared the distal cross-sectional shape of the propodial (humerus and femur) from diverse subclades including Elasmosauridae, Polycotylidae, Pliosauridae, and Rhomaleosauridae. Elasmosauridae is a plesiosauromorph while the other three are pliosauromorphs including Polycotylidae, which is phylogenetically more closely related to Elasmosauridae. We used semi-landmarks to capture the shape and performed canonical covariate analysis (CVA) on the data. Our results failed to show a statistically significant difference between the morphotypes or between limb types; however there is a statistically significant difference across clades ($p < 0.03$). This suggests that flipper cross-sectional shape is broadly more constrained by phylogeny or swimming efficiency in general and overshadows more subtle differences due to ecomorphology.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Seasonal variation effect on *Salvator merianae* decomposition and implication for reptilian mummification

Singleton, Owen J., Maddox, Hannah M.,
Drumheller, Stephanie K.

Earth, Environmental, and Planetary
Sciences, University of Tennessee Knoxville,
Knoxville, Tennessee, United States

Vertebrate taphonomic studies historically have focused on the decay and decomposition of mammals, leaving the topic of non-mammal decomposition comparatively understudied. Similarly, the effect of seasonal variation and weather conditions on decomposition is well-understood in mammals, and these factors are often assumed to produce comparable effects in non-mammal subjects. However, a growing body of work focusing on decomposition in non-mammalian groups suggests that anatomical differences between major vertebrate groups can significantly affect how they are recycled into the environment.

Two sets of thirty Argentine tegus (*Salvator merianae*) were left to decay naturally in a wooded clearing in eastern Tennessee, U.S.A. A wire enclosure allowed small invertebrates to access the remains while barring larger, vertebrate scavengers from removing them. To determine the effect of seasonal variation on the progression of decay, one set was positioned in the summer (mid-May 2023) and the other set in winter (February 2024). Observations were made daily in the early stages of decomposition to track a variety of variables for each group regardless of season. Specific weather conditions were tracked using publicly available weather datasets for the area provided by the National Weather Service.

Our observations have largely aligned with previous studies on seasonal variation of decay, with notable differences stemming from anatomical differences between mammals and reptiles. Every individual in our warm weather run entered the dry stage of decomposition in under a month, and the active and advanced stages of decomposition lasted for a shorter time than observed in the cold weather run, in which most specimens were still in the active to advanced stage of decay after three months of exposure. Insect communities also differed greatly between the two treatments. Temperature fluctuations and colder conditions in particular disrupted the life cycle of observed insects, limiting their activity and affecting downstream patterns of disarticulation, which varied significantly between the cranial and postcranial skeleton, both within the observed specimens and when compared to mammals. These results displayed the complexities that go into the final disposition of remains and suggest that examination of clade-level anatomical variation should be considered when interpreting patterns of completeness, disarticulation, and soft tissue retention in fossil vertebrates.

Funding Sources Funding statement: This research was funded by the University of Tennessee Department of Earth, Environmental, and Planetary Sciences and the David B. Jones Foundation.

Colbert Prize Session

A new ichnospecies of *Ameghinichnus* from the Newark Basin: ichnocladistics and palaeoecological implications

Slibeck, Bennett, Olsen, Paul E.

Columbia University, New York, New York,
United States

The Newark Basin ichnospecies of *Ameghinichnus* – the type material of which comes from the middle Jurassic La Matilde Formation of Argentina – has been mentioned briefly in the literature but is described here for the first time. The new ichnite is known from several trackways found in fine-grained red mudstones from the early Hettangian Strata of the upper Towaco Formation at the Riker Hill site (Kidde Dinosaur Park), in Roseland, NJ; which closely follows the ETE, and sits just below the lavas of the Hook Mountain Basalt in the Newark Basin [201.9 Ma]. The type specimen presents remarkable anatomical detail in a 10-step trackway highlighting its phalangeal pads and sharp claw marks, impressed most visibly on the manus. These specimens are placed within the ichnogenus *Ameghinichnus* based on their consistent phalangeal formula [2, 3, 3, 3, 3 in both manus and pes] and having a manus and pes of nearly equal size. This specimen differs from others in the ichnogenus due to its more asymmetrical manus, and the presence of an elongate calcaneal heel stretching posterior-medially from the pes. Three specimens are known from Riker Hill and one specimen from the middle Shuttle Meadow Formation of the Hartford Basin are included in this new species. An ichnological assignment is made based on the following: 1. None of the specimens display scales despite excellent examples of scale preservation on other comparatively detailed tracks from the Towaco formation. 2. The distinct phalangeal formula is present only in advanced therapsid synapsids but appears below the base of the Mammalia; 3. This ichnospecies was made by a substantially larger track-maker than most known contemporaneous Mammaliaformes. Both tritylodonts and trithelodonts of similar sizes are known from contemporaneous units, and provide probable trackmakers, placing *Ameghinichnus* sp. within the Mammaliaforma. Paleoecologically, this new species provides a link between the abundant non-mammalian synapsids of the

Permian and Triassic and the appearance of advanced cynodonts / mammaliaforms in the Jurassic. Behaviorally, it suggests that at least transiently, the trackmakers were present on the same marginal lacustrine lake-flats that hosted significantly larger animals like the *Eubrontes* trackmaker. This species helps paint a picture of an abundant, though non-diverse, post ETE Newark Basin, with its small size supporting the hypothesis that the lack of diversity is not a taphonomic bias.

Funding Sources The author of this work was funded by a graduate research fellowship from the National Science Foundation. Support for equipment came from the Columbia Climate School.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Skull ontogeny of *Tarbosaurus bataar*

Slowiak, Justyna, Szczygielski, Tomasz

Institute of Paleobiology, Polish Academy of Sciences, Warsaw, Poland

Tarbosaurus bataar is one of the largest and best represented tyrannosaurid species in the fossil record. Numerous fossils, including complete skeletons of varied size, were found in several locations representing the Nemegt Formation in Mongolia. The rich fossil material gives an opportunity to follow the pattern of ontogenetic changes in the skull of *Ta. bataar*. Specimens of body length from 2–3 meters to ca. 12 meters were compared. For the first time, the skull of an early subadult individual of *Ta. bataar* is analyzed and a new reconstruction of the skull of an adult *Tarbosaurus* is provided, differing from previously published illustrations. It appears that the snout of adult *Ta. bataar* was not as narrow and short as reconstructed in the previous works. The new look on the skull morphology of *Ta. bataar* together with the examination of the timing of morphological

changes that occurred during its ontogeny, enables comparisons of *Ta. bataar* with the ontogenetic series of the North American large tyrannosaurids: *Tyrannosaurus rex*, *Gorgosaurus libratus*, and *Daspletosaurus horneri*.

Funding Sources Funding for this work was received from National Science Centre, Poland, grant no. 2019/35/B/NZ8/02292.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Mammalian tooth emergence in a seasonal world

Smith, B. H.^{1,2}

¹Museum of Anthropological Archaeology, University of Michigan, Ann Arbor, Michigan, United States, ²Center for Advanced Study of Human Paleobiology, George Washington University, Washington, District of Columbia, United States

The young of toothed mammals must erupt teeth to reach feeding independence. How tooth emergence integrates with gestation, birth and weaning is explored here for 71 species in nine orders of placental mammals. Age of completed deciduous dentition and ages of emergence of first and second permanent molars are compared to age of weaning, length of total maternal investment (gestation plus lactation) and body and brain size.

Questions developed from previous study of high-quality primate data (22 of the 71 species) are examined here on the total sample. Rather than correlation, comparisons focus on equivalence, sequence, relation to absolutes (six months, one year), the distribution of error and adaptive extremes. Results are considered in an adaptive context because graduating into feeding independence is critical to survival of

young and to reproductive fitness of the mother.

These mammals differ widely at birth, from no teeth to all deciduous teeth emerging, but commonalities appear when infants transit to independent feeding. With few exceptions, weaning takes place with an entire deciduous dentition, closest in time to emergence of first permanent molars and well before second molars emerge.

Another layer of meaning appears when developmental age is counted from conception because the total time to produce young feeding independently comes up against seasonal boundaries that are costly to cross for reproductive fitness. Mammals of a vast range of size and taxon, from squirrel monkey to moose, hold conception-to-first molars at just under one year.

On a broad level, age of emergence of the first permanent molar is a reasonable proxy for age of weaning, the two statistically indistinguishable from each other ($p = .96$ in paired-t test of $\log_{10}$ values, $n=67$). Close comparisons, however, can reveal effects of dietary guild or phylogeny and speak to the risk of extinction for slow-reproducing mammals.

Dental development is a valuable life-history parameter for any mammal, one that can be studied for living and extinct species, enlarging our ability to test hypotheses in the ecological present and to make more dynamic inference about the past.

Funding Sources Accumulating the 'mammal dental library' was supported by SBR-9408408 from the US National Science Foundation.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Forelimb biomechanics of the derived therizinosaur *Nothronychus* from the Upper Cretaceous of Southern Utah

Smith, David K.

Biology, Northland Pioneer College,
Holbrook, Arizona, United States

Therizinosaurs were a clade of omnivorous to herbivorous maniraptoran theropods regarded as close to the origin of birds and are known from the Upper Cretaceous of Asia and North America. The derived representatives possessed multiple musculoskeletal traits convergent with neornithine birds. As such, the function of the enlarged forelimbs and unguals has been the subject of some discussion.

Nothronychus graffami was a derived therizinosaur represented by a well-preserved specimen from the marine Tropic Shale of southern Utah. Most of the right pectoral girdle and forelimb was collected. No carpals were preserved, but much of the manus is available. Many of the manual elements are taphonomically flattened, but the pectoral girdle and forelimb are in fair condition. For this project, a functional semilunate carpal, as described for other therizinosaurs, is included. Considerable soft tissue at the shoulder is assumed.

The forelimb of *Nothronychus* was CT-scanned to produce DICOM images. Object files were then created from the images and imported into Blender. The furcula, scapula, and coracoid were combined into one object, the humerus a second object, the antebrachium a third and the metacarpals and phalanges were treated as separate objects. Objects were imported into OpenSim Creator. Three-dimensional movement was modelled at the shoulder and wrist with gimbel joints. The elbow and interphalangeal joints were treated as two-dimensional hinge joints. The final dynamic model was derived from previous muscle reconstructions. Published values for *Tyrannosaurus* and

extant birds were used to estimate some parameters.

Total movement was considered typical for a maniraptoran theropod and combined active and passive components. It includes protraction/retraction, abduction/adduction, and long axis rotation at the shoulder. The forelimb could not abduct above the spinal cord. Flexion/extension was modelled at the elbow. Flexion/extension/hyperextension is permitted at the wrist, with the addition of abduction/adduction about the semilunate carpal. Flexion/extension was estimated at each of the phalanges, but some were taphonomically distorted. Moment arms were computed with OpenSim to estimate torque for each muscle spanning joints at varying angles.

Technical Session 5: Paleozoic Herpetology
(Wednesday, October 30, 2024, 1:45 PM)

A new slender and long-bodied amphibamiform temnospondyl from the Late Carboniferous Mazon Creek Lagerstätte reveals the earliest occurrence of body elongation in Dissorophoidea

So, Calvin¹, Mann, Arjan², Pardo, Jason²,
Sues, Hans-Dieter³

¹The George Washington University
Department of Biological Sciences,
Washington, District of Columbia, United States, ²Field Museum of Natural History,
Chicago, Illinois, United States, ³National
Museum of Natural History, Washington,
District of Columbia, United States

Substantial anatomical support has been established for a temnospondyl origin of Lissamphibia, but the timing of the origin of lissamphibian-like ecomorphology remains uncertain. Temnospondyls, and particularly dissorophoids, are reconstructed as having salamander-like bodies, but it has not been established when this bauplan first appeared.

Generally, body shape is a well-established proxy for ecology in living salamanders, with salamanders broadly including flat, stout, slender, and eel-like ecomorphotypes, with vertebral count and presacral length the most striking distinctions between these categories. Recent work has hypothesized an origin of lissamphibians, or at least batrachians, from a short-bodied ancestor, with subsequent increases in presacral length in caecilians and several salamander clades. However, little is known about the diversity of presacral length, and therefore of body form, among putative lissamphibian forerunners. Here, we report a new amphibamiform species from the Late Carboniferous Mazon Creek Lagerstätte (309-307 Ma) in Illinois analyzed using microCT imaging and rendered in Dragonfly. FMNH PR 5055 bears a uniquely elongated body plan with approximately 30 presacral vertebrae, the highest count known among Paleozoic dissorophoids. This contrasts with the typical body plan of amphibamiforms, ranging from 17 to 26 presacral vertebrae found in terrestrial members (e.g., *Amphibamus*, *Doleserpeton*, *Gerobatrachus*, *Micropholis*, *Milnererpeton*, *Platyrrhinops*). Furthermore, soft-tissue impressions around the trunk and tail regions demonstrate a narrow and slender body shape revealing a novel ecomorphotype among Permo-Carboniferous amphibamiforms that starkly contrasts with the wide, stout shape observed in soft-tissue impressions of *Amphibamus* and *Milnererpeton*. Additionally, the new taxon possesses a shallow otic notch, a small internarial fontanelle, and a much narrower skull than the coeval *Amphibamus grandiceps*, resembling more closely the early Permian (Cisuralian) *Doleserpeton*. Bayesian inference and maximum-parsimony phylogenetic analyses support placement of FMNH PR 5055 as the outgroup to the clade comprising lissamphibians, *Gerobatrachus*, and branchiosaurids. The slender and elongated body of FMNH PR 5055 demonstrates that the lissamphibian stem

possesses a wider range of body forms than traditionally assumed and that the lissamphibian body plan evolved within an already morphologically diverse assemblage.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The largest lamniform shark (Chondrichthyes: Neoselachii) from the Upper Cretaceous strata of the Antarctic Peninsula

Soares, Marina B., Freitas, Gabriel d., Sayão, Juliana M., Kellner, Alexander W.

Geology and Paleontology, Museu Nacional, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Rio de Janeiro, Brazil

The sedimentary layers of the Marambio Group, James Ross sub-Basin of the Antarctic Peninsula, have been the object of the PALEOANTAR Project, coordinated by the Museu Nacional/UFRJ, Brazil. The collection effort resulted in a large number of Chondrichthyes materials (teeth and vertebrae) from Cretaceous strata, especially from the Snow Hill Island (Campanian-Maastrichtian) and López de Bertodano (Maastrichtian) formations. Traditionally, vertebrae have received little attention in studies dealing with Cretaceous Antarctic chondrichthyans, since most studies focus on teeth that have more diagnostic features. Thus, the few references of neoselachian vertebrae from the Marambio Group only mention indeterminate elements or, at most, indeterminate lamniforms. Although isolated vertebrae are taxonomically uninformative, they can be used to provide estimates of body size. So far the PALEOANTAR Project has collected a total of 67 isolated shark vertebrae from the James Ross and Vega Islands, all characterized by vertebral centers preserved within carbonate concretions. Some still contain remains of mineralized cartilage on the external surface. Among

those, one specimen (MN 7834-V) stands out for its size. It comes from the López de Bertodano Formation of the Vega Island, is amphicoelous and has a diameter of 104 mm. Well-marked concentric rings are arranged around the notochord (chordacentrum). A worn part reveals the internal anatomy of this element, showing radial lamellae, characterizing the asterospondyl pattern. These characteristics allow us to refer MN 7834-V to the Lamniformes. Applying body size estimation equations to sharks [TL (cm) = $0.281 + 5.746$ (CD) and TL (m) = $0.22 + 0.058$ (CD); TL = total length; CD = diameter of the center], we obtained values of 6.25m and 5.97m, respectively, which have to be regarded as the minimum length of the animal. The largest lamniform identified for Antarctica, based on teeth, is *Cretolamna appendiculata*, measuring 3.6 m, which is considered a medium-sized taxon. Lamniforms longer than 6 m are included in the category of giant forms, which in the Late Cretaceous are represented only by *Scapanorhynchus*, *Hispidaspis*, *Cretoxyrhina*, and *Cretodus*, which are recorded mainly in latitudes between 30 and 35°N. Therefore MN 7834-V reveals the largest lamniform known for the Antarctic Peninsula to date and demonstrates that giant lamniforms inhabited the southernmost seas (~60°S) in the Late Cretaceous.

Funding Sources Funding was received from the Conselho Nacional de Desenvolvimento Científico e Tecnológico CNPQ 442677/2018-9; 440902/2023-1; 308515/2023-4; 406902/2022-4.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Early lepidosauromorph diversity of southwestern Germany

Sobral, Gabriela, Schoch, Rainer R.

Staatliches Museum für Naturkunde
Stuttgart, Stuttgart, Germany

Lepidosauromorphs constitute one of the most diverse groups of vertebrates, accounting for almost a third of the current vertebrate diversity. In spite of this, the early part of their evolutionary history remained mostly unknown for several decades. Exciting new findings, however, have significantly increased the diversity of early lepidosauromorphs and renewed the attention given to this otherwise obscure time of the diapsid evolution. The most important locality for this renewed interest is Vellberg, in Southwestern Germany. It had so far yielded two new lepidosauromorph taxa, and here we describe for new ones from the same locality. The first taxon is characterized by a very broad parietal, a well-developed, knobbed prefrontal, and a broad squamosal with a deep, bifid articulation for the postorbital, and a short ventral process with a rounded tip. The second taxon has a strongly downturned lower jaw, a maxilla with a very prominent, rounded dorsal process, and a humerus with articular ends set to 90° of each other. The third one has a straight dentary with a well-developed mentonian process and a squamosal similar to that of the first taxon, but differing from it in the long and narrow ventral process. Finally, the last taxon bears a slender dentary with a low coronoid process and a sigmoid femur. All taxa show a pleurodont-like dentition with a small area ankylosed to the labial wall of the dental shelf, no lingual wall, and no interdental plates. The dental features of the new taxa do not match that of any other early lepidosauromorph taxa, adding to the already high diversity of implantation types among them. These different types of dental morphologies may at least partially explain the diversity observed in lepidosaurs, and possibly represent a high diversity in the modes of food processing and micro-niche partitioning. These ecological aspects are also reflected in the different squamosal

morphologies of the first and third taxa, and in the dentary anatomy of the third taxon. The first taxon potentially displays some degree of cranial kinesis while the third taxon may have been able to perform propalinal movements. The new taxa highlight the incredible contribution of the Vellberg locality for the early evolutionary history of the group and add to the great ecological diversity of early lepidosauromorphs.

Funding Sources This project was funded by the Deutsche Forschungsgemeinschaft (397562308).

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Investigating the relationship between annual growth rate and vascular organization in non-avian theropod dinosaurs using Bayesian threshold modeling

Sombathy, Riley S.², D'Emic, Michael D.¹, O'Connor, Patrick M.^{2,3}

¹Biological Sciences, Ohio University, Athens, Ohio, United States, ²Biology, Adelphi University, Garden City, New York, United States, ³Earth and Space Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States

Skeletochronological studies using fluorescent labelling methods have found support for the hypothesis that the density of vascular anastomosing in the cortex of long bones is correlated with the daily rate of bone deposition in long bones, however, the scaling of growth rates measured daily does not readily translate to rates measured on annual scales due to uneven growth through the year. Since growth in fossils is inferred on annual scales via cortical growth marks, we tested the hypothesis that annual growth rate is correlated to shifts in the density of vascular anastomoses by using Bayesian

threshold models on a sample of twenty femora and twenty tibiae from thirty-four taxa of non-avian theropod dinosaurs. Threshold modeling treats discrete traits as a continuous variable called a liability, which has specific threshold values that govern when state changes occur. We can then compare the liability and a second continuous variable to identify if changes of the discrete and continuous trait are correlated along a phylogeny. Published data were used to identify the specific region in each bone representing the period of maximum annual growth. We then classified the density of vascular anastomoses in the maximum growth zone as either minor (e.g., longitudinal vascularity) or major (e.g., plexiform, reticular, or laminar vascularity) and collected the maximum body mass gained annually in both kilograms (BM_{kg}) and as the maximum annual percentage increase in body mass ($BM_{\%}$) from published data. We ran four million iterations of each model and extracted the mean and 95% confidence intervals (CI) of the correlation coefficient. Our results indicate that only BM_{kg} models provide a reliable correlation between annual growth rate and the degree of vascular anastomosis. The evolution of longitudinal canals seems to be correlated with shifts to slower maximum annual growth rate, whereas vascularity with denser anastomosing is correlated with shifts to faster annular growth, supporting the hypothesis of a correlation between the density of vascular anastomoses and the rate of bone apposition at different temporal scales.

Funding Sources OCEES GRFP 2024

Technical Session 6: Ornithischia II (Thursday, October 31, 2024, 8:00 AM)

Intra- and inter-specific variation in *Psittacosaurus* (Dinosauria; Ornithischia)

and its implications for sympatry in early-diverging ceratopsians

Son, Minyoung¹, Erickson, Gregory M.², Zhou, Chang-Fu³, Yin, Ya-Lei⁴, Makovicky, Peter¹

¹Department of Earth and Environmental Sciences, University of Minnesota Twin Cities, Minneapolis, Minnesota, United States, ²Department of Biological Science, Florida State University, Tallahassee, Florida, United States, ³College of Earth Science and Engineering, Shandong University of Science and Technology, Qingdao, Shandong, China, ⁴College of Paleontology, Shenyang Normal University, Shenyang, Liaoning, China

The ceratopsian genus *Psittacosaurus* is the most speciose non-avian dinosaur with reports of sympatric species at multiple sites. However, intraspecific variation within these morphologically similar species has not been examined fully, questioning both current taxonomy and distributions.

We examined *Psittacosaurus* species with reports of sympatry including new specimens assigned to *P. mongoliensis*, *P. lujiatunensis*, *P. meileyingensis*, and *P. sinensis* to characterize ontogenetic and other intraspecific variation in each. The range of variation seen in the complete growth series of *P. mongoliensis* and *P. lujiatunensis* reveals many supposedly diagnostic features as subject to taphonomic deformation or ontogenetic variation.

Different *Psittacosaurus* species can be differentiated based on unique combinations of variably developed craniofacial characters relative to comparably sized and/or developmentally-aged individuals of other species. Our survey of *Psittacosaurus* taxonomy accounting for intraspecific variation supports a distributional pattern in which only a single species is found in each region/locality. Furthermore, no morphological changes outside the range of ontogenetic and taphonomic variation are observed across stratigraphic levels within

each region. Additionally, specimens from different regions show differences in character combinations that transcend the ontogenetic variation within any regionally delimited single species. Reported cases of sympatric *Psittacosaurus* species are instead attributed to taphonomic deformation, ontogenetic variation, and/or other intraspecific variation. Histologically mature *P. sinensis* exhibit a mosaic of features observed in either juveniles or adults of other species, which combined with its small adult size and paedomorphic growth pattern, indicate heterochronic evolution.

Our revised taxonomic framework points to *Psittacosaurus* being diverse with allopatric species being morphologically conservative and geologically long-lived. The genus itself has a duration of ~25M years, with species age ranges of up to ~10M years for *P. sinensis* and ~6M years for *P. meileyingensis*. This stands in marked contrast to the pattern of rapid diversification in later-diverging ceratopsids characterized by multiple sympatric, but short-lived species.

This study highlights the need for studies in intraspecific variation and warrants caution in evaluating modes of speciation while the assessment of taxonomic diversity is in flux.

Funding Sources This research was supported by the NSF, FRES award (#1925884) to P. J. Makovicky and UMN Thesis Research Travel Grant and Dayton Bell Museum Fund to M. Son.

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

The first small-bodied diapsid reptiles from the famous Konservat-Lagerstätte in the Grès à Voltzia (Middle Triassic: lower Anisian) of northeastern France

Spiekman, Stephan¹, Rossi, Valentina^{2,7}, Foth, Christian⁴, Slater, Tiffany S.^{2,7}, Bath Enright, Orla¹, Dollman, Kathleen⁵, Serafini, Giovanni⁶, Sues, Hans-Dieter³, McNamara, Maria E.^{2,7}, Schoch, Rainer R.^{1,8}

¹State Museum of Natural History Stuttgart, Stuttgart, Germany, ²School of Biological, Earth and Environmental Sciences, University College Cork, Cork, Ireland, ³Environmental Research Institute, University College Cork, Cork, Ireland, ⁴Department of Geosciences, University of Fribourg, Fribourg, Switzerland, ⁵European Synchrotron Radiation Facility, Grenoble, France, ⁶Dipartimento di Scienze Chimiche e Geologiche, Università degli Studi di Modena e Reggio Emilia, Modena, Italy, ⁷Department of Paleobiology, National Museum of Natural History, Washington DC, District of Columbia, United States, ⁸Institut für Biologie, Universität Hohenheim, Stuttgart, Germany

The clastic sediments of the Grès à Voltzia of northeastern France (Upper Jura Sandstein) were deposited in a deltaic setting just as the Muschelkalk Sea began to inundate the Central European Basin. It is renowned for its exquisite preservation of diverse flora and fauna, particularly plants and insects. Due to its early Anisian age (~245 mya), it represents a crucial record for understanding of the floral and faunal changes in the aftermath of the Permian-Triassic mass extinction. Despite its wealth of fossils, tetrapod remains have been poorly represented at Grès à Voltzia, with only a single temnospondyl, *Eocyclotosaurus lehmani*, having been described thus far. Recently, the State Museum of Natural History in Stuttgart (SMNS) acquired the largest known collection of Grès à Voltzia fossils, which will be featured in a special exhibition at the museum in 2025. Here, we present three previously undescribed reptile skeletons from this collection. They represent articulated remains of particularly small-bodied diapsids (maximum preserved length <12 cm), belonging to two different diapsid taxa. The first specimen is a small

tanysaurian archosauromorph. Its skeleton is largely complete but heavily phosphatised, obscuring most anatomical details. The specimen is most reminiscent of *Macrocnemus* spp. in its overall body proportions, despite being much smaller (61 mm) than known specimens of that taxon. The second taxon is a drepanosauromorph reptile represented by two skeletal specimens, one preserving a largely complete postcranium, and another an excellently preserved but tiny skull. This is the stratigraphically oldest record of this clade and provides further evidence of the rapid diversification of reptiles in the Triassic. Reconstruction of the skeletal anatomy of these specimens was aided by UV-induced fluorescence. In addition, the skull has been virtually reconstructed using propagation phase-contrast synchrotron microtomography (PPC-SRμCT). Our findings highlight several features suggesting an arboreal and insectivorous lifestyle in this taxon. Together, these taxa emphasize the significance of the Grès à Voltzia for our understanding of the recovery of wooded ecosystems, not only for plants and invertebrates but also for small tetrapods. Planned future investigation of the mineralogical composition of the Grès à Voltzia may reveal the properties that facilitate the exceptional preservation seen at this Lagerstätte.

Funding Sources DFG Grant No. SCHO 791/7-1 to Rainer Schoch, ERC Grant H2020-ERC-COG-101003293-PALAEOCHEM to Maria McNamara, and The Lauer Foundation PSE to Giovanni Serafini.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

A new occurrence of *Saurichthys* (Actinopterygii) from the Dockum Group of Texas (Late Triassic, Norian) highlights the uneven tempo of the appearance of

specialized jaw morphologies in ray-finned fishes

Stack, Jack, Nesbitt, Sterling J., Stocker, Michelle R.

Geosciences, Virginia Polytechnic Institute and State University, Blacksburg, Virginia, United States

Neopterygian ray-finned fishes (Actinopterygii) include a morphologically diverse array of biters, ranging from species with narrow, elongate jaws that efficiently transmit motion (=fast bites) and deep, short jaws that efficiently transmit force (=strong bites). Late Triassic (Norian) marine assemblages in Europe are some of the earliest to include neopterygians with short, deep jaws analogous to extant taxa with powerful, force-specialized bites. Although these assemblages include fast biters with elongate jaws, these species are exclusively non-neopterygians. Late Triassic (Norian) freshwater assemblages from the western United States are an opportunity to compare the evolution of actinopterygian biting in marine and freshwater environments. We collected elongate rostral fragments and teeth from microvertebrate sites in the Late Triassic (?early Norian) Boren Ranch beds (Dockum Group) of Texas. We determined that these fossils belong to the extinct ray-finned fish *Saurichthys* based on the presence of teeth with caps of translucent tissue (=acrodin) placed on fused, elongate rostromaxillary elements. The Dockum taxon is distinct from *Saurichthys* from the Late Triassic (Norian) Chinle Formation of Arizona in lacking prominent, dorsal-ventral ridges along the lateral surface of the oral margin of the rostromaxilla. The occurrences of *Saurichthys* in the Dockum Group and previous reports in the Chinle Formation expand the geographic and environmental range of the taxon outside of the marine northwestern Tethys in the Norian. Previous phylogenetic and paleoecological study of *Saurichthys* indicate its position

outside the actinopterygian crown group and its morphological convergence on living ray-finned fishes with lengthened jaws and fast bites. Therefore, the novel species of *Saurichthys* was most likely a fast-biting predator, preceding the appearance of neopterygians with extremely elongate jaws in the Middle Jurassic. Our finding reinforces an apparent disjunct timing of the evolution of force and velocity specialized bites in neopterygians, implying that the initial ecological diversification of the clade that occupies ~50% of extant vertebrate species diversity began with force specialized biting. Our work implies that morphologically distinct specializations of the same function that are present in extant taxa, such as force and velocity specialized biters, evolved with different frequencies in deep time.

Funding Sources David B. Jones Foundation (SJN/MRS); NSF Career #1943286 (SJN); Virginia Tech Geosciences (JS).

Colbert Prize Session

Variation in the Early Permian North American synapsid cleithrum

Stancik, Lauren A.^{1,2}, Flis, Chris², Rosscoe, Steven¹

¹Kimbrell School of Geosciences, Midwestern State University, Wichita Falls, Texas, United States, ²Whiteside Museum of Natural History, Seymour, Texas, United States

Major anatomical changes have been observed and documented as tetrapods evolved to live on land. The loss of the cleithrum is one such change. While a major pectoral bone in fish, in all living tetrapods, excluding anurans, the cleithrum is absent. In the Cisuralian Epoch (Early Permian), most tetrapod lineages still exhibit a distinct cleithrum. Despite the evolutionarily transitional importance of the bone and its purpose as a functional muscle attachment

site, few studies have examined the early synapsid cleithrum in detail since the 1940s. Due to a paucity of material, little has been done to differentiate the cleithrum across early synapsid taxa. Collection and identification are hindered because the bone resembles a rib and is commonly disarticulated from the rest of the pectoral girdle. This study attempts to provide a more comprehensive understanding of the bone, laying the groundwork for future collections efforts. Specimens from the Craddock Bonebed in Baylor County, Texas, are the focus of this study. The Craddock has been a major collection site since the early 1900s, and multiple articulated skeletons have been documented. The site is an abandoned stream channel environment within the Clear Fork Group's Arroyo Formation. Synapsids such as *Dimetrodon* dominate, although cleithra from the genus are rare. Many skeletons have been recorded with signs of predation or scavenging, which may play a role in this scarcity. Specimens from the Craddock are compared to other synapsid taxa from the Early Permian. Photographs and illustrations are used to highlight diagnostic features within each specimen. A working vocabulary has been developed to better describe these diagnostic features, and formal descriptions for each specimen have been prepared.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Pronounced morphological diversity of
squamates in a Hell Creek (Montana, USA)
microsite**

Steele, Aaron¹, Bohus, Caleb P.⁴, Stroup,
Adrienne^{1,5}, Clark, Alexander^{3,1}, Caroll,
Nathan², O'Connor, Jingmai^{1,3}

¹Negaunee Integrative Research Center, Field
Museum of Natural History, Chicago, Illinois,
United States, ²Department of Earth
Sciences, Carleton University, Ottawa,

Ontario, Canada, ³Gantz Family Collections
Center, Field Museum of Natural History,
Chicago, Illinois, United States, ⁴Committee
on Evolutionary Biology, University of
Chicago, Chicago, Illinois, United
States, ⁵Carter County Museum, Ekalaka,
Montana, United States

Crown-group squamates originated in the
Middle Jurassic epoch (Bathonian ~168 MYA),
but entered an explosive radiation in the
Middle to Late Cretaceous, coinciding with
the Cretaceous Terrestrial Revolution
(Barremian-Campanian 125-80 MYA).
Terrestrial squamates in Cretaceous North
America reached the peak of their diversity in
the Maastrichtian, but were severely affected
by the KPg extinction. Much of what we know
about squamates from this age originates
from fragmentary fossils, but as the
morphology of the teeth and mandibles are
highly diagnostic in squamates, even these
fragments have proven sufficient to identify
squamates by species. Here we describe the
herpetofauna of Tooke's microsite, a site in
the Upper Hell Creek formation of Montana.
This site has yielded a dozen distinct dental
morphotypes of squamate as of this writing,
and while all of these fragments originate
from small-bodied animals, they display
marked diversity in tooth morphologies—the
morphotype with the largest teeth has teeth
nearly three times as wide as the morphotype
with the smallest teeth. This site is dominated
by fossils aligned with the chamopsiid family,
which is to be expected from a Hell Creek
site; but the ranges in tooth shape, size, and
orientation exceed previous known species
diversity of any single microsite. More
research is needed to clarify how many of
these morphologies represent unique taxa—as
squamate dentition changes with age, some
may represent earlier ontogenetic stages of
known taxa.

Technical Session 2: Paleontological
Practices: Preparation & Scientific Methods,

Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Digitizing collections in small museums: a case study at Pioneer Trails Regional Museum

Steffen, Darrah¹, Gallucci, John²

¹Paleontology, Pioneer Trails Regional Museum, Bowman, North Dakota, United States, ²Geology and Geological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, United States

Analysis of the fossil record requires aggregation of paleontological data from individual fossil localities. Prior to computers, these datasets were compiled by hand, a painstaking undertaking that took years of effort and forced paleontologists to make difficult choices about what types of data to consider. Digitization has greatly increased the amount of data available, but there is still a wide amount of ‘dark data’ unaccounted for. With the second digital revolution of paleontology and digitization efforts in museums, the amount of ‘dark data’ has been greatly reduced. However, there are still highly underutilized collections in small museums, leaving many specimens unknown. These collections have not been fully digitized due to the constraints placed on them due to budgets, staff, and/or location. Looking at a case study of Pioneer Trails Regional Museum (PTRM) in Bowman, ND, we aim to shed light on the importance of collection access through digitization and how this can be done under the constraint of a small museum. We will outline the processes used to complete the Bureau of Land Management Hell Creek Formation specimens housed at the museum. This project was completed with funding from the Institute of Museum and Library Services (IMLS). With the IMLS grant, we were able to hire an intern to assist with digitizing written records on fossil specimens and localities

dating from 1984 to 2013. These specimens and localities were documented from sites in Hell Creek Formation strata in Slope and Bowman Counties, North Dakota; Harding County, South Dakota; and Fallon County, Montana. We used Specify7 to compile and store various information on fossil specimens, including age, taxon, element, locality information, and collection date. Taxa ranged from aquatic vertebrates (e.g., *Lepisosteus*, *Melivius*, *Champsosaurus*) to terrestrial vertebrates (e.g., *Richardoestesia*, *Tyrannosaurus*, *Triceratops*) of varying completeness and condition. Several thousand fossil specimens and over 800 localities have been digitized to date, with work ongoing to add more information (associated publications, photographs of specimens, etc.) to the PTRM’s digital database.

Funding Sources This project was completed with funding from the Institute of Museum and Library Services (IMLS).

Technical Session 5: Paleozoic Herpetology (Wednesday, October 30, 2024, 1:45 PM)

Refining the geochronologic context of vertebrate assemblages from the Carboniferous-Permian transition in western North America

Stine, Jonathan M.^{1,2}, Feinberg, Joshua M.^{1,2}, Huttenlocker, Adam³, Irmis, Randall^{4,5}, Henderson, Charles M.⁶, Read, Michael T.⁷, Fernandez, Diego P.⁵

¹Institute for Rock Magnetism, University of Minnesota- Twin Cities, Minneapolis, Minnesota, United States, ²Earth and Environmental Sciences, University of Minnesota-Twin Cities, Minneapolis, Minnesota, United States, ³Department of Integrative Anatomical Sciences, University of Southern California, Los Angeles, California, United States, ⁴Natural History Museum of Utah, University of Utah, Salt Lake City, Utah,

United States, ⁵Department of Geology & Geophysics, University of Utah, Salt Lake City, Utah, United States, ⁶Department of Earth, Energy and Environment, University of Calgary, Calgary, Alberta, Canada, ⁷Department of Earth Sciences and Geologic Resources, Stephen F. Austin State University, Nacogdoches, Texas, United States

The upper Paleozoic Cutler Group of southern Utah, USA, is a key sedimentary archive for understanding the environmental and biological effects related to the planet's last pre-Quaternary icehouse-hothouse state change: the Carboniferous–Permian transition (CPT), between 304–290 Ma. Paleontological data collected over several decades suggests that within the Cutler Group, the CPT corresponds to a broad shift from primarily aquatic vertebrate assemblages towards more terrestrial biota. This change coincides with, and may be related to, a large-scale aridification trend recorded in the rock record as a progression from shallow marine carbonate, followed by fluvial siltstone, culminating in a thick aeolian sandstone. Nevertheless, the lack of precise geochronologic control results in a tenuous correlation of these regional phenomena to environmental and climate processes operating at the global scale across the CPT, making it difficult to test hypotheses for the observed biotic transition.

The goal of the PERMIA Project (Paleozoic Equatorial Records of Melting Ice Ages) is to refine the geochronology of the Cutler Group by integrating new observations from micropaleontology (conodonts and fusulinids), ⁸⁷Sr/⁸⁶Sr chemostratigraphy, magnetostratigraphy, and cyclostratigraphy to test these hypotheses. Preliminary biostratigraphic data from both core (Elk Ridge Core #1) and outcrop (Valley of the Gods, Bears Ears National Monument) have revealed primarily uppermost Carboniferous species such as *Streptognathodus* cf. *S. virgilicus* within the upper marine layers of the

lower Cutler beds. Paleomagnetic results primarily show reversed declinations and shallow inclinations, typical of the Kiaman reversed superchron (~319–266.7 Ma). One exception to this is a thin zone of mixed to normal polarity, which could potentially be correlated to the Kartamysian Normal Event (~299.3 ± 0.3 Ma). Current results suggest that the environmental shifts demonstrated in the geologic record potentially corresponds to the Early Permian development of more intense glaciation. This provides a possible mechanism for the ecological shift, with more terrestrial taxa such as diadectomorphs and sphenacodontians. This multidisciplinary study has the potential to provide critical insights into the environmental and evolutionary implications of this major climatic transition.

Funding Sources National Science foundation: NSF-2221050, NSF-2219902, NSF-2219947, NSF-2153786, NSF-1951112. University of Minnesota Grants in aid #500130.

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

New species of *Albertosaurus* from a distinct stratigraphic unit of the Horseshoe Canyon Formation corresponding to faunal and climatic changes

Stock, Jordan C.¹, Powers, Mark J.¹, Coppock, Colton¹, Raun, Gorm S.¹, Sharpe, Henry S.¹, Voris, Jared T.², Napoli, James G.³, Currie, Philip J.¹

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Earth, Energy and Environment, University of Calgary, Calgary, Alberta, Canada, ³North Carolina Museum of Natural Sciences, Raleigh, North Carolina, United States

Previously limited tyrannosaur material from the Horseshoe Canyon Formation of Alberta,

Canada, has led to the recognition of a single tyrannosaurid species, *Albertosaurus sarcophagus*. However, the discovery of new *Albertosaurus* specimens has prompted a review of all *Albertosaurus* material. In this review, we recognize two stratigraphically separated and distinct morphotypes of *Albertosaurus* in the Horseshoe Canyon Formation, utilizing morphometric analyses of all known maxillae and discrete cranial characters. One morphotype includes the type series and several other specimens of *Albertosaurus sarcophagus*, all of which were collected from the Horsethief and Morrin members of the Horseshoe Canyon Formation. The other morphotype consists of a near complete skeleton and all cranial material from the *Albertosaurus* bonebed in Dry Island Buffalo Jump Provincial Park, both localities being from the upper Tolman Member.

The upper Tolman Member morphotype specimens display a suite of morphological differences in the quadrate, squamosal-postorbital contact, cranial pneumaticity, and sinuses throughout the skull that distinguish them from the lower Horsethief-Morrin Member morphotype. All osseous features are consistent across specimens within each morphotype regardless of ontogenetic stage, there is little to no evidence of intermediate morphologies. Variation in proportions is observed, however, discrete characters are consistent providing clear diagnostic apomorphies.

The two stratigraphically separated tyrannosaurid species correspond with faunal turnover best seen in herbivorous dinosaurs, and a climatic change in the Horseshoe Canyon Formation. The Horsethief Member represents a wetter and hotter climate with *Edmontosaurus regalis* as the dominant megaherbivore, while the Tolman Member is cooler and drier with *Hypacrosaurus altispinus*.

Funding Sources This research was funded by the Dinosaur Research Institute.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

A well-preserved specimen of the stem-cheloniid *Pacifichelys urbinai* from the Upper Miocene Monterey Formation of California (USA) and the evolution of Pacific marine tetrapod dispersals during the Miocene

Stock, Tristan J., Parham, James

Geology, California State University Fullerton,
Redondo Beach, California, United States

Modern hard-shelled sea turtles (crown group Cheloniidae, seven extant species) originated in the middle or late Miocene. The fossil stem of this clade is found from Cretaceous to Miocene strata from all continents except Antarctica, but pan-cheloniid specimens from the Late Miocene, a transitional time between stem and crown lineages, are rare. Here, we report the first well-preserved pan-cheloniid from the Late Miocene (LACM 21850), a subadult stem cheloniid from the Upper Miocene part of the Monterey Formation of Orange County, California (USA). LACM 21850 was collected from a pure diatomite, suggesting a rapid burial in diatom ooze. The specimen includes a well-preserved skull with palatal characters allowing identification as *Pacifichelys urbinai*, previously described from skulls from the Pisco Formation of Peru 9.5-8.6 Ma. Diatoms recovered from the skull surface of LACM 21850 allow for accurate dating to 8.8-8.6 Ma, making it approximately coeval or slightly younger than the Pisco specimens. LACM 21850 preserves extensive postcranial material that includes the following plesiomorphic characters: retroarticular processes on the phalanges, humeri lacking a v-shaped, distally shifted, lateral process, and an incomplete femoral trochanter

separated by a fossa. These characters support the previous referral of similar limb material to *Pacifichelys hutchisoni* from the older (Middle Miocene, 15.9-15.2 Ma) Sharktooth Hill bonebed (Round Mountain Silt) of Kern County, California (USA). The presence of *P. urbinai* in California (USA) and Peru makes this the first marine tetrapod species to be recognized on the Pacific coasts of both North and South America during the Miocene. This discovery also reinforces previous work highlighting faunal similarities between the Monterey Formation and those of the Pisco Basin, showing that several lineages of marine tetrapods had independently dispersed across the eastern Pacific equatorial waters by the late Miocene.

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

Clade-specific relationships between digging mode, body size, and cranial suture complexity in mammals

Strassberg, Sarah S.

Committee on Evolutionary Biology,
University of Chicago Division of the
Biological Sciences, Chicago, Illinois, United
States

Nasofrontal suture (NFS) complexity is extremely variable among extant mammals, ranging from simple and nearly invisible (e.g., talpids) to moderately complex (e.g., hedgehogs) to highly indigitated (e.g., spalacids). Other cranial sutures' morphologies respond to factors such as food hardness, masticatory strain, and static loading of cranial ornaments, but the factors underlying NFS complexity remain understudied. Elevated NFS complexity in fossorial taxa such as cistecephalid dicynodonts and some *Palaeocaster* species may be correlated with aspects of fossoriality. A broad survey of NFS complexity across Mammalia can untangle phylogenetic,

functional, and body size-related patterns affecting this character and may elucidate its capacity for prediction of behavioral and ecological traits (e.g., degree of fossoriality, digging mode preference). Here, I conduct such a survey across 172 extant and 66 fossil mammal species, including taxa from Rodentia, Carnivora, Eulipotyphla, Afrotheria, and Xenarthra, with a focus on species that engage in fossorial behaviors. Specimens were photographed in dorsal view, and the minimum and actual length of the NFS measured from the midline to the junction with the frontomaxillary and zygomaticomaxillary sutures. Suture complexity was calculated as (actual NFS length) / (minimum NFS length). Across Rodentia, head-lift and chisel-tooth diggers exhibit significantly higher NFS complexity ($p < 0.05$) than scratch diggers and non-fossors, perhaps reflecting a need for mitigation of increased biomechanical stresses caused by moving substrate with the incisors and/or dorsal skull. However, scratch-digging and non-fossorial murids also display high NFS complexities, a possible result of gnawing and/or elevated cranial stresses brought on by myomorphy. Preliminary analyses suggest that correlations between body size and NFS complexity are largely clade-specific, with the smallest members of some orders exhibiting highly reduced NFS complexity (e.g., Eulipotyphla), but not others (e.g., Rodentia). Phylogenetic comparative analyses (e.g., phylogenetic generalized least squares) will be conducted to further investigate how strongly phylogeny affects the relationships between body size, digging mode, and NFS complexity within and across clades. This project will provide new insights into the phylogenetic and functional significance of an understudied cranial suture and a better understanding of functional morphology in fossil taxa.

Funding Sources Burke Museum Vertebrate Paleontology Collections Study Award

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

To fuse or not to fuse: drivers of symphyseal fusion in whales

Strauch, Rebecca J.¹, Peredo, Carlos M.^{1,2}

¹Department of Geology and Environmental Earth Science, Miami University, Oxford, Ohio, United States, ²Department of Biological Sciences, Miami University, Oxford, Ohio, United States

Cetaceans are a diverse group of marine mammals well-known for exhibiting extreme modifications to the mammalian body plan inherited from their terrestrial ancestors. These modifications, such as dorsally placed nostrils on top of the skull and reduced hind limbs, facilitate life in the water. Even after becoming fully aquatic, whales continue to modify their morphology as they diversify in feeding ecology. This diversity of feeding modes manifests in morphological disparity of the feeding apparatus, such as tooth count, rostral length, and mandibular fusion. This study examines variation in the mandibular symphysis to understand macroevolutionary patterns of the feeding morphology in whales.

In mammals, the mandibular symphysis is where left and right mandibles articulate anteriorly at the midline. Union of the mandibles may range from completely unfused and kinetic (e.g. anteaters) to completely fused and immobile (e.g. hominids). Cetaceans span this range, with some lineages evolving to the extremes. Odontocetes repeatedly evolve extreme fusion and elongation, whereas mysticetes have evolved unfused mandibles with no bony connection. Diverse symphyseal morphologies are likely linked to diverse feeding ecologies across Cetacea. For example, extreme elongation facilitates raptorial piscivory, and unfused mandibles

accommodate bulk filter feeding. Understanding macroevolutionary patterns associated with this trait, however, requires a more comprehensive study that examines its broader distribution.

This study examines the temporal and ecological drivers of symphyseal fusion in whales. We document and describe the diversity of symphyseal fusion and elongation. We analyze symphyseal fusion across phylogeny and identify key temporal and phylogenetic transitions. Finally, we explore potential drivers of fusion in cetaceans, including feeding ecology, major climatic events, and other changes in Earth systems. The results of this study bear on how dynamic Earth systems drive macroevolutionary patterns in whales.

Funding Sources This work was funded by the Burke Museum Vertebrate Paleontology Collection Study Grant and Miami University Department of Geology and Environmental Earth Science.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

New exceptionally-preserved specimens of *Microgomphodon oligocynus* offer novel insights into the ecomorphology of the most derived therocephalian (Synapsida: Therapsida)

Stuart, Brandon P.^{1,2}, Huttenlocker, Adam³, Wolvaardt, Frederik P.⁴, Fernandez, Vincent⁵, Botha, Jennifer^{1,6}

¹Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa, ²School of Geosciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ³Department of Integrative Anatomical Sciences, University of Southern California, Los Angeles, California, United States, ⁴Karoo Palaeontology, Iziko Museums of South Africa, Cape Town, Western Cape,

South Africa, ⁵The European Synchrotron Radiation Facility, Grenoble, France, ⁶GENUS: DSI-NRF Centre of Excellence in Palaeosciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

The Permo-Triassic baurioid radiation produced the most speciose and globally widespread therocephalian lineages into the subsequent Early and Middle Triassic. Among baurioids, the Bauriamorpha convergently evolved multiple derived “mammal-like” features such as an osseous secondary palate and complex buccolingually expanded postcanine teeth. Although relatively well-represented in northern Pangea, the majority of endemic genus-level bauriamorph diversity in the Karoo Basin was lost by the late Early Triassic (Olenekian) with only two taxa (*Microgomphodon oligocynus* and *Bauria cynops*) of the Bauriidae family being present. Here, we provide novel ecomorphological data on one of the latest-surviving and morphologically specialized therocephalians, *Microgomphodon oligocynus*, by examining three specimens which represent an ontogenetic series (skull lengths 60–92mm). All three specimens were recovered from different *Cynognathus* Assemblage Zone localities in the Burgersdorp Formation of the Beaufort Group (Karoo Supergroup). Notably two of these specimens include the largest articulated skeleton (SAM-PK-K11601) as well as the smallest skeleton (CGS CGP/1/44), and the latter is encased inside the terminal chamber of a burrow. Using a combination of X-ray computed tomography (CT) and synchrotron X-ray CT scanning we provide the first postcranial description of *Microgomphodon* and compare the postcranial anatomy with that of other therocephalians. Additionally, we present the first osteohistological and microanatomical description of the largest known bauriid therocephalian skeleton. We showcase several characters that are autapomorphic and reveal previously unknown

ecomorphological diversity in the group. *Microgomphodon* is characterized by a stocky postcranial bauplan with an enlarged scapula that possesses a prominent enigmatic scapular flange; a broad manus with elongated metacarpals, shortened proximal phalanges, and long unguals; enlarged ilia; a robust femur and tibia. Finally, we explore how these anatomical and microanatomical features of *Microgomphodon*, coupled with the presence of an individual preserved in the terminal burrow chamber, provide strong evidence for the fossorial capabilities of the genus. Overall, this study details nearly every facet of the anatomy of *Microgomphodon*, producing the most in depth palaeobiological investigations of a bauriid therocephalian to date.

Funding Sources GENUS: DSI-NRF Centre of Excellence in Palaeosciences, National Research Foundation (Grant No. 136513), the Palaeontological Scientific Trust funded this research.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

New anatomical information of *Glyphoderma kangi* (Placodontia, Sauropterygia, Reptilia) from the Middle Triassic of South China

Su, Cindy X.¹, Gu, Shulun¹, Jiang, Da-yong¹, Motani, Ryosuke², Rieppel, Olivier³, Zhou, Min¹, Sun, Zuoyu¹

¹School of Earth and Space Sciences, Geological Museum, Peking University, Beijing, Beijing, China, ²Department of Earth and Planetary Sciences, University of California, Davis, Davis, California, United States, ³Integrative Research Center, The Field Museum of Natural History, Chicago, Chicago, Illinois, United States

Glyphoderma kangi from the Ladinian of the Middle Triassic is the oldest record of

cyamodontoid placodont known in South China, but the anatomy of its skull and dorsal shell was briefly described previously and most details were ambiguous. Two mostly complete and well-preserved skeletons, XNGM FY-R01 and XNGM FY-R02, are described here to reveal new anatomic information on the skull, pectoral girdle, pelvic girdle, transverse processes, ribs, and gastralia. Besides the unique osteoderms with radiate grooves and ridges that form the carapace, six other types of osteoderms are found covering the skull and the mandible, composing the lateral wall and forming an incomplete inner layer of the carapace, respectively. Different from the holotype, the dorsal and lateral sides of the skull are nearly completely covered by osteoderms, causing very few areas of the cranium exposed. The ventral side shows the palatal complex and the mandible, with rounded, plate-like teeth carried by the maxilla and palatine. An inner layer of the carapace had never before been mentioned or described in cyamodontoid placodonts. It is presumed that the dorsal ribs and the osteoderms forming the inner layer could reinforce the periphery of the carapace. Features including relative limb length indicate that *Glyphoderma kangi* has reached the marine adaptation step of at least M4. Considering its morphology and ecology, *Glyphoderma kangi* probably lived a benthic life where danger mainly came from above. This study provides new information on the anatomy of the species, especially revealing the ventral view of the species for the first time, and complements our knowledge of the structure of the dermal armor of Cyamodontoidea.

Funding Sources Funding for this work was received from NSFC.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Curating the cave: It's a trap!

Sullivan, Colleen A., Sims, Megan, Miceli, Samantha

Division of Vertebrate Paleontology,
Biodiversity Institute, Lawrence, Kansas,
United States

Natural Trap Cave (NTC) is a Bureau of Land Management (BLM) collection primarily repositied at the University of Kansas Biodiversity Institute, Vertebrate Paleontology division (KUVVP). It is one of the most studied collections within KUVVP and comprises approximately 25% of the entire KUVVP collection. In summer 2023, numerous cataloging errors were identified in the NTC collection, such as pairs of specimens with duplicate catalog numbers but data for only one specimen in the pair, or “missing” specimens that were accounted for with records but had an incorrect catalog number written on the specimen. These errors have impacted researchers who may unknowingly publish mismatched stratigraphic and temporal data, which can have detrimental implications for biogeographical studies. The errors have also led to difficulties locating specimens and ensuring their proper cataloging, which is in violation of standards in the Department of the Interior (DOI) Manual 411 and several DOI Museum Property Directives. Further, these cataloging errors have postponed efforts to integrate the NTC database, which has never been publicly accessible, with the rest of the KUVVP collections database that is searchable online. This delay hampers the public's ability to view the specimen records and strains collection staff's time when providing records for individual requests. The goal of this project was to identify and resolve cataloging errors while ensuring NTC database records are accurate, so they can be publicly searchable and the collection can be brought back into BLM compliance. To accomplish this, we took a three-step approach: Inventory, Identify, Remediate. First, a comprehensive inventory of NTC specimen numbers and physical locations was

manually created. Then, a semi-structured text-processing program was developed in R to identify duplicate numbers in the inventory, saving hundreds of worker-hours searching each number. Data conflicts were then resolved by comparing specimens with duplicate numbers against card catalogs, digital records, and field notes to ensure bones were properly numbered and associated with the appropriate stratigraphic data. This project highlights the need for institutions to frequently conduct collection inventories and establish standardized curation workflows. It also provides an example for potential curation workflows and the integration of technical skills into the workflow, which could make cataloging errors easier to detect and resolve.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Physical 3D model of partial ribcage confirms that avian uncinat processes act as levers for the appendicocostalis musculature

Sullivan, Corwin^{1,2}, Hatch, Keeley³, Katerenchuk, Alyson³, Wang, Yan-yin¹, Wong, Jaime³

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Philip J. Currie Dinosaur Museum, Wembley, Alberta, Canada, ³Mechanical Engineering, University of Alberta, Edmonton, Alberta, Canada

Crown (neornithine) birds typically have several pairs of bony prongs, the uncinat processes (UPs), extending caudodorsally from the midshaft portions of the vertebral ribs near the cervicodorsal transition. A slip of Mm. appendicocostales (MA) connects each UP to the caudally adjacent rib, and electromyographic evidence indicates that MA likely drive inspiration. Existing 2D geometric models suggest UPs act to increase the moment arms of the MA slips.

We used a physical model to study avian UP function in 3D. The unilateral model comprised two successive vertebral ribs and their corresponding sternal ribs, with the intervening parts of the vertebral column and sternum. The vertebral and sternal ribs were rods of equal length, with complete rotational freedom at each end, and the sternum was part of a fixed frame. The vertebral column was a beam that could slide dorsoventrally but was otherwise immobile, so that mirroring the ribs would always result in bilateral symmetry. The first vertebral rib bore a rod about half the length of a rib segment, representing a UP. Kinematic analysis indicated that the UP provided a 20% increase in the torque available for rib protraction and retraction. More interestingly, replicating breathing by mimicking MA contraction alone proved impossible because the system was highly under-defined (the ribcage could accommodate each incremental decrease in muscle length by adopting any of a number of different configurations). Based on minimization of work, the system tended to respond to muscle contraction with movements that minimized volumetric change. An additional kinematic constraint, representing a muscle (i.e. M. obliquus abdominis externus) that limited the movement of the UP, was needed to produce large changes in volume.

By enhancing the moment generated by MA, neornithine UPs presumably help these slips move the large mass of the sternum and associated muscles. When ventilation and wingbeat are decoupled, a flying bird may have to inhale against resistance from a contracting M. pectoralis or M. supracoracoideus. Bony UPs occur in most non-neornithine birds and a small number of non-avian dinosaurs, but differ from those of neornithines in not being fused to the vertebral ribs. Furthermore, cartilaginous UPs similar to those of extant crocodilians were likely widespread in Dinosauria. Unfused or unossified UPs may have been less effective,

rigid levers than those of neornithines, but likely had the same basic function.

Funding Sources This work was funded by the Natural Sciences and Engineering Research Council of Canada (Discovery Grants RGPIN-2017-06246, RGPIN-2023-04916).

Technical Session 12: Euarchontoglires
(Friday, November 1, 2024, 8:00 AM)

Biogeography and community structure of Eurasian and African large mammals from the Late Miocene to the present: continental-scale turnover, functional stability, and no wave of dispersal associated with *Homo* Out of Africa.

Sun, Jijia¹, Bibi, Faysal¹, de la Torre, Jacio²

¹Museum für Naturkunde, Leibniz Institute for Evolution and Biodiversity Science, Berlin, Germany, ²Instituto de Historia, CSIC-National Research Council, Madrid, Spain

The origin of early hominins in Africa is widely accepted based on fossil and archeological evidence. There are different ideas on the context or possible drivers of the dispersal, including environmental change, faunal change, evolutionary change, or technological advances. Additionally, there are questions about the impact of hominins on Eurasian faunas after their dispersal there. For example, several large carnivores are believed to have accompanied hominins from Africa into Eurasia, and possibly these new arrivals could have precipitated major changes in Eurasian mammal community structure. But this has not been synthetically examined before. The spatial and temporal distribution of large mammal faunas contemporary with early *Homo* could help us understand the context and impact of hominin dispersal out of Africa.

In this study, we focused on the Eurasian and African large mammal faunas of the last 10

Ma. We conducted both taxonomic (genus-level) and functional clustering based on pairwise similarity in order to better understand the faunal context and potential impact of hominin dispersals on Eurasian community structure. Body mass, diet and locomotion were used as functional traits. We tested two hypotheses: 1) the dispersal of hominins across Eurasia around or shortly after ~2 Ma was part of a wave of faunal dispersal out of Africa; 2) the arrival of hominins at Eurasian sites coincided with major changes in the functional structure of large mammal communities in Eurasia.

Our results indicate that hominin dispersal from Africa to Eurasia during the early Pleistocene was not part of a significant faunal dispersal and that Eurasian faunas have remained distinct from African faunas since at least the early Pliocene. Our results also indicate a relative stability in community functional structure across Eurasia and Africa since at least 10 Ma.

Funding Sources Funding for this work was received from ERC Advanced Grant BICAEHFID (to I.d.L.T.),

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

3D scanning the Pipestone Creek Bonebed as a mapping technique during fossil excavation and preparation: preserving key context of fossil localities

Sweder, Jackson¹, Bamforth, Emily^{1,3}, Scott, Maximilian J.², Kerr, Aidan¹

¹Philip J Currie Dinosaur Museum, Wembley, Alberta, Canada, ²Department of Geological Sciences, University of Saskatchewan, Saskatoon, Saskatchewan, Canada, ³Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba, Canada

A variety of tasks are required in fossil excavation to safely extract specimens from the ground for preparation, preservation and research. Many of these tasks involve keeping diligent records of the fossil locality and geological context through taking notes, photos, and drawings of the fossil in situ prior to and during excavation. One important aspect of fossil context is the relation of the fossil relative to other specimens surrounding it. Historically, quarry mapping using sketches of the fossils on a grid has been used to record this information. Incorporating strike and dip measurements of specimens while mapping can help to include relative direction, as well as relative depth, of the fossils in the ground. Photos may also help record this information as well.

In the case of the Pipestone Creek Bonebed (PCB) in northern Alberta, Canada, all these techniques have been used to record fossil context. This type of mapping has been employed since this monotaxic *Pachyrhinosaurus* bonebed was discovered in the early 1970's, and has contributed greatly to our understanding of the site. However, there are some unique challenges of mapping the PCB. The density of the bonebed, with as many as 300 specimens per square meter, results in a high degree of specimen overlap. This vastly complicates the mapping process, as drawing so many specimens onto a single sheet of paper, with associated notes, can quickly result in a confusing cluster on the map sheet. The maps become difficult to read in the densest pockets of fossils.

A solution implemented at the PCB uses a handheld three-dimensional (3D) visible light scanner to digitally map the individual grids, allowing for the capture of more precise information of fossil context in 3D space. These digital maps are created before and after every large fossil is removed, or once every two days of excavation, to capture the majority of small (<10cm) fossils. These digital maps improve data resolution by

comparison to paper maps because the scanner removes potential user error and visual bias during manual mapping of the fossil, even when using a plumb bob to mark key points on the grid that the fossil occupies. This technique allows researchers to gain a much more precise and comprehensive understanding of the bonebed deposition and taphonomy going forward, providing future studies with more accessible information.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

Revised biostratigraphic age of the late Paleocene *Titanoides* locality, Bison Basin, Wyoming, and its paleobiogeographic implications

Sweedler, Rory E.¹, Rust, Kathleen L.², Beard, K. Christopher²

¹Geology, University of Kansas, Lawrence, Kansas, United States, ²Biodiversity Institute and Ecology & Evolutionary Biology, University of Kansas, Lawrence, Kansas, United States

Middle to late Tiffanian mammalian faunas of western North America are poorly understood compared to those dating to the latest Paleocene, particularly outside of the Bighorn Basin, Wyoming. The *Titanoides* locality in the Bison Basin, south-central Wyoming has yielded an understudied mammalian assemblage that was previously assigned to the *Plesiadapis fodinatus* lineage zone (Ti-5) based on the presence of *Plesiadapis fodinatus*, which has been cited as an index taxon for Ti-5. Iterative fieldwork at the *Titanoides* locality over the past two decades has significantly augmented its mammalian fauna, but key index taxa for the base of Ti-5, including *Probathyopsis* (Dinocerata) and *Arctostylops* (Arctostylopidae), have never been recovered there. Our updated faunal list includes 21 taxa representing nine orders, nearly doubling the known diversity of the

locality. With a significantly larger sample than previously known, we reidentify the plesiadapid occurring at the *Titanoides* locality as *Plesiadapis churchilli* and report the first occurrence of *Ignacius frugivorus* from the locality, a paromomyid whose temporal range does not extend into Ti-5. The co-occurrence of *Plesiadapis churchilli* and *Ignacius frugivorus*, rather than *P. fodinatus* and *Phenacolemur archus*, indicate the *Titanoides* locality should be placed in the *Plesiadapis churchilli* lineage zone (Ti-4a). This correlation is reinforced by the occurrence of *Arctocyon mumak*, *Aletodon conardae*, *Protictis paralus*, and *Ectocion cedrus* at the locality. This study documents temporal range extensions for *Acmeodon* and *Mimotricentes fremontensis*, taxa whose last occurrences were previously thought to occur during the *Plesiadapis rex* lineage zone (Ti-3). Results from our biostratigraphic analysis highlight the utility of first appearances of allochthonous clades versus gradually evolving endemic lineages, such as *Plesiadapis*, species of which are difficult to discriminate with small sample sizes. Preliminary comparisons reveal a conspicuous dissimilarity between the *Titanoides* fauna and the contemporaneous Divide Quarry fauna and younger sites in the Bighorn Basin. Instead, closer affinities were found between the *Titanoides* locality and older Tiffanian localities in the Bighorn Basin as well as those to the south. These faunal comparisons have implications for the biogeography of the middle Tiffanian in North America, suggesting a north-south dichotomy of mammalian faunas that could reflect paleodrainage networks.

Funding Sources This research was supported by the David B. Jones Foundation, KU, and the Association for Women Geoscientists. Fieldwork was facilitated by BLM permit PA15-WY-234.

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

Collaborative collections management of the Cretaceous vertebrates of the Mahajanga Basin, Madagascar: from the physical to the digital

Swenson, Sierra K.¹, Walker, Lindsay J.², McGee, Nicole A.^{3,1}, Rakotozafy, Bakoliarisoa^{4,5}, Hummel, Rudolph R.⁵, MacKenzie, Kristen¹, Krause, David W.⁵

¹Integrative Collections, Denver Museum of Nature & Science, Denver, Colorado, United States, ²School of Life Sciences, Arizona State University, Tempe, Arizona, United States, ³Museum and Field Studies, University of Colorado, Boulder, Colorado, United States, ⁴Mention Bassins Sédimentaires Evolution Conservation, Université d'Antananarivo, Antananarivo, Madagascar, ⁵Earth & Space Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States

The Late Cretaceous Madagascar Collection at the Denver Museum of Nature & Science (DMNS) represents over 30 years of collaborative work from the Mahajanga Basin of Madagascar, involving Malagasy scientists working alongside an international group of researchers from multiple institutions. In an effort to create a more equitable research relationship, the project aims to: 1) physically transfer half of the specimens currently housed at DMNS to the University of Antananarivo (UA) in Madagascar; 2) establish a shared specimen database to maintain digital unity across dispersed collections; and 3) empower UA to continue to manage its specimens and their data in a secure and sustainable repository into the future.

Since 2023, DMNS has accelerated the preparation of these collections for transfer to UA. This process has involved the

development and refinement of digitization workflows, the preparation of >1,800 specimens, the division and curation of specimens, and the training of early career paleontologists and collections professionals. This includes the intensive and immersive training of a doctoral candidate from UA in both preparation practices and collections management.

A central component of this project has been the establishment of a new Symbiota portal to facilitate collaboration between DMNS and UA. Symbiota is an open-source data management software that can be accessed by users at both institutions. Over the past year, >2,500 specimen records (including all vertebrate holotypes) have been added to the portal and are linked to a curated taxonomic backbone. Importantly, the portal has demonstrated the potential of Extended Specimen data through external linkages, including to 3D data maintained in MorphoSource. The portal has also enabled the publication of specimen records to larger data aggregators (GBIF and iDigBio), in turn allowing for the integration of Madagascar Project-generated data with records published by other institutions.

In this presentation, we will provide an overview of what has been accomplished to date, including how the new data portal has been integrated into workflows developed for this project; how, moving forward, DMNS and UA will use the portal to further the goals of the Madagascar Project; and how opportunities have arisen as a result of this novel use of Symbiota. Likewise, we will consider what challenges have been overcome, and we will forecast next steps for the project.

Funding Sources This work was funded by the US National Science Foundation, and most recently NSF Award #2242716.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Largest North American mastodon recovered in Acadia Parish, Louisiana: preliminary causes and paleoecology implications of mastodon size

Sylvester, Chase, Hargrave, Jennifer E.

University of Louisiana at Lafayette, Ville Platte, Louisiana, United States

A partial skeleton of the American mastodon was recently discovered in the Carrier Mastodon Site near the town of Church Point in Acadia Parish, Louisiana. Skeletal remains include teeth, tusk fragments, a partial innominate, and vertebrae. Other fossils recovered from the site include horse, bison, turtle, and jaguar. The mastodon specimen represents the largest American mastodon discovered to date, based upon length and width ratio measurements of the M3. Generally, most large specimens of American mastodon were recovered from the Gulf Coast. However, the M3 ratio of the Carrier mastodon is larger than all previously discovered specimens of American mastodon, and over nine percent larger than other Louisiana specimens. The larger size of the Gulf Coast specimens, and particularly the Carrier mastodon, suggests that the Pleistocene ecology of the area favored growth conditions suitable to mastodon. The most notable paleoecological factors that possibly contribute to the Carrier mastodon's size are food availability, food quality, climatic conditions, predation, and competition. Preliminary results from comparative analysis, multivariate analysis, and regression modeling using paleovegetation, mastodon distribution, and predator distribution maps show that Pleistocene Louisiana created suitable habitat for mastodons.

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Mandibular allometry in Asian *Stegodon* (Mammalia, Proboscidea)

Tablizo, Meyrick U.¹, van den Bergh, Gerrit D.², Fernando, Allan Gil S.¹

¹National Institute of Geological Sciences, University of the Philippines Diliman, Quezon City, Metro Manila, Philippines, ²School of Earth, Atmospheric and Life Sciences, University of Wollongong, Wollongong City, New South Wales, Australia

Stegodon, a genus of extinct proboscideans, once roamed across much of Asia throughout the late Miocene to Pleistocene epochs. The genus included a variety of species and subspecies, some of which demonstrated remarkable cases of insular dwarfism—a phenomenon where species isolated on islands evolve smaller body sizes compared to their mainland relatives. This dwarfism is particularly notable in islands such as Honshu, Luzon, Panay, Mindanao, Sangihe, Sulawesi, Flores, Sumba, Timor, and Java. In some of these islands, multiple colonization events were identified, along with the apparent transition from a “normal”-sized to a dwarfed form. However, the phylogenetic relationships among these *Stegodon* taxa remain obscure, while the underpinnings behind these changes in body size remain poorly explored.

In this study, we examined the morphological allometry in the mandibles of several *Stegodon* taxa, namely *S. miensis*, *S. aurorae*, *S. orientalis*, *S. trigonocephalus*, *S. florensis*, *S. sondaari*, along with the *Stegodon* materials from Luzon. The dental wear age classes of the mandibular specimens were determined to generate a growth curve. The measurements of the mandibular parameters were log-transformed before these were plotted in bivariate graphs, and the linear regression model was calculated. Preliminary

results reveal that when considered collectively, the maximum width of the articulated tooth in wear and the height of the mandibular corpus at the ascending ramus are negatively allometric, while the occlusal length is isometric with respect to the maximum width of the mandibular corpus. Meanwhile, disparities between the trends were apparent if treated separately per taxa. The observed delay in the decrease in the tooth size compared to the rest of the mandible was apparent in several specimens. We predict that these patterns are reflected in the changes in the allometric trends. These interspecific differences in mandibular ontogeny may provide clues for the mechanism underlying the dwarfing in *Stegodon* and reveal phylogenetic signals to assess the possible ancestral mainland population.

Funding Sources University of the Philippines Diliman OVCRD Outright Research Grant (Project No. 232330 ORG)

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Large-scale project management fit for a Jurassic giant

Tamez-Galvan, Evan, Polich, Alexandria, Toth, Natalie G., MacKenzie, Kristen

Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States

The Denver Museum of Nature & Science (DMNS) has collected vertebrate fossils from the Upper Jurassic Morrison Formation (Fm) for over a century, and as a result, hosts one of the largest Morrison dinosaur collections in the western United States. Specimens from this collection (e.g., *Stegosaurus*, *Diplodocus*, *Apatosaurus*, *Allosaurus*) have been the subject of numerous publications, provided training for dozens of students, interns, volunteers, and entry-level scientists,

and have offered invaluable community science opportunities through authentic, research-based paleontological experiences. However, this fossil collection consists of logistically challenging, complex, heavy, large (1m+) sauropod fossils that make access for research, education, and exhibition a challenge. Additionally, the majority (90%+) of the fossils were in need of various levels of preparation, repair, stabilization, and archival housing using modern conservation materials and methods. In order to address these critical issues, we developed a workflow which allowed us to effectively and efficiently manage a large-scale preparation and collections project while working through hundreds of specimens collected over the past century. Over the course of one year, the DMNS preparation labs (staff, interns, and volunteers) have successfully improved the stability and long-term storage of over 1,300 Morrison Fm vertebrate fossils, which will ultimately increase the longevity of the specimens for future research. Our workflow extends beyond general preparation and collections management to include the creation of digital models despite the challenges associated with moving and scanning large fossils. By integrating 3D scanning technology into our workflow, DMNS has made its Morrison Fm collection safe, stable, accessible, and engaging for external audiences—researchers, educators, and fossil enthusiasts. In addition to generating digital models, the repair, stabilization, and rehousing of the project's fossils ensure the specimens will be stored securely for decades to come. It is anticipated that the project workflow developed for large and delicate Morrison Fm fossils will serve as a model to increase accessibility of similar sized collections at museums and universities.

Funding Sources The Institute of Museum and Library Services and the United States Forest Service provided funding for this project.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

An unusual adaptation in the eggshell of a non-avian maniraptoran dinosaur

Tanaka, Kohei², van der Linden, Tom⁴, Therrien, François¹, Zelenitsky, Darla K.³

¹Faculty of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan, ²Oertijdmuseum, Boxtel, Netherlands, ³Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada, ⁴Dept. of Earth, Energy and Environment, University of Calgary, Calgary, Alberta, Canada

Like birds, non-avian theropod dinosaurs laid hard-shelled eggs in which pore canals extend through the calcareous layer to allow the exchange of respiratory gases during egg incubation. In previous studies, eggshell porosity has been quantified for various theropod eggs using pore canal cross-sectional area, pore canal length, and egg mass. Such values correspond to rates of gas conductance through the eggshell, which have been linked to various environmental, nesting, or life history factors. Here we report porosity values of an unusual theropod eggshell assigned to the ootaxon *Porituberoolithus*, likely belonging to a small non-avian maniraptoran, from uppermost Cretaceous (Campanian-Maastrichtian) deposits of Alberta, Canada. The eggshell is characterized by an outer surface ornamented with nodes, some of which are very prominent. Interestingly, pore openings are only present near the apex of the prominent nodes but are lacking elsewhere on the eggshell surface. This pore pattern is atypical of theropod (and other dinosaur) eggshell where pores are almost always located in the lows between nodes or ridges on the outer surface. We found that the eggshell porosity of *Porituberoolithus* was unexpectedly low for its shell thickness (0.56

mm without nodes) and attribute this to the increase in pore length, as a result of the location of the pores in prominent nodes. Eggshell porosity would have been about 30% higher if the pores had been located in the lows between nodes, due to a shorter pore canal length. The nodes in *Porituberoolithus* appear to have functioned to decrease porosity, rather than to prevent obstruction of pores by nesting substrates as previously proposed for other dinosaur eggs. Although low porosity values usually indicate egg incubation in an at least partially-open style nest, as commonly found in other maniraptorans, it is currently unknown if the unusual adaption of *Porituberoolithus* is related to certain life history factors, nesting or environmental conditions.

Funding Sources Natural Sciences and Engineering Research Council of Canada Discovery Grant to DKZ

Japan Society for the Promotion of Science (JSPS) KAKENHI JP22K14133 to KT

Colbert Prize Session

Comparative analysis of modern East Asian crocodylians through mass spectrometry of collagen proteins and application to ancient material

Tanaka, Miu^{5,3}, Kobayashi, Yoshitsugu¹, Eda, Masaki¹, Izumi, Hiroe¹, Kikuchi, Hiroki², Sun, Guoping⁴

¹Science, Hokkaido University, Sapporo, Hokkaido, Japan, ²Kanna Dinosaur Center, Tano District, Gunma, Japan, ³Museum, Hokkaido University, Hokkaido, Japan, ⁴Archaeology and Museology, Lanzhou University, Lanzhou, China, ⁵Zhejiang Provincial Institute of Relics and Archaeology, Hangzhou, China

Crocodylia is a group of the semi-aquatic predators represented by approximately 30 species in the tropics and subtropics. Due to

the relatively small morphological diversity among species, there are some difficulties in identification in fossil research, especially for fragmentary specimens. Zooarchaeology by Mass Spectrometry (ZooMS) is a new approach that has rapidly evolved in the last decade, allowing the identification of numerous zooarchaeological species. This study is the first report of the ZooMS approach for crocodylian bones, focused on identifying ancient crocodylian bones using collagen peptide fingerprinting.

The Chinese alligator (*Alligator sinensis*) is the only extant *Alligator* species found outside the Americas. Meanwhile, the crocodylians of East Asia include the Malayan gharial (*Tomistoma schlegelii*) and the salt-water crocodile (*Crocodylus porosus*). We sampled three specimens of *A. sinensis*, two specimens of *T. schlegelii*, and two specimens of *C. porosus* as modern references. Protocols for collagen extraction in ZooMS were performed, followed by analysis using mass spectrometry (TOF-MS, and LC-MSMS). Spectra data were subjected to database searches using PEAKS for the identified sequences. Additionally, BLASTP was conducted to identify sequences unique to the taxon.

The results indicated 23 peaks specific in *Alligator* and 12 peaks specific to the other two crocodylians. Moreover, ten sequences of peptides showed homologous residues between *Alligator* and the other two crocodylians. In comparison, previous work on birds has reported at least five peaks in the fingerprints between chicken (*Gallus gallus*) and duck (*Anas platyrhynchos*). Previous studies on molecular phylogenetic research estimated the divergence time of *Alligator* and *Crocodylus* to be 101.0 Ma, and that of chicken and duck to be 82.1 Ma. The substantial disparity in fingerprinting between *Alligator* and *Crocodylus* (or *Tomistoma*) compared to birds may indicate a long period of divergence. This result was applied to crocodylian dentaries and osteoderms from

the Tianluoshan Site (7000-5500 B.P.), located at the Yu-Yao City, Zhejiang Province, China. Our analysis demonstrated that these bones corresponded to the specific peaks of *Alligator*, aligning with the occurrence of *A. sinensis* dentaries from the same site identified based on morphological features. This suggests that the peak list of Asian crocodylian collagen from three taxa may apply to fossil and archaeological materials.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Diversity and taphonomy of the Upper Cretaceous Mesaverde and Lance formation's vertebrate faunas in Wyoming: A collection-based analysis of the University of Wyoming Geological Museum and Tate Geological Museum vertebrate paleontology collections

Tenney, Zachary D.¹, Worrell, Whitney E.¹, Slattery, Joshua³, Cavigelli, Jean-Pierre²

¹Department of Geology and Geophysics, University of Wyoming, Casper, Wyoming, United States, ²University of Wyoming Geological Museum, Laramie, Wyoming, United States, ³Tate Geological Museum, Casper, Wyoming, United States

The Campanian Mesaverde and Maastrichtian Lance formations of Wyoming are renowned for their rich fossil vertebrate faunas. Despite an extensive history of collection and study, there have been no comprehensive quantitative regional surveys of these formation's faunal diversities and taphonomic biases that influenced their faunal compositions. To quantify local and basinal faunal diversities of these formations, various biodiversity metrics in conjunction with rarefaction and GIS spatial analysis were conducted using 11,700 specimens from 341 localities housed in the University of Wyoming Geological Museum and Tate Geological Museum vertebrate paleontology

collections. Groups examined include amphibians, dinosaurs, mammals, reptiles, bony fish, sharks, and rays. To account for potential sample and preservational biases within these collections, we categorized localities by depositional environment (e.g., fluvial channel, floodplain), type of fossil concentration (e.g., micro-, macro-bonebeds), and whether the collection has been published on in a peer-reviewed article(s) and/or thesis/dissertation(s). Our results reveal that non-marine, aquatic clades, such as turtles, crocodylians, and bony fish are the most common taxa in these formations followed by dinosaurs and mammals. The 'monograph' effect is observable in collections with the highest diversities, which reflects the influence of targeted, site-specific research on increased taxonomic richness and abundances. There is an inherent collection preference towards fluvial channel deposits with few collections from floodplain and lacustrine deposits. Most fluvial channel deposit localities contain environmentally condensed, time and spatially averaged fossil assemblages. These fluvial assemblages include autochthonous aquatic faunal components mixed with allochthonous faunal constituents from floodplain and lacustrine settings that were reworked and concentrated into the bonebeds. Our collections-based survey also shows that most Mesaverde and Lance formation sites lack detailed stratigraphic and sedimentological data needed for determination of age, depositional setting, and taphonomic influences on fossil assemblages. Therefore, to conduct effective collections-based research, it is recommended that appropriate contextual data include high-resolution stratigraphic and lithofacies data.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Basal is better: a re-evaluation of *Syndyoceras cooki* (Artiodactyla, Protoceratidae) petrosal morphology and the pitfalls of inferring evolutionary relationships based on derived morphologies

Theodor, Jessica¹, Robson, Selina Viktor¹, Nugent, Kaigh A.¹, Tucker, Shane T.²

¹Biological Sciences, University of Calgary, Calgary, Alberta, Canada, ²Nebraska Highway Paleontology Program, University of Nebraska State Museum, Lincoln, Nebraska, United States

The Protoceratidae are an extinct family of North American artiodactyls known from the Eocene to the Pliocene. Protoceratids are thought to belong to Tylopoda, a suborder that also includes camelids, oromerycids, and oreodonts. Among protoceratids, *Syndyoceras* is one of the most well-known, in part because the *Syndyoceras* ear region is thought to resemble that of ruminants rather than tylopods. These observations were based on early CT data that could not be used to make digital models. We have re-scanned the holotype of *Syndyoceras cooki*, allowing us to describe the auditory region morphology in greater detail and compare it to other protoceratids, tylopods, and ruminants.

The petrosal of *Syndyoceras* is quite similar to that of *Protoceras*, a more basally branching protoceratid. The main difference is that the ventrolateral border of the *Protoceras* petrosal is broad and flat while the *Syndyoceras* petrosal forms a keel. Both genera have a highly derived morphology not found in leptotragulids (early protoceratids). The most notable feature shared between *Protoceras*, *Syndyoceras*, and ruminants is a flat ledge of bone occupying the dorsomedial portion of the petrosal. This ledge separates the cerebrum and cerebellum. In protoceratids, the squamosal encroaches on the petrosal, forming a temporal meatus and

dividing the dorsal petrosal into two sections: the flat ledge and a convex portion of tegmen tympani. No such association is present in ruminants, and the entire dorsomedial surface of the petrosal is flat. The flat ledge is not found in other tylopods or early protoceratids, suggesting an independent acquisition within the family. The other feature thought to connect *Syndyoceras* to ruminants is a reduced-to-absent subarcuate fossa. Both *Syndyoceras* and *Protoceras* have a shallow depression that does not constitute a true subarcuate fossa. Early protoceratids have a true subarcuate fossa, so it is likely that the loss in *Protoceras* and *Syndyoceras* is also convergent with ruminants. A similar reduction or loss has occurred in other tylopod families. Taken together, the similarities between *Syndyoceras* and ruminants likely do not indicate a close evolutionary relationship. Indeed, later branching protoceratids appear to have a stereotyped petrosal morphology distinct from all other artiodactyls. This morphology may provide information as to the relationships within Protoceratidae, but it is unlikely to be informative about interfamilial relationships.

Funding Sources This project was partially funded by an NSERC Discovery Grant awarded to J. M. Theodor

Technical Session 11: Theropoda I (Friday, November 1, 2024, 8:00 AM)

Life in the fast lane: comparative anatomy and histology of hindlimbs preserved in the stomach of a tyrannosaurid reveal cursorial adaptations and rapid growth in *Citipes elegans* (Oviraptorosauria: Caenagnathidae) possibly as a means of escaping predation

Therrien, François^{1,2}, Zelenitsky, Darla K.², Tanaka, Kohei³, Voris, Jared T.²

¹Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada, ²Department of Earth, Energy, and Environment, University of Calgary, Calgary, Alberta, Canada, ³Graduate School of Life and Environmental Sciences, University of Tsukuba, Tsukuba, Ibaraki, Japan

Preserved in the stomach of a young tyrannosaurid, the hindlimbs of two individuals of *Citipes elegans* are, ironically, the most complete remains ever discovered of this small oviraptorosaur. As this taxon was previously known mainly from isolated metatarsi from the Upper Cretaceous Dinosaur Park Formation of Alberta, Canada, the new specimens allow us to conduct a comparative study of the anatomy and histology of *Citipes* in order to gain insight into its paleoecology. The hindlimb of *Citipes* is elongate and gracile. The femur is straight, the tibia is long and slender, and the fibula is a very slender rod closely adpressed to the latter. An adaptation to make long strides, the distal leg of *Citipes* is very elongate (219% of femur length), far longer than in most theropods but similar to the caenagnathoid *Avimimus*, the troodontids *Sinornithoides* and *Saurornithoides*, and the dromaeosaurids *Bambiraptor* and *Halszkaraptor*. The pedal digits of *Citipes* are long and gracile as in other oviraptorosaurs, being proportionally longer than in troodontids, ornithomimids, and tyrannosaurids, but shorter than in dromaeosaurids (except for digits 1 and 2). Digit proportions differ slightly among oviraptorosaur species, suggesting possible locomotor/behavioral adaptations in this clade. In *Citipes*, digit 1 is characterized by an elongate cylindrical phalanx I-1 proportionally similar to that of *Chirostenotes* and *Corythoraptor*, but twice as long as in other oviraptorosaurs. Digit 2 is proportionally similar to that of *Conchoraptor* and *Oksoko* but much shorter than in *Chirostenotes* and *Corythoraptor*. Digits 3 and 4 are proportionally shorter than in *Chirostenotes* and *Corythoraptor* due to shorter distal phalanges but longer than in other

oviraptorosaurs due to longer proximal phalanges. Histological analyses reveal the predominance of woven primary bone, indicative of fast growth, in the bone cortex of *Citipes* individuals of different ages. Whereas the *Citipes* individuals ingested by the tyrannosaurid are yearlings that had reached half of adult body mass, the largest *Citipes* specimen known is an old individual that exhibits lines of arrested growth and an external fundamental system, showing this individual had reached somatic maturity at the age of 4 and died at the age of 7. Together, these anatomical and histological analyses suggest that *Citipes* was a swift, cursorial animal that grew fast and reached adult size at a young age, which likely aided in escaping predation.

Funding Sources Royal Tyrrell Museum Cooperating Society (FT), NSERC Discovery Grant (RGPIN 04854, DKZ), JSPS KAKENHI (JP22K14133, KT), Eyes High and Killam Doctoral Scholarships (JTV)

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Lawless teeth indeed: repeated reversals of edentulousness in dicynodont therapsids

Thomas, Henry N.¹, Peacock, Brandon R.^{1,2}

¹Department of Biological Sciences, Idaho State University, Pocatello, Idaho, United States, ²Idaho Museum of Natural History, Pocatello, Idaho, United States

Dollo's Law, the notion of evolutionary irreversibility, is often applied to infer that loss of complex traits cannot be undone. The Law has been invoked in instances of full tooth loss (edentulousness) in tetrapods, which is widely accepted to be permanent; for example, there are no instances of tooth reappearance in bird or turtle evolution once teeth are lost. In tetrapods, reversal of tooth

loss has only been reported in frogs, with a handful of inferred reversals in the upper jaw, and a single taxon, *Gastrotheca guentheri*, regaining teeth in the lower jaw.

Dicynodonts represent an additional case study in which to test reversal of edentulosity. Although dicynodonts are characterized by toothless anterior beaks, and most species only bear a single pair of caniniform “tusks”, a few dicynodont taxa also bear teeth on the premaxilla, dentary, and on the maxilla posterior to the caniniforms. The phylogenetic position of some of these toothed dicynodonts suggests possible re-evolution of teeth, but this has been untested and previously dismissed as unlikely. To assess the evolution of edentulosity in dicynodonts, we performed maximum likelihood ancestral state reconstruction on an updated phylogenetic analysis of anomodonts (362 characters, 138 OTUs) that largely replicates modern topologies. We treat changes in presence/absence of teeth on the premaxilla, maxilla (both enlarged caniniforms/tusks and postcaniniform teeth), and dentary as separate events.

We reconstruct the loss of anterior premaxillary teeth at the base of Dicynodontia, and that loss remains permanent. Within later dicynodont evolution we reconstruct four losses of teeth each on the maxilla (postcaniniform) and dentary, and six instances of caniniform loss. Critically, we reconstruct eight instances of secondary tooth gain. Emydopoidea show multiple instances of tooth loss and regain, but the clade is reconstructed as ancestrally toothed in the maxilla and dentary. Strikingly, *Australobarbarus* and *Tropidostoma* are reconstructed as re-evolving maxillary “tusks”, postcaniniform maxillary teeth, and dentary teeth from a completely edentulous ancestor within Cryptodontia. Constraining tooth loss to be irreversible drastically increases the total number of state changes (from 25 to 47). We posit that the dicynodont

tooth suppression pathway was relatively plastic, allowing for both repeated tooth loss and regain; questioning the universality of Dollo’s Law in vertebrate tooth evolution.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Geochemical fingerprinting of bentonite beds in the Dinosaur Park Formation, Alberta to reduce uncertainty regarding stratigraphic correlations and dinosaur biostratigraphy

Thompson, Michael G.¹, Brink, Kirstin¹,
Brown, Caleb M.², Durkin, Paul¹

¹Department of Earth Sciences, University of Manitoba, Winnipeg, Manitoba, Canada, ²Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada

The Campanian aged Dinosaur Park Formation (DPF) outcrops predominantly in Dinosaur Provincial Park (DPP), Alberta, a UNESCO World Heritage site that produces some of the highest quality and quantity of dinosaur fossils in the world. These abundant and diverse fossil assemblages, alongside the easily accessible outcrop that contains them, have made the DPF a prime subject to test hypotheses regarding dinosaur ecology and evolutionary trends. It has been noted that dinosaur assemblages in the DPF in DPP contain differing taxa between lower and higher strata, suggesting faunal turnover events occurred through the represented time interval. However, the exact timing and causes of these faunal turnovers remains unclear primarily because the DPF is composed of fluvial sandstones and floodplain mudstones with considerable variation in thickness and lateral extent. This variability has prevented the use of stratigraphic marker beds, resulting in a relatively poorly resolved stratigraphic framework for the DPF in DPP, and therefore uncertainty regarding the stratigraphic

placement of dinosaur fossil sites and the boundaries of proposed dinosaur biozones.

To address this issue, we stratigraphically and geochemically analyzed seven bentonite beds in the DPF within DPP, five of which have well resolved absolute dates that temporally constrain ~2 million years. Bentonites are ideal chronostratigraphic markers because they represent rapid deposition during a single volcanic event over a large lateral extent and contain phenocrysts that can be geochemically analysed and dated, allowing for each to be assigned its own unique geochemical “fingerprint”. Each sample was stratigraphically contextualized through a measured section, and elevation for each sampled bentonite bed was recorded to 2 cm vertical resolution. Geochemical fingerprinting utilized Electron Probe Micro-Analyzer analysis of mineral phenocrysts including biotite, feldspars, and other accessory minerals. Our results show that bentonites in DPP have previously unidentified unique geochemical and visual traits that can be differentiated, specifically using the percentages of Al, Fe, and Mg oxides within analyzed biotite crystals. The geochemical fingerprints reported herein for these bentonites are a critical first step to establish a resolved stratigraphic framework for the DPF in DPP and increase the accuracy of estimates for timelines regarding dinosaur evolution and turnover in DPP.

Funding Sources Funding is Provided by NSERC Discovery Grants awarded to Dr. Paul Durkin (#2018-06026) and Dr. Kirstin Brink (#2021-00364).

Technical Session 16: Mammal Evolution
(Friday, November 1, 2024, 1:45 PM)

The efficiency of three forelimb joints and its correlation with habit specialization in extant mammals

Thurber, Nick, Motani, Ryosuke

Earth and Planetary Sciences , UC Davis,
Davis, California, United States

All living mammals use the forelimb in some capacity to maintain a lifestyle specialization or habit. The bones of mammalian forelimbs are shaped to facilitate specific behaviors associated with a habit, and yet phylogenetic variations obscure such behavioral signals. By focusing on mechanical characters, it may be possible to remove such obscurity and find the connection between shape and habit. In order to quantitatively test this hypothesis, we focused on the mechanical advantage of forelimb joint motions. Several multivariate statistical analyses were performed on a database containing species name, habit type and mechanical characters for 205 extant mammal specimens representing 189 species, 150 genera and 16 orders. The habit types were coded as fossorial (scratch-digging, humeral rotation digging, hook-and-pull digging and lateral digging), arboreal, ricochet (adapted for jumping), semi-aquatic, aquatic or terrestrial. The mechanical characters involved the three forelimb joints with 6 shoulder (flexion, extension, adduction, abduction, internal and external rotation), 2 elbow (flexion and extension) and 2 wrist motions (flexion and extension). The shoulder, elbow and wrist muscle moment arms in relation to the out-force lever arm (the total length of the humerus, ulna, and hand respectfully) were used to calculate mechanical advantage. Preliminary analyses suggest separation between the fossorial and the non-fossorial taxa, with varying degrees of separation within each. Separation among habit types, further supports the separation within fossoriality as proposed by previous authors. Among all habit types, the greatest separation occurs between the mechanical advantage of shoulder adduction and elbow extension with the greatest difference between shoulder adduction and wrist flexion. Future work includes incorporating additional taxa and applying ranges to the mechanical

advantages found in extinct mammal taxa forelimbs to reveal the most efficient motion and therefore preferred habit.

Funding Sources Data analysis was supported by Durrell Funding provided by the Earth and Planetary Sciences Department, UC Davis, CA.

Colbert Prize Session

A new study of the Florissant fauna and its diversity

Tkacik, Stephanie¹, Eberle, Jaelyn J.¹, Meyer, Herbert²

¹Geology, University of Colorado Boulder, Boulder, Colorado, United States, ²Florissant Fossil Beds National Monument, Florissant, Colorado, United States

The late Eocene (Chadronian) Florissant Formation in Colorado preserves some of the greatest biological diversity of any formation in the United States, recording almost two thousand species of plants and animals. Despite its overall great diversity, the vast majority of Florissant species are plants and invertebrates preserved in lacustrine deposits, terrestrial mammals are not as well known. Renewed collecting in recent years, particularly 2022 and 2023, has yielded new specimens which reveal a greater level of mammalian diversity at Florissant. These new fossils represent an additional suborder, a genus of marsupial, and two rodent genera. Additionally, while the genus *Leptomeryx* was documented previously, we now recognize two species of *Leptomeryx*. Specimens of note are a tooth fragment belonging to an erinaceomorph, molars or premolars from the marsupial *Herpetotherium*, the rodents *Hesperopetes* and *Namatomys*, and molar fragments confirming the presence of *Leptomeryx speciosus* and *L. mamifer*. Additional specimens of the taxa *Adjidaumo*, *Paradjidaumo*, *Mesohippus*, and

Pseudoprotoceras have been recovered, along with a second jaw of the talpid *Oreotalpa florissantensis*. Other recovered specimens likely represent additional rodent genera.

The increased quantity of specimens lends itself to an analysis of species richness and diversity. Prior studies hypothesized that during the Chadronian, the elevation of the Florissant Formation was comparable to the elevation of the Florissant Fossil Beds National Monument today. Using rarefaction analyses, the Florissant mammal fauna from UCM Loc. 92179 was compared to White River Formation localities: DMNH Loc. 19 in eastern Colorado, and DMNH Loc. 59 in central Wyoming, with the latter containing more than twice the number of specimens recovered from Florissant. The results of our preliminary analysis show that the mammalian fauna at Florissant is similar in overall diversity to that of the locality in eastern Colorado and actually higher in diversity than the locality in Wyoming. While the potential of collecting bias cannot be ruled out, this is consistent with studies by others of modern mammal diversity which show that diversity tends to be greatest at elevations midway up mountains.

Funding Sources This work was funded with grants from the Geology and Museum departments of CU Boulder.

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

Anatomical reconstruction of ornithischian hip joint soft tissues and its significance for interpreting hindlimb function

Tsai, Henry P.^{1,2}

¹Biology, Southern Connecticut State University, Middletown, Connecticut, United States, ²Biomedical Sciences, Missouri State

University, Springfield, Missouri, United States

Epiphyseal cartilage, which covers the ends of tetrapod limb bones, are critical appendicular structures that allow for the mobility, force transmission, and longitudinal growth of long bones. Although cartilage is rarely preserved in the fossil record, osteological correlates of their attachment can be identified at the chondro-osseous junction, which permits inference of cartilage structure and putative function. Previous studies on the evolution of archosaurian hip joints have indicated the employment of both fibrocartilage and hyaline cartilage in constructing the functional joint surface, as well as subsequent modification of either structure in the sauropod and theropod lineages. This study aims to examine the evolutionary transitions in hip joint soft tissues of ornithischians, a diverse group of non-avian dinosaurs that occupied a wide range of body sizes and underwent multiple, independent morphological transitions in the locomotor apparatus. Femora and pelvic materials from 65 taxa were examined for osteological correlates indicative of the type and extent of hip joint soft tissue attachment, such as distinguishable attachment sites of fibro- and hyaline cartilage. Select specimens were digitized as three-dimensional surface models to quantify bony hip joint congruency, a proxy for cartilage thickness. Key evolutionary transitions in joint soft tissues were estimated using phylogenetic comparative methods. Congruency of the bony hip joint of ornithischians is broadly comparable to those of theropods, indicating a comparable contribution of soft tissue in maintaining articulation. The proximal femora of early ornithischians retain the plesiomorphic state of smooth growth plates and clearly demarcated cartilage attachment surfaces, indicative of a relatively thin hyaline cartilage core surrounded by a sleeve of fibrocartilage. However, thyreophorans and ceratopsids independently evolved indistinct

cartilage attachment surfaces, suggesting that a composite articular cartilage tissue similar to that of modern birds are achieved in these lineages. Finally, none of the ornithischians examined in this study achieved the level of hip joint cartilage thickness present in sauropods, as indicated by more congruent hip joints and less rugose femoral growth plate textures. These results indicate that major lineages of ornithischians evolved novel load bearing solutions to contend with the challenges of increasing body size and postural transitions.

Funding Sources This research is supported by the Faculty Startup Grant of Southern Connecticut State University.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Ontogenetic changes in the structural performance and morphology of the mandible of *Theriognathus microps* (Therapsida: Therocephalia)

Tse, Yuen Ting¹, Norton, Luke A.², Stuart, Brandon P.², Huttenlocker, Adam¹

¹Intergrative Anatomical Sciences, University of Southern California, Los Angeles, California, United States, ²Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, South Africa

The therocephalian *Theriognathus microps* was a carnivorous nonmammalian therapsid whose fossils are relatively abundant in the late Permian of southern Africa and is well-represented by juvenile and adult specimens. It is characterized by multiple enigmatic craniodental features including the absence of postcanine teeth, a bowed dentary, and a streptostylic jaw joint. Unlike the postdentary bones of extant marsupial mammals, it has been previously proposed that the angular, a bone which is important for muscle attachment, shows positive rather than

negative allometric growth. To explore changes in an ontogenetic series of *Theriognathus*—and to explain the structure-function changes in the jaw—we investigated changes in jaw strength and jaw shape using seven specimens of *Theriognathus* representing juveniles, small subadults, and larger adults (skull lengths range from 67 -245 mm). We performed 2D finite element analysis (FEA) and calculated mesh-weighted arithmetic mean (MWAM) strain for each model to estimate changes in overall strain distribution and mean strain experienced by model of each growth stage. We also applied 2D geometric morphometrics (GM) to explore the regions experiencing the most shape changes in the growth series. Our FEA results show that the area experiencing the highest strain is in the surangular and articular regions, which is consistent in all growth stages. There is a gradual decrease in overall MWAM strain experienced by the jaw going from juvenile to large adult. We believe this is mainly caused by the increase in depth of the dentary bone with some contribution of decrease in size of the postdentary fenestra, which mitigates tensile strain and lowers the MWAM strain experienced by the entire jaw. Our GM results show an increase in depth of the dentary angle and width of the coronoid process, and reduced postdentary fenestra size from juvenile to adult stage. Overall, *Theriognathus* exhibits a gradual increase in jaw strength through ontogeny. The increase in jaw depth might be an indication of their change in dietary preference from juvenile to adult, in which adults were able to grip or tear more robust or tougher materials. Since major jaw closing muscles were hypothesized to be inserted mainly in the postdentary region and coronoid process of the dentary, the positive allometry in the angular could contribute to dissipation of stress during biting and hence help to maintain the stability of the jaw joint.

Funding Sources Funding to AKH and YTT from NSF-DEB-2325381.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Estimating *Alligator* body size based on skeletal remains, with application to the Gray Fossil Site of Northeastern Tennessee

Turala, Madelyn, Schubert, Blaine W.,
Gunnin, Davis, Samuels, Joshua X.

East Tennessee State University, Johnson
City, Tennessee, United States

Body size is linked to many aspects of an organism's biology, and estimation of size is regularly employed in paleontological studies to better characterize life histories of extinct animals. Several studies have examined correlation of total body length to skeletal measurements in the American alligator (*Alligator mississippiensis*), with some being better predictors of total length than others. Femur length has been found to be tightly correlated with total body length in *A. mississippiensis*, and this relationship has been used to estimate body size of extinct crocodilians. Using the femur, we estimated the body size of *Alligator* from the Gray Fossil Site (GFS), an early Pliocene sinkhole lake deposit in the southern Appalachians of northeastern Tennessee. Our results suggest that the GFS *Alligator* is smaller on average than modern *A. mississippiensis*. A relatively smaller size in the GFS *Alligator* could reflect phyletic size differences between the extant and extinct form, inadequate sampling of the fossil record, or phenotypic plasticity related to environmental conditions and/or food availability. New data shows other limb elements may also be tightly correlated with total body length and useful for body size estimation size in *A. mississippiensis*, which is the focus of ongoing research.

Technical Session 8: Paleontological Practices: Management & Ethics (Thursday, October 31, 2024, 1:45 PM)

Paleontological resource monitoring strategies developed and implemented by the U.S. National Park Service

Tweet, Justin, Santucci, Vincent

Paleontology Program, National Park Service, Cottage Grove, Minnesota, United States

Management of paleontological resources on public lands poses challenges stemming from balancing competing imperatives. On National Park Service lands, natural resources such as fossils are preserved and managed for the benefit of the public. Visitors have opportunities to observe fossils in their geological setting, a key component of the park experience. At the same time, it is easy for these non-renewable resources to be “loved to death” by over-visitation, vandalism, and theft. Fossils are also at risk from natural processes, from day-to-day weathering to dramatic events such as fires, flooding, coastal storms, and rockfalls. Many of these natural processes are exacerbated by climate change. Losses by any means impair the stewardship of paleontological resources for the public as a whole. In order to address these issues, the National Park Service has developed and implemented monitoring strategies for fossils at several parks. Monitoring is a necessary component of resource management, providing indications of the stability and condition of resources and allowing staff to react effectively to changes and plan properly for the future. It is also a natural follow-up to a comprehensive field-based inventory, and often leads to new discoveries. The pilot paleontological resource monitoring program was developed in the late 2000s at Glen Canyon National Recreation Area, where fluctuating lake levels impact the condition of fossil vertebrate tracks preserved in Lower Jurassic rocks. Following this pilot project,

paleontological monitoring was established at several other parks, including Chesapeake and Ohio Canal National Historical Park, Death Valley National Park, George Washington Birthplace National Monument, Point Reyes National Seashore, and Zion National Park. These parks encompass a wide variety of fossil resources and potential impactors, so monitoring strategies are customized for each park’s situation and conditions. In general, though, plans focus on repeat visits to sites to assess changes over time. As baseline information is determined for more parks via inventories, monitoring strategies will be developed to follow, drawing on the lessons learned at these initial paleontological resource monitoring parks.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Two new sauropod-bearing localities in the Antlers Formation (Trinity Group, Lower Cretaceous, Aptian-Albian) of north Texas

Tykoski, Ronald S., Gabay, Tabatha, Slovacek, Mariah, Smith, Briana, Contreras, Dori

Science, Perot Museum of Nature and Science, Dallas, Texas, United States

The Antlers Formation (Trinity Group, Lower Cretaceous) and its equivalents in northern Texas, southern Oklahoma, and southwestern Arkansas formed on a seasonally arid coastal plain along the southern margin of North America during Aptian-Albian transition time. The Antlers Formation contains fossil vertebrate assemblages similar to parts of the Cloverly and Cedar Mountain Formations of western North America, and the Arundel Formation of far eastern North America. We report on two new sauropod-bearing sites in the Antlers Formation of north Texas. The ‘Hartman Site’ (Cooke County, Texas) has a high-diversity fauna represented mostly by surface-collected microvertebrate fossils. Represented taxa include actinopterygian

fishes, amphibians, squamates, turtles (including a partial *Naomichelys* skeleton), crocodyliforms, and dinosaurs. Dinosaur elements include teeth (ornithischians, theropods, and sauropods), a dromaeosaurid partial humerus, and caudal vertebrae and limb bones of one or more titanosauriform sauropods. The site also has large pieces of petrified wood. The 'Hamilton Ranch Site' near Forestburg, Texas yields the partial skeleton of a titanosauriform sauropod. The bones are well-preserved and to date include caudal vertebrae and chevrons, dorsal ribs, and limb bones including a semi-articulated partial pes. These sites are just the most recent of multiple sauropod localities in the Trinity Group. Sauropods are known from a few localities in contemporaneous parts of the more widely exposed Cedar Mountain and Cloverly Formations further north that formed in more humid inland settings. However, the relatively high number of sauropod localities and proposed diversity of sauropods in the Trinity Group is unexpected given the extremely limited amount of accessible exposures and subsequent low chances of discovery in the region. It is possible these Early Cretaceous sauropods thrived in or even preferred the more seasonally arid conditions along the lower-latitude (~30°N) coastal plain of southern North America at the time. This is consistent with patterns of high sauropod abundance and diversity in other units formed under seasonally dry conditions, such as the Late Jurassic Morrison Formation of western North America.

Funding Sources Funding for this work came from the Perot Museum of Nature and Science.

Technical Session 7: Ungulates (Thursday, October 31, 2024, 8:00 AM)

A new basal chaeomysticete from the Early Oligocene of Washington State

Uhen, Mark D.¹, Brand, Nickolas A.³, Peredo, Carlos M.², Taylor, David⁴, Pollock, Jack⁵

¹Department of Atmospheric, Oceanic, and Earth Sciences, George Mason University, Fairfax, Virginia, United States, ²Schiele Museum of Natural History, Gastonia, North Carolina, United States, ³Department of Biological Sciences, Miami University, Oxford, Ohio, United States, ⁴Department of Geology, Portland State University, Portland, Oregon, United States, ⁵Oregon Museum of Science and Industry, Portland, Oregon, United States

A new specimen of a stem mysticete was discovered by James Goedert and collected by David Taylor and James Goedert from the area around the mouth of the Twin River, Clallam County, Washington State. This locality is in close proximity to the type locality of *Sitsqwayk cornishorum* and *Fucaia goedertorum*, which were discovered in the Twin River Quarry.

The specimen was recovered from the Chattian (Late Oligocene) Pysht Formation of the Twin River Group. The Pysht Formation is comprised of mudstones, siltstones and sandstone deposited on the shelf. The specimen includes a relatively complete, well-preserved skull, mandible, vertebrae, rib fragments, an ulna, and proximal humerus. The dorsal side of the skull has been completely prepared, with the ventral side yet to be completed.

The dorsal, posterior, and lateral presentations of the skull express some features similar to *Sitsqwayk*, while others are more similar to *Maiabalaena*. The shape and orientation of the nuchal crest and the robusticity and shape of the zygomatic process of the squamosal are similar to those features in *Sitsqwayk*. Features from the orbital region and more anterior such as the conformation of the nasals and frontals on the dorsal surface of the rostrum are more similar to those features in *Maiabalaena*. Previous phylogenetic analyses have placed

these two taxa in a clade at the base of Chaecomysticeti and preliminary phylogenetic analysis also places the new specimen in a clade with *Sitsqwayk* and *Maiabalaena* at the base of Chaecomysticeti.

With the addition of this new specimen, the *Sitsqwayk* clade now includes three separate taxa, all from the Pacific Northwest of the United States. Cetaceans from this clade are all large for the time they are known from, with skulls around 1 meter or more in length, with broad and flat rostra that lack teeth. These stand in stark contrast to the Aetiocetidae from similarly aged deposits. Aetiocetids are considerably smaller, bear teeth, and have narrower rostra than any examples from the *Sitsqwayk* clade. This juxtaposition emphasizes that both toothed mysticetes and toothless mysticetes coexisted throughout the entire Oligocene and that there was significant diversity of feeding ecologies over this time and niche differentiation of chaecomysticetes from aetiocetids within the same habitat.

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

Illuminating the variability, utility, and limitations of diffusion modeling of trace element concentration profiles in fossil bones

Ullmann, Paul¹, Drewicz, Amanda², Goldsmith, Erika R.³, Gallucci, John⁴, Tumarkin-Deratzian, Allison⁵, Terry, Dennis⁵, Ash, Richard⁶, Grandstaff, David⁵

¹Geology & Geological Engineering, University of North Dakota, Grand Forks, North Dakota, United States, ²SUEZ Wakefield, Brighouse, United Kingdom, ³Geosciences, Virginia Tech University, Blacksburg, Virginia, United States, ⁴Geology and Geological Engineering, South Dakota School of Mines and Technology, Rapid City, South Dakota, United

States, ⁵Earth and Environmental Science, Temple University, Philadelphia, Pennsylvania, United States, ⁶Geology, University of Maryland, College Park, Maryland, United States

Rare earth elements (REEs) and uranium (U) are negligibly present in bones during life but become ubiquitously enriched during fossilization. Postmortem uptake of these trace elements imparts chemical signatures reflective of the composition and redox of surface and groundwaters in the environment of burial. Resulting concentrations of REEs and U often decrease inward from the cortical margin, creating profiles for which the timescales of elemental uptake can be estimated through fitting of models based on Fick's second law of diffusion. However, reliability of modeled diffusion period estimates remain unclear, and questions linger about the consistency of such models' predictions among elements and depositional settings. To explore these questions, we conducted sensitivity analyses of diffusion models fit to the concentration-depth profiles of U and five REEs from LA-ICPMS transects of 21 fossil bones preserved in diverse Cretaceous–Miocene depositional settings across North America. The shortest modeled diffusion periods were only a few thousand years, but estimates also varied by several orders of magnitude, even for the same trace element and among specimens preserved in similar depositional settings. Whereas the light and middle REEs generally yielded consistent diffusion period estimates within a given fossil, U and the heavy REE ytterbium occasionally yielded much longer estimates. Neither differential uptake mechanics nor variable timeframes of uptake by different elements can account for these contrasts because U and the REEs exhibit similar diffusivities within bone and they are incorporated concurrently under saturated conditions. Therefore, we interpret that such contrasts may instead reflect either changes in the composition of pore fluids as they

diffused through the cortex and/or a proportionally greater influence of double-medium diffusion on the concentration profiles of these heavier and commonly less-abundant trace elements. Diffusion period estimates also rely heavily on the assumed time spent in saturated/phreatic conditions, which may be difficult to constrain. Cumulatively, our findings reveal: (1) the comparative value of diffusion models for illuminating site- and specimen-specific diagenetic histories; (2) the key importance of constraining model assumptions (especially saturation history), and; (3) how it is essential to investigate a diverse suite of trace elements to fully expound the diagenetic history of any given specimen.

Funding Sources This research was funded by Temple University, Rowan University, NSF DGE Award 1002809, and the University of North Dakota.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

The taphonomy of a new *Gastonia* (Ankylosauria) site in the Yellow Cat Member of the Cedar Mountain Formation (Barremian, Early Cretaceous) of Utah

Ummel, Caleb H., Luckau, Tyler, Frewin, Jacob, Scheetz, Rod, Britt, Brooks

Geology, Brigham Young University, Provo, Utah, United States

The Barremian-aged Yellow Cat Member of the Cedar Mountain Formation (CMF) is one of North America's most prolific vertebrate-bearing Early Cretaceous units. Here, we report a new site within this member, the May Rae Quarry, located near Arches National Park in eastern Utah. The bone-bearing lithosome, a 0.2-0.75 m thick silty mudstone, extends ~50 m and is situated ~12m above the base of the formation. This horizon of sandstones, siltstones, and silty mudstones

is here interpreted as floodplain and splay units related to fluvial channels of the Poison Strip Sandstone Mbr of the CMF.

Over 1200 vertebrate specimens have been recovered, predominantly from the ankylosaurian dinosaur *Gastonia*, representing a minimum of four individuals based on crania. Other dinosaurs include the dromaeosaurid theropod *Utahraptor* (shed teeth and a metatarsal), an indeterminate, medium-sized theropod (metatarsal), and a sauropod (a single caudal vertebra). Invertebrates consist of uncommon unionid bivalves and mm-scale burrows, with fossil root traces being common.

The unionids originated from a perennial stream; disarticulation suggests postmortem burial. The dominance of *Gastonia* elements, including articulated hand and foot bones, indicates these dinosaurs died on floodplains near perennial streams. *Utahraptor* shed teeth imply predation/scavenging. Bone breakage is common, characterized by diagonal breaks, associated fragments, and scratch marks. Bones were trampled, broken, slightly transported, and buried shortly after death, some retaining connective tissues. Isolated root traces in the matrix indicate that sediments entombing the bones were subaerially exposed, allowing sparse vegetation to establish. The absence of a well-formed paleosol in the bonebed indicates a subsequent flooding event shortly after the initial burial and before significant soil development.

Our preliminary analysis of the May Rae Quarry shows that *Gastonia* carcasses accumulated over a short period on a floodplain, were scavenged by *Utahraptors* and possibly insects, and were trampled by larger animals. The bones experienced minimal transport and were buried in muddy silt by a small crevasse splay flowing NW to SE. Sparse vegetation rooted a decimeter or more into the muddy silt before another flooding event buried the area.

Excavation of this site is ongoing, and further work on this and other Gastonia-bearing sites will shed light on the environments in which this taxon lived and was preserved.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

The developmental origin of the propatagial muscle and its implication for the evolutionary process of the wing musculoskeletal system in theropods

Uno, Yurika, Hirasawa, Tatsuya

Department of Earth and Planetary Science, Graduate School of Science, the University of Tokyo, Bunkyo-ku, Tokyo, Japan

The propatagium constituting the rostral area of the wing represents an evolutionary novelty in the lineage towards birds. According to our previous statistical analyses of angles of elbow joints preserved in articulated fossil skeletons, this structure first evolved in maniraptoran dinosaurs. Along the leading edge of the propatagium of extant birds, a skeletal muscle, namely the propatagial muscle, spans between the shoulder and wrist. Although some hypotheses on homology have been proposed, the evolutionary origin of the propatagial muscle has remained elusive. To solve this problem, here we analyzed embryonic developments of the forelimb muscles in the chicken (*Gallus gallus*) as a model of birds, as well as in outgroup taxa including the American alligator (*Alligator mississippiensis*) and Madagascar ground gecko (*Paroedura picta*). In addition to histological observations, we identified myoblasts and tendon progenitor cells through *in situ* hybridization of marker genes, such as *MyoD* and *scleraxis*, respectively. In the chicken embryo, the propatagium became recognizable concomitant to the flexion of the elbow joint by stage 33. Subsequently, the dermis along the leading edge of the propatagium

hypertrophied by stage 35. In the alligator and gecko embryos at comparable developmental stages, such a hypertrophied dermis was not observed. Three populations of mesenchymal cells that were adjacent to the myoblasts of the deltoid (DE), biceps brachii (BB), and extensor metacarpi radialis (EMR) muscles, later migrated towards the hypertrophied dermis in the chicken embryos, eventually becoming differentiated into the propatagial muscle. Expression of *MyoD* was clearly detectable at least in these cells adjacent to the DE myoblasts. These three cell populations were absent in the outgroup taxa, and it is likely that they were evolutionary derived from the DE, BB, and EMR muscles. *Scleraxis*-positive cells were not recognizable along the edge of the propatagium, thus the “propatagial tendon” or “ligament” in some previous descriptions is in fact purely a skeletal muscle. These results suggest that the propatagial muscle is a composite muscle connected to the hypertrophied dermis, and analyses of topographical changes of the DE, BB, and EMR muscles in maniraptoran evolution based on fossils will rationalize the evolutionary process of the newly acquired skeletal muscles within the propatagium.

Funding Sources JSPS KAKENHI Grant nos. 17H06385, 19K04061, 22H01341 and 24KJ0675; Sasakawa Scientific Research Grant no. 2022-5036

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Stable isotope geochemistry of the large-bodied pantodont *Coryphodon* from the Western Interior of North America

Unruh-Friesen, Evan G.¹, D'Emic, Michael D.¹, Hoffmann, Simone², Smiley, Tara M.³

¹Biology, Adelphi University, Brooklyn, New York, United States, ²Anatomy, New York

Institute of Technology, Old Westbury, New York, United States, ³Ecology and Evolution, Stony Brook University, Stony Brook, New York, United States

Some of the best examples of past climate change come from the Paleogene, a period in Earth's history punctuated by several major hyperthermal events. The Paleocene–Eocene Thermal Maximum (PETM, ca. 56 Ma) was the first and most severe hyperthermal of the Paleogene and is often cited as an analog for modern climate change. Effects of the PETM include changes to fluvial landscapes, pronounced floral turnover, and dramatic effects on mammalian evolution. One such affected mammal is the hippopotamus-like *Coryphodon*, the first mammalian mega-herbivore (body mass > 1000 kg). To understand how *Coryphodon* adapted to intense periods of climate change, we analyzed published $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ isotopic data from the enamel of nearly 70 *Coryphodon* teeth. Data were correlated to nine biozones spanning the upper Paleogene to lower Eocene (ca. 57–52 Ma). $\delta^{18}\text{O}_{\text{en}}$ values for *Coryphodon* range from 17.5‰ to 24.0‰ whereas $\delta^{13}\text{C}_{\text{en}}$ values range from -17.0‰ to -9.0‰, indicating great dietary breadth and use of a range of habitats from tropical understory to subtropical savanna. Leading into the PETM, there is an increase in the range of isotopic data and a more than 2‰ positive shift for $\delta^{18}\text{O}_{\text{en}}$ and 2‰ negative shift for $\delta^{13}\text{C}_{\text{en}}$ mean values. Compared to the PETM interval, the means and ranges of samples from other non-hyperthermal intervals are not substantially different. Recent fieldwork complements these isotopic data by documenting a broad array of depositional environments, allowing us to further evaluate spatial isotopic variation related to habitat and climate change alongside temporal variation. While isotopic data from *Coryphodon* during the PETM reveals a distinct increase in isotopic range, published isotopic data do not currently exist for *Coryphodon* during later Paleogene

hyperthermal intervals, which occurred during the Wasatchian 5 North American Land Mammal Age. We report novel isotopic data from *Coryphodon* specimens from Wasatchian 5. Preliminary $\delta^{13}\text{C}_{\text{en}}$ data range from -13.1‰ to -12.1‰ and do not reveal a substantial shift or increase in range, suggesting a different evolutionary and/or ecological response to climate change in the genus in these later hyperthermals. This hypothesis will continue to be tested with further bulk and serial isotopic sampling. By resolving isotopic data for *Coryphodon* we can better understand how the first large-bodied mammal responded to climate change and can test for similar responses in other mega-herbivores, past or present.

Funding Sources Funding for this work was received from the Keck Geology Consortium, Toomey Foundation for Natural Sciences, and Eppley Foundation for Research.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

The first occurrence of hadrosauroid eggshells from Upper Cretaceous deposits of France

van der Linden, Tom¹, Zelenitsky, Darla K.³, Fraaije, René H.¹, Valentin, Xavier⁴, Garcia, Géraldine⁴, Holwerda, Femke M.², Schulp, Anne S.²

¹Oertijdmuseum, Zennewijnen, Gelderland, Netherlands, ²Calgary University, Calgary, Alberta, Canada, ³Université de Poitiers, Poitiers, France, ⁴Utrecht University, Utrecht, Netherlands

Dinosaur egg remains are relatively common in Campano-Maastrichtian deposits of the Aix-en-Provence in southern France. These fossils have been assigned to multiple oofamilies and ascribed to various dinosaur taxa found in the region, including nodosaurs (Cairanoolithidae), sauropods

(Megaloolithidae, Fusioolithidae), and theropods (Montanoolithidae, Prismatoolithidae). Despite the fact that hadrosauroids are relatively well represented in these deposits, their eggs (Spheroolithidae) have yet to be reported.

Here, we report the first occurrence of Spheroolithidae from the late Maastrichtian upper 'Argiles et Grès à Reptiles' Formation of Aix-en-Provence. The collection of approximately 300 eggshell fragments from a very small area suggests they belong to a single egg. The eggshell is on average a millimetre thick, has an anastomosing ornamental pattern, a prolatospherulitic eggshell structure, and a prolatoanaliculate pore system. These specimens can be confidently attributed to Spheroolithidae and are most comparable to such ootaxa from Asia and North America.

Since spheroolithids have been ascribed to hadrosauroids, these new eggshells are consistent with known dinosaur taxa succeeding the faunal turnover of the late Maastrichtian Ibero-Armorican island. From late Campanian-early Maastrichtian nodosaur-rhabdodontid fauna, paleocommunities turned over to the late Maastrichtian hadrosauroid fauna. With this new discovery, oofaunas of the late Maastrichtian are represented by the eggs of hadrosaurs, titanosaurs, and theropods. The geographic and stratigraphic proximity of these new spheroolithid eggshells to those of *Megaloolithus* indicate that hadrosauroids and titanosaurs were nesting in the same environments during the late Maastrichtian of Aix-en-Provence.

Funding Sources Funding for this work was received from the NSERC Discovery Grant.

New Middle Miocene astrapotheres remains from Quebrada Honda, Bolivia

Van Orman, Julia¹, Anaya, Federico², Croft, Darin A.³

¹Biology, Macalester College, Saint Paul, Minnesota, United States, ²Facultad de Ingeniería Geológica, Universidad Autónoma "Tomás Frías", Potosí, Bolivia, Plurinational State of, ³Anatomy, Case Western Reserve University, Cleveland, Ohio, United States

Astrapotheres were an order of South American native ungulates (SANUs) that lived from the late Paleocene to the Middle Miocene and ranged from northern Venezuela to Patagonia and even dispersed to Antarctica. The subfamily Uruguaytheriinae includes four genera that are the geologically youngest representatives of the order and were restricted to extra-Patagonian latitudes of South America. Nearly all named species come from tropical latitudes (north of 15° S), the sole exception being the poorly known *Uruguaytherium*. Quebrada Honda is a late Middle Miocene site in southern Bolivia (~22° S) and, along with La Venta, Colombia, is the geologically youngest dated fossil site with astrapotheres. We describe a new specimen from the Rio Rosario local area and compare it to previously reported specimens from the Quebrada Honda local area. The new material includes a partial left maxilla preserving DP2-DP3, part of the alveolus of DP4, and an associated lower incisor. The previously reported material includes a mostly complete m3 and other dental fragments collected almost 50 years ago that were never described, and a posterior cranium referred to *?Xenastrapotherium*. Relatively few deciduous teeth are known for astrapotheres, and no deciduous premolars have been described for uruguaytheriines, making direct morphological comparisons difficult. However, the presence of an incisor means that the Quebrada Honda material is not referable to *Granastrapotherium snorki*, which lacks incisors. The material appears to

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

be intermediate in size between previously described species, ~15-30% larger than *Hilarchotherium castanedaii*, *Xenastropotherium christi*, and *Xenastropotherium kraglievichi*, but ~15-20% smaller than *Granastropotherium snorki*, *Hilarchotherium miyou*, and *Uruguaytherium beaulieu*. The Quebrada Honda material likely represents a new species, but its generic affinities are presently unclear. Despite the temporal overlap between Quebrada Honda and La Venta, they have virtually no species or even genera in common, a pattern reinforced by the astrapothere material described here. However, the presence of an uruguaytheriine astrapothere at Quebrada Honda suggests some paleoenvironmental similarities with La Venta and other Middle Miocene sites (e.g., Fitzcarrald and Tumbes, Peru; Alto Juruá, Brazil) where their remains have been reported, such as a warm, lowland setting with permanent bodies of water.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Southern giants: locomotory and sensory adaptations of diprotodontid marsupials from the late Cenozoic of Australia and New Guinea

van Zoelen, Jacob D.

College of Science and Engineering , Flinders University, Adelaide, South Australia, Australia

Giant mammals exert a major influence on terrestrial ecosystems due to their size and the ways in which they use and modify landscapes. Although many large species became extinct over the past 100,000 years, iconic survivors include elephants, rhinoceroses, hippopotamuses and tapirs. On the Australian continent, the extinct marsupial diprotodontids have often been cast as the functional and ecological equivalents of such placentals, but the

validity of these claims remains poorly tested, a situation exacerbated by 186 years of taxonomic confusion. Through comparisons of over 2,200 3D digitised bones, I re-appraised the taxonomy of late Cenozoic diprotodontids and investigated their locomotory adaptations and vision. Analysis of visual systems was conducted through measurements of orbit orientation, and geometric reconstructions of eye volume and placement using the surrounding contours of the orbit. Of the Pleistocene species, I consider five (*Diprotodon optatum*, *Nototherium mitchelli*, *Zygomaturus trilobus*, *Hulitherium tomasettii* and *Maokopia ronaldi*) to be taxonomically valid. Each had a distinct geographical distribution; with only *D. optatum* consistently occurring sympatrically with other species. All five are present in fossil deposits dated to within the last 100,000 years. Comparisons of limb-bone morphology demonstrate that all Pleistocene species exhibit unique adaptations to plantigrade graviportal locomotion. The function and weight-bearing role of the digits are vastly reduced/absent compared with that of the carpals/tarsals. Furthermore, the pisiform is modified into a secondary heel for efficient long-distance walking. The mid-Pliocene appearance of these adaptations coincided with expansion of open habitats. Advanced specialisation in the limbs of *N. mitchelli* is demonstrated in the form of a passive locking mechanism in the elbow, facilitated by the medial ulnar collateral ligament. Further unique specialisations are observed in the eye orbit region of *M. ronaldi*. It displays demonstrably larger, more convergent eyes than any other diprotodontid. This is likely reflective of a nocturnal niche in the subalpine tundra of New Guinea. These discoveries highlight the ecomorphological distinctness of diprotodontids among giant mammals; they were as unique to the Australian continent as the kangaroo or echidna. Ongoing research on diprotodontid anatomy and ecology is

expected to shed light on the impacts of their loss from Australian ecosystems.

Funding Sources This research was funded by the Australian Government Research Training Program Scholarship (Excellence).

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

**Dental wear facets in
Pachycephalosauridae are more similar
than previously thought**

Varriale, Frank¹, Maya-Romero, Alex²

¹Biology Department, King's College, Wilkes-Barre, Pennsylvania, United States, ²Molecular and Cell Biology, University of California, Berkeley, Berkeley, California, United States

Previous workers have documented a variety of facet configurations in pachycephalosaurid taxa, from the apically located planar facets devoid of cutting edges on maxillary teeth of *Prenocephale* (MgD-I/104) to the lingual maxillary facets of *Homalocephale* (MPC-D 100/1201) that are so extensive they form a confluent occlusal plane across the entire maxillary dentition. To test these interpretations, we examined facet configuration and type (attrition/abrasion) in a variety of pachycephalosaurid taxa.

Wear on maxillary crowns of *Pachycephalosaurius* (TCMI 2004.17.1) exhibits four configurations: a large mesiolingual attrition facet; large mesiolingual and a smaller distolingual attrition facet; a third abrasion facet apicolingually positioned between these attrition facets; or a large attrition facet that broadly covers the lingual surface of the crown. *Stegoceras* (UALVP 02) shares with *Pachycephalosaurius* large mesiolingual or paired mesiolingual and distolingual attrition facets, but not the other two configurations. Dentary crowns of cf. *Sphaerotherolus*

(NMMNH P-30068) exhibit either single or double attritional facets like those of *Stegoceras* where the larger facet is located distolabially and the smaller mesiolabially.

Facets in *Homalocephale* resemble similarly placed facets in *Pachycephalosaurius* but do not form a confluent surface, being slightly offset among crowns. Additionally, the aberrant apical facets in *Prenocephale* are an affectation of weathering, with much of the apical-most enamel and dentine missing and fragmented to give the false appearance of faceting. Remnants of true attritional facets are preserved on three left maxillary teeth in *Prenocephale*. Although poor preservation has diminished their extent, the position of these facets implies that they covered the mesiolingual crown more extensively, akin to the large mesiolingual maxillary facets of *Pachycephalosaurius* and *Stegoceras*.

Goyocephale (MPC-D 100/1501) was not examined by us, but previously published figures of this specimen show large mesiolingual to lingual maxillary facets that resemble those in *Pachycephalosaurius* and *Homalocephale*. The figured dentary teeth imply the presence of double facets like those of *Stegoceras* and cf. *Sphaerotherolus*.

We interpret the similarity of facets among pachycephalosaurids to indicate a more congruent pattern of mastication among taxa, with previous interpretations of widely varying wear indicative of highly disparate diets having lost support.

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

A new double clutch of *Prismatoolithus* eggs from the Cretaceous Two Medicine Formation of Montana and nesting site fidelity in non-avian dinosaurs

Varricchio, David J.¹, Allen, Harrison J.², Scannella, John³

¹Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ³Museum of the Rockies, Montana State University, Bozeman, Montana, United States

The term ‘site fidelity’ has been applied to several dinosaur sites, including those representing prosauropods, sauropods, theropods, and hadrosaurs, highlighting recurrent nesting at these places. For neontologists, site fidelity typically refers to the regular or seasonal reuse of a favored locale, such as a breeding ground or nest by an individual animal. Although some dinosaur sites may show cross-cutting relationships among egg clutches, the ambiguous representation of time by most sedimentary units makes it difficult to assess these paleontological examples on both a temporal and individual scale.

Museum of the Rockies (MOR) 11880 represents an exceptional specimen from the Upper Cretaceous Two Medicine Formation of Montana that approaches the neontological meaning of site fidelity. MOR 11880 consists of two clutches of elongate, asymmetric *Prismatoolithus* eggs belonging to troodontids. Medical CT-scanning both revealed the full compliments of eggs and provided three-dimensional views of their relationships. A lower clutch contains 21 eggs represented solely by their narrow, tapered ends. These otherwise upright eggs have been sharply truncated, leaving only a few centimeters of their entire 14 cm length intact. A similarly arranged second clutch of thirteen eggs sits a few centimeters above the first. The tight emplacement of the upper clutch above the first suggests a second nesting event took place directly and shortly after the first, narrowing both the temporal and spatial scale of ‘site fidelity’.

Two earlier examples of similar double clutches are known for *Prismatoolithus*: MOR

676, also from the Two Medicine and ZMNH M8711 from the Liantoutang Formation of southeastern China. The two Montana examples represent approximately 10% of the known Two Medicine clutches. These specimens indicate site fidelity on an ecologic, rather than geologic, time scale and at approximately the individual rather than species level. Factors such as nesting success and territoriality, in addition to favorable substrates, may have influenced the behaviors recorded by these specimens.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Leveraging digital scanning and 3D printing technology to reveal new information and create the most accurate mount of the Late Cretaceous Dinosaur *Troodon formosus*.

Varricchio, David J.¹, Williams, Scott A.², Serio, Michael^{2,4}, Hall, Lee², Metz, Eric T.², Smith, Matt³

¹Earth Sciences, Montana State University, Bozeman, Montana, United States, ²Museum of the Rockies, Bozeman, Montana, United States, ³Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Science, Beijing, Beijing, China, ⁴Smith Studios Inc., Livingston, Montana, United States

Troodon formosus (*Troodon*) is a theropod dinosaur from the Late Cretaceous of North America primarily known from fragmentary fossil material within the Judith River and Two Medicine formations. The upper member of the Two Medicine has produced *Troodon* eggs and nests, along with numerous body fossils. However, no complete skeleton has yet been found for *Troodon*; previous reconstructions have relied on filling gaps in the skeleton with sculpted bones. This obstacle has been surmounted utilizing digital modelling and 3D printing to create the most complete

mounted skeletal reconstruction of *Troodon* to date.

To overcome preservation limitations, surface scans were made from multiple *Troodon* fossils housed in Museum of the Rockies' (MOR) collections, generating digital copies of every representative element available. Scanned bones were digitally scaled, combined, and retro-deformed when necessary leading to a nearly complete reconstruction of the skeleton. From this model, resin 3D printed copies of each bone were produced. The elements were mounted by a professional studio who also sculpted any remaining missing pieces. This reconstruction referenced more direct fossil material than any previous *Troodon* reconstruction to date. The resulting skeleton shows proportionally long legs and a shorter tail for *Troodon*, especially when compared to current skeletal reconstructions.

This study utilized digital and physical reconstruction methods, mounting for the first-time specimens that would have been previously overlooked. The final skeleton sheds light on the anatomy and morphology of *Troodon* and has implications for the utility of 3D scanning and printing for the mounting of incomplete vertebrate specimens. This mount will be displayed in the summer of 2025 as part of *Cretaceous Crossroads*, a new permanent exhibit at MOR showcasing a new interpretation of this enigmatic dinosaur.

Funding Sources Funding for this project is provided by the WEM foundation and Anne and Ed Teppo.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Herbivore diets in the early Pleistocene Haro River Quarry of Pakistan

Vetter, Lael¹, Kaur, Anubhav Preet², Thirumalai, Kaustubh¹, Saunders, Jeffrey J.³,

Kerrison, Nicole⁴, Pobiner, Briana⁵, Behrensmeyer, Anna K.⁶, Patnaik, Rajeev⁷, Jukar, Advait M.⁸

¹Geosciences, University of Arizona, Tucson, Arizona, United States, ²Department of Humanities and Social Sciences, Indian Institute of Science and Education, Mohali, India, ³Tumamoc Desert Laboratory, University of Arizona, Tucson, Arizona, United States, ⁴Lunar and Planetary Laboratory, University of Arizona, Tucson, Arizona, United States, ⁵Anthropology, Smithsonian Institution, Washington, District of Columbia, United States, ⁶Paleobiology, Smithsonian Institution, Washington, District of Columbia, United States, ⁷Centre for Advanced Studies in Geology, Panjab University, Chandigarh, India, ⁸Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States

The Haro River Quarry is an exceptional assemblage of early Pleistocene (ca. 1.7-1.2 Ma) fossil vertebrates from northern Pakistan in the Campbellpore Basin. This assemblage is thought to have been accumulated by the extinct hyaena, *Pachycrocuta brevirostris*. Following its initial discovery in 1935, a comprehensive excavation of the Haro River Quarry was not attempted until the early 1980s when three "pods" or accumulation zones were uncovered in the quarry. The most fossiliferous of these is known as Pod 2, which has produced hundreds of skeletal remains of fossil vertebrates, many of which are modified by carnivores, as well as coprolites. Early Pleistocene assemblages of this density are virtually unknown from the early Pleistocene Upper Siwaliks of Indo-Pakistan, and thus offers a tantalizing opportunity to study the paleoecology of a local faunal assemblage where individuals may have been contemporaneous. In this region, the early Pleistocene was also a time of progressive aridification, along with cooler climate and enhanced seasonality. However, the faunal assemblage at Haro River Quarry presents a curious case of taxa that are not

typically associated with these ecosystem shifts to more open environments, including the presence and abundance of mesodont and brachyodont taxa such as cervids and suids, as well as hypsodont bovids. Here we present stable isotope measurements of tooth enamel $\delta^{13}\text{C}$ and $\delta^{18}\text{O}$ from a suite of herbivore specimens. We explore the relationship of the diet of these taxa, comparing enamel isotopes and dental morphology, and test the hypothesis of strict fidelity of evolutionary dental morphology to diet in these herbivores. Preliminary evidence suggests that both cervids and bovids were eating a mixed C_3/C_4 or predominantly C_4 diet, while suids show a clear isotopic signal of mixed C_3/C_4 diet. We further compare our results with published tooth enamel isotope data from other Early Pleistocene Assemblages from the Upper Siwaliks of India, and from extant cervids in the region. Our results suggest that despite having relatively low-crowned teeth, cervids exhibit a great deal of ecological flexibility, which may have allowed them to persist through the increasingly fluctuating environments of the Pleistocene.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

High sauropod diversity on Africa in the Late Cretaceous: new fossils from Niger (Farak Formation: Cenomanian)

Vidal, Daniel^{1,2}, Keillor, Tyler¹, Ciudad Real Ballester, María², Gascó Lluna, Francesc^{3,4}, Baumgart, Stephanie L.⁵, Myhrvold, Nathan P.⁶, Sereno, Paul C.¹

¹Organismal Biology and Anatomy, University of Chicago, Chicago, Illinois, United States, ²Grupo de Biología Evolutiva, UNED, Madrid, Madrid, Spain, ³Facultad de Humanidades y Ciencias Sociales, Universidad Internacional Isabel I de Castilla, Burgos, Spain, ⁴Museo de Benagéber, Benagéber, Spain, ⁵Department of

Physiological Sciences, University of Florida, College of Veterinary Medicine, Gainesville, Florida, United States, ⁶Intellectual Ventures, Bellevue, Washington, United States

Diagnostic sauropod remains are scarce at the dawn of the Late Cretaceous (Cenomanian) on Africa, prior to rising sea levels that flooded and subdivided land areas. During this stage, large-bodied theropods, such as *Spinosaurus* and *Carcharodontosaurus*, are often better known than coeval sauropods. Expeditions to the Farak Formation in Niger have yielded the most complete assemblage of Cenomanian sauropods to date on Africa. Partial to nearly complete skeletons have been discovered for four new sauropods.

The first is a rebbachisaurid comparable in size to *Nigersaurus* with a shorter neck. It has short dorsal and anterior caudal neural spines (twice centrum height), with dorsal hyposphene-hypantrum articulations even more reduced than in *Nigersaurus*, present only in the last dorsal vertebra. The second is a sail-backed rebbachisaurid closer in body size to *Rebbachisaurus* with anterior caudal neural spines at least taller than five times centrum height. The third is a giant somphospondylid titanosauriform with a stoutly proportioned femur exceeding 190 centimeters in length. It has short mid-posterior dorsal vertebrae with fully developed hyposphene-hypantrum articulations and camellate bone extending into the base of the tail. Mid caudal vertebrae have amphiplatyan articulations and tall neural arches. The fourth is a medium sized titanosauriform with an exceptionally long neck, slender limbs, and a proportionately short tail. The forelimb is moderately elongate (humerus 82% femur length), and the fibula has a hypertrophied anterior trochanter.

These sauropods are known from multiple specimens from two locations, their age reasonably well constrained by the overlying strata of the Cenomanian-Turonian

transgression. They correspond in general to the well-known sauropod faunas from the Huincul and Candeleros Formations of Argentina, where small to medium diplodocoids and medium to large titanosauriforms were the dominant large-bodied herbivores.

Funding Sources Daniel Vidal receives funding from a Marie Skłodowska Curie Actions grant (EvoSaurAF 101068861).

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Testing models of biotic survival and recovery from the Permo-Triassic mass extinction and climate crisis

Viglietti, Pia A.^{1,2}, Angielczyk, Kenneth D.^{1,2}, Huttenlocker, Adam³, Botha, Jennifer², Smith, Roger M.^{2,4}, Crowley, James⁵, Browning, Claire⁴, Seerane, Thabile^{2,6}, Abbott, Caroline P.⁷

¹Negaunee Integrative Research Center, Field Museum of Natural History, Chicago, Illinois, United States, ²Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ³Department of Integrative Anatomical Sciences, University of Southern California, Los Angeles, California, United States, ⁴Karoo Palaeontology, Iziko South African Museum, Cape Town, Western Cape, South Africa, ⁵Department of Geosciences, Boise State University, Boise, Idaho, United States, ⁶Department of Geosciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ⁷Committee on Evolutionary Biology, University of Chicago, Chicago, Illinois, United States

Biodiversity research indicates that current species loss rivals the most catastrophic extinction in the history of animal life – the Permo-Triassic Mass Extinction (PTME) ca.

251.9 Ma. The Karoo Basin stands out for its complete PTME boundary section and abundant vertebrate fossils spanning various body sizes, terrestrial ecologies, and environments. We need a more precise geochronological framework to understand spatiotemporal scales of biodiversity and evolutionary change that followed the PTME, and the factors that promote or inhibit recovery from such crises. Karoo tetrapod occurrences vary in time and space, influenced by a range of environmental and ecological factors. To address the timing and synchronicity of vertebrate extinctions across the Karoo Basin, our working group established a time-calibrated framework that assigned over 1400 fossils to 19 distinct lithostratigraphic bin intervals at two study sites including the Permo-Triassic Palingkloof Member and the Triassic Katberg Formation. Bipartite network analysis demonstrates that these bin intervals offer a statistically reliable description of PTME fossil occurrences, providing a finer level of detail compared to broader biostratigraphic assemblages or data focusing on individual specimen occurrences at the meter level. A maximum depositional age of 251.7 ± 0.3 Ma for the lower Palingkloof Member overlaps with the global Permo-Triassic boundary (251.9 Ma), as do unpublished ages presented here within a novel high-resolution Bayesian stratigraphic framework for South Africa's Karoo PTME. These results support traditional hypotheses about the placement of the Permo-Triassic boundary and the extinction in the Karoo. Broader impacts of our working group emphasizes capacity-building, permanent archiving of physical specimens and digital data for future study, in addition to strengthening international collaborations through the South African based “PalaeoLink” Program. Educational theatre will tell the story of extinct mammal relatives to young learners in local South African languages through our team’s ‘Puppet Planet’ program. The outcome will enhance understanding of vertebrate responses to extreme climatic and

ecosystem instability, while also aiding in the prediction of long-term biotic responses to future environmental changes to safeguard existing biodiversity.

Funding Sources PAV and KDA: NSF DEB-2325380, Field Museum Grainger Bioinformatics Center; AKH: NSF DEB-2325381

Regular Poster Session 4 (Saturday, November 2, 2024, 4:30 - 6:30 PM)

Paleontology at the junior level: engaging adults in paleontological thinking in professional learning focused on inclusion, diversity, equity, and access, in formal and informal educational contexts

Vital, Demetrios

IDEAL Center, Science Museum of Minnesota, Minneapolis, Minnesota, United States

Adult participants in professional development (PD) facilitated by the IDEAL Center of the Science Museum of Minnesota (SMM) engaged in comparative anatomy and paleontological activities, in order to strengthen participants' capacities towards greater inclusion, diversity, equity, and access (IDEA) in their work.

In PD programs designed for two different professional sectors — one for formal K-16 educators, and one for informal science institution (ISI) staff — participants learned paleontology content through pedagogical structures designed to inclusively and equitably engage all participants in meaningful learning. Participant groups had sector-specific framing — K-16 educators focused on pedagogical strategies for disrupting oppressive systems in formal education, whereas ISI staff focused on strategies for growing IDEA within their organizational contexts — with extended discussion on systemic change necessary for

fields of formal and informal science education to become equitably inclusive of historically marginalized perspectives.

These program tracks included formal and informal evaluation. Participant reflection revealed growth in understanding paleontological concepts, as well as in participants' conceptions of how to build more inclusive professional and educational spaces.

The pedagogical design of the programming, including intent, structure, content, and foundational research, is described herein, with examples of participant self-reflection and evaluation.

Funding Sources The professional development programs described herein were supported by iPAGE 2.0 - 2020 NSF AISL #2011859, and Minnesota Legacy Funding.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

A perplexing new peripitychid mammal specimen from the lower Paleocene D1 sequence of the Denver Formation of Colorado (Corral Bluffs, El Paso County)

Vohs, Athena¹, Weaver, Lucas N.¹, Chester, Stephen G.², Lyson, Tyler³

¹Museum of Paleontology & Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States, ²Department of Anthropology, Brooklyn College, City University of New York, New York, New York, United States, ³Department of Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States

Archaic ungulates ('condylarths') were among the most speciose group of mammals in the aftermath of the Cretaceous-Paleogene (K-Pg) mass extinction in North America. Corral Bluffs, an exposure of the lower

Paleocene D1 sequence of the Denver Formation in the Denver Basin of Colorado, is emerging as one of the most exceptional records of early archaic ungulates, yielding numerous well-preserved fossils from the first ca. 1 Ma of the Paleocene. Here, we describe a new archaic ungulate specimen (DMNH EPV.143118) from the upper Puercan 2 North American Land-Mammal 'age' at Corral Bluffs, ~100 m above the pollen-defined K-Pg boundary, represented by left and right dentary fragments, a right maxilla fragment, and an associated p1–2. We identify the specimen as a peripitychid based on: (1) premolars larger and more inflated than the molars, (2) molar cusps conical and appressed, and (3) lingual margin of upper molars slopes away from the protocone apex. Among peripitychids, DMNH EPV.143118 resembles the 'Anisonchinae' (*Anisonchus*, *Gillisonchus*, *Haploconus*, *Mithrandir*), a likely non-monophyletic group, in exhibiting: (1) a hypocone that projects lingually past the protocone apex (but not as prominent as in Conacodontinae), (2) absent protostyle, and (3) columnar and reduced paraconid. Among 'anisonchines', DMNH EPV.143118 shares several similarities with the upper cheekteeth (which are more diagnostic than the lowers) of *Mithrandir* and *Gillisonchus*, but also with those of a specimen (UCM 34166) referred to as *Alticonus* (?*Tinuviel*) *gazini*: (1) narrow stylar region, (2) M2 the most transverse molar, and (3) relatively pronounced pre- and postcingulae on the molars. DMNH EPV.143118 exhibits a mosaic of dental features that collectively differ from those taxa, however. It differs from *Gillisonchus* and *Mithrandir* but resembles UCM 34166 in: (1) lacking a deep groove separating the lingual faces of the hypocone and protocone, (2) paracone shifted buccally to metacone, (3) more pronounced parastylar and metastylar lobes and ectoflexus. However, DMNH EPV.143118 differs from UCM 34166 and resembles *Gillisonchus* and *Mithrandir* in: (1) P4 larger than M1 with a prominent protocone, (2) reduced para- and

metaconules, (3) protocone more closely appressed to para- and metacone. Thus, we hypothesize that DMNH EPV.143118 represents a new species. Future comparative and phylogenetic analyses will clarify its taxonomic affiliations and evolutionary relationships among 'anisonchines'.

Funding Sources National Science Foundation (Frontier Research in Earth Sciences grant EAR-2317666).

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

New tyrannosaurid material from the marine Bearpaw Formation of Alberta sheds light on the turnover between Judithian and Edmontonian faunas in northern Laramidia

Voris, Jared T.¹, Therrien, François³, Coppock, Colton², Zelenitsky, Darla K.¹

¹Earth, Energy, Environment, University of Calgary, Calgary, Alberta, Canada, ²Royal Tyrrell Museum of Palaeontology, Drumheller, Alberta, Canada, ³Biological Sciences, University of Alberta, Edmonton, Alberta, Canada

A gap in the terrestrial faunal record of northern Laramidia exists from 74.5 Ma to ~72.5 Ma, between the Judithian and Edmontonian land mammal age faunas. This interval, informally referred to as the 'Bearpaw gap', coincides with the last major transgressive-regressive cycle of the Western Interior Seaway (WIS) that resulted in the deposition of the Bearpaw Formation (Fm) in Alberta, Saskatchewan, and Montana. This marine unit has yielded a rich and diverse marine fauna but has also produced occasional terrestrial vertebrate (dinosaur) remains. Prior description of three skeletons of the saurolophine *Prosaurolophus maximus* from the Bearpaw Fm of Alberta indicates

that the nature and rate of the terrestrial Judithian-Edmontonian faunal turnover could be elucidated from diagnostic specimens preserved in this formation.

Here we report on another diagnostic specimen from the Bearpaw gap, a partial skull of a tyrannosaurid found ~8 m above the base of the Bearpaw Fm near Lethbridge, Alberta, Canada. The specimen, represented by various articulated to associated bones of the posteroventral region of the skull (e.g., jugal, quadratojugal, palatine, surangular), can be confidently identified as the tyrannosaurine *Daspletosaurus horneri*, based on the presence of an ascending process of the jugal, a small pneumatopore in the dorsal process of the quadratojugal, and a ventrolaterally oriented surangular shelf. This new *D. horneri* specimen, along with the occurrences of *P. maximus*, demonstrates that some species from older Judithian faunas (i.e., upper Dinosaur Park and upper Two Medicine fms) persisted into the early Bearpaw transgressive phase (circa 74.3 Ma) of the WIS in southwestern Alberta.

Our comprehensive survey of specimens from the well-sampled Horseshoe Canyon Formation further north in southcentral Alberta reveals that saurolophines were present but *Daspletosaurus*-line tyrannosaurines were absent. The latter either disappeared during the Bearpaw gap or persisted into later Edmontonian times in geographic areas with poor preservation potential. Given that the genus *Daspletosaurus* is most common in Judithian-aged deposits of southernmost Alberta and Montana, fossil evidence for Edmontonian-aged *Daspletosaurus*-line tyrannosaurines should be sought in these more southerly regions since albertosaurines appear to have dominated southcentral Alberta.

Funding Sources Izaak Walton Killam Memorial Scholarship to JTV
NSERC Discovery Grant to DKZ

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Using stable isotopes to deduce context clues and evaluate dietary ecology from a collection of historic cercopithecoid skeletons from Lake Victoria

Walker, Madelaine R.¹, Nockerts, Rebecca², Fox, David L.³, McNulty, Kieran P.²

¹Anthropology, University of Minnesota Twin-Cities, Minneapolis, Minnesota, United States, ²Ecology, Evolution, and Behavior, The University of Minnesota Twin-Cities, Minneapolis, Illinois, United States, ³Earth and Environmental Sciences, The University of Minnesota Twin-Cities, Minneapolis, Minnesota, United States

Historic and museum skeletal collections can be valuable resources for researchers as models for fossil taxa and assemblages. Isotopic studies are effective for quantifying the dietary ecology of living and extinct organisms, but their destructive nature makes it difficult to perform analyses on large samples ethically. Although performing such analyses on specimens from historical collections can reduce the need for collecting new skeletal materials and contribute insights into dietary ecology, inconsistencies and gaps in recordkeeping pose challenges to interpreting their results.

One such sample is the Niel C. Tappen primate collection, housed at the University of Minnesota's Evolutionary Anthropology Laboratory and originally assembled in the 1950s. The majority of specimens in this collection are wild-shot from forested areas on the north shore of Lake Victoria. They were brought to Tappen during fieldwork in Kampala, Uganda, by a local hunter and by rural residents responding to a newspaper advertisement. However other individuals were brought from Kome Island in Lake Victoria or donated by Makerere College

Medical School. Provenance information was described broadly in publications, but precise records for every individual are not known.

Here we analyzed carbon, oxygen, and nitrogen isotope ratios from bone apatite and collagen for three species in the Tappen collection that are commonly sympatric: *Cercopithecus ascanius* (n=22), *Chlorocebus aethiops* (n=22), and *Lophocebus albigena* (n=27). The mix of individuals from different populations in this collection echoes uncertainty in the spatial and temporal context of many fossil assemblages. We use the results of these analyses to assess the population affinities of individuals within each species and evaluate differences in their dietary ecology.

We find that $\delta^{13}\text{C}$, $\delta^{15}\text{N}$, and $\delta^{18}\text{O}$ results allow us to identify specimens that may have come from the medical school. Our analyses show that stable isotopes $\delta^{13}\text{C}$, $\delta^{18}\text{O}$, and $\delta^{15}\text{N}$ from bone collagen and carbonate samples provide clues to help resolve long-standing questions about the collection. Once those individuals are controlled for, we further find that *C. ascanius* consumed more ^{13}C depleted foods than *Ch. aethiops*, with no difference in $\delta^{15}\text{N}$ content. Hence, there seems to be subtle niche differentiation between these two species.

Funding Sources University of Minnesota's Creating Inclusive Cohorts Training Program

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Middle ear evolution in Early Cretaceous eutherian mammals

Wang, Haibing, Wang, Yuan-Qing

Paleomammalogy, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The middle ear ossicles in modern mammals are repurposed from postdentary bones in non-mammalian cynodonts. Recent discoveries by paleontological and embryonic studies have developed different models for the middle ear evolution in mammaliaforms. However, the evolutionary scenario of the middle ear in early therians remains poorly understood. The discovery of the Early Cretaceous eutherian *Cokootherium* from the Jehol Biota reveals, to our knowledge for the first time, that in eutherians the Meckelian cartilage was ossified but reduced in size. This illustrates a gradual reduction of the ossified Meckelian cartilage in Mesozoic mammaliaforms. Furthermore, the discovery of the Early Cretaceous eutherian *Microtherulum* from the Jehol Biota reveals a detached middle ear with a well-preserved articulation of the malleus and incus. The malleus and incus of *Microtherulum* provides the earliest-known evidence of the saddle-like incudomalleal joint seen in modern therians. It suggests that this novel configuration originated no later than the Early Cretaceous in eutherians and represents a major apomorphy of Early Cretaceous eutherians. In contrast to the distinct saddle-like incudomalleal articulation in therians, the differences between the overlapping versus the half-overlapping incudomalleal joints in monotremes and stem mammals would be relatively minor. Unlike other Mesozoic mammaliaforms, the massive malleus with the orbicular apophysis in *Microtherulum* represents a morphological innovation in the middle ear. This suggests a microtype middle ear by definition and raises questions about the evolution and transformation of different middle ear morphotypes in therians. Adaptation to high-frequency hearing in Early Cretaceous eutherians can be facilitated by a detached middle ear with the saddle-shaped incudomalleal joint (as seen in *Microtherulum*), in conjunction with the innovation of inner ear structures (e.g., a bony cribriform plate, a primary bony lamina, the

base of the secondary bony lamina, and a nearly 360° coiled cochlear canal). Current evidence indicates that significant evolutionary innovations of the middle ear in modern therians evolved in Early Cretaceous.

Funding Sources Funding for this work was received from the Youth Innovation Promotion Association, CAS (2021068) and National Natural Science Foundation of China (42288201, 42272017).

Technical Session 17: Theropoda II (Saturday, November 2, 2024, 8:00 AM)

Insight into troodontid tooth attachment and replacement from a new *Urbacodon* (Theropoda, Troodontidae) from the Upper Cretaceous Iren Dabasu Formation, China

Wang, Shuo, Ding, Nuo, Yang, Rui

East China Normal University, Shanghai, China

Tooth attachment and replacement play significant roles in the feeding ecology of polyphyodont vertebrates, yet these aspects have remained largely unexplored in non-avian paravians including troodontids. Here, we describe a new troodontid species, *Urbacodon norelli* sp. nov., recovered from the Upper Cretaceous Iren Dabasu Formation of Inner Mongolia, China, based on an incomplete right dentary and 12 associated replacement teeth. *U. norelli* is distinguished from all other known troodontids, including its relative *U. itemirensis* from Uzbekistan, by several features: the presence of paired dentary symphyseal foramina, the presence of a relatively steep anterior margin of the dentary, the absence of a dentary chin, the presence of a common groove hosting the anterior 12 dentary teeth, and the presence of relatively larger dentary teeth. Phylogenetic analysis places both species of *Urbacodon* as sister taxa to *Zanabazar junior*, confirming their status as later-diverging troodontids.

Radiographs revealed an alternating tooth replacement pattern in *U. norelli*, with a maximum Zahnreihen-spacing estimated to be 3. During tooth replacement, the anteriorly inclined interdental septa, which wedge between anterior dentary teeth, undergo frequent remodeling as the developing tooth moves upwards, particularly anterolabially. This rapid turnover leaves insufficient time for an interdental plate to form, resulting in the absence of such structures in this specimen. The frequent remodeling of periodontal tissues accompanying tooth replacement likely accounts for the absence of interdental plates. The discovery of this new troodontid expands our understanding of paravian theropods from the Upper Cretaceous Iren Dabasu Formation and provides valuable insights into troodontid tooth biology.

Technical Session 13: Synapsida (Friday, November 1, 2024, 8:00 AM)

Constraints and drivers of the ecomorphological evolution of Permian synapsid carnivores

Warshaw, Elias A.

School of Earth Sciences, University of Bristol, Bristol, United Kingdom

The Permian saw a drastic restructuring of tetrapod communities, marking a shift away from the water-based assemblages of the Carboniferous and towards more fully terrestrial systems composed of the ancestors of reptiles and mammals. Perhaps the greatest beneficiaries of this shift were the synapsids, which dominated tetrapod assemblages for much of the Permian. This is especially true within the carnivore guild, with synapsid carnivores undergoing multiple adaptive radiations and continuing to explore new ecospace until their devastation at the Permian-Triassic boundary. Recent work has identified a dramatic increase in ecomorphological disparity among synapsid

carnivores through the Permian, recording growing complexity of contemporary ecosystems. Identifying the evolutionary mechanisms underlying this pattern represents an opportunity to deepen our understanding of the relative contributions of different constraints and drivers in guiding the course of vertebrate evolution over large time scales and major ecological transitions.

Here I demonstrate that trends in the cranial shape evolution of Permian synapsid carnivores were intimately related to trophic ecology, with subsidiary roles played by intrinsic constraints on morphospace occupation. Skull shape was quantified across representatives of every major Permian radiation of synapsid carnivores using two-dimensional geometric morphometrics, with morphospace occupation visualized using principal component analysis of Procrustes-transformed coordinates. The functional morphology of sampled taxa was explored using linear morphometrics of features relevant to prey capture and food processing, which were used to group taxa into objective feeding groups according to the recently developed consensus clustering approach. Finally, cranial modularity was used as a proxy for structural constraints on cranial evolution, as quantified by anatomical network analysis. Phylogenetic comparative methods were performed in R using a recently compiled supertree from the literature, allowing trends across form, function, and modularity to be compared. I found a consistent significant relationship between cranial shape and function, with significant shape covariation between modules indicating loose constraints on skull shape evolution. These results emphasize the macroevolutionary effects of competition and adaptation, contributing to longstanding debates surrounding the causal mechanisms for observed evolutionary patterns.

Funding Sources This work was not supported by any external funding sources.

Colbert Prize Session

Evolution of the tympanic middle ear in the lineage towards birds

Watanabe, Takumi, Hirasawa, Tatsuya

Earth and Planetary Science, University of Tokyo, Tokyo, Japan

In the tetrapod evolution, tympanic ears evolved independently at least four times, and represent key innovations for impedance matching between the air and body. While the evolution of the tympanic ear in mammals has been well studied, those in other lineages have remained unclear. Here, we focused on the jaw joint and middle ear in lineage towards birds.

First, we analyzed the developmental processes of the jaw joint and middle ear in the chicken, American alligator, and Chinese softshell turtle embryos. Histological sections were stained with Alcian blue, hematoxylin, and eosin, and the histological images were aligned and reconstructed three-dimensionally using Avizo software.

In the alligator and turtle, the retroarticular process (RAP) on the hyoid arch element was formed rostrocaudally, and the mandibular depressor muscle (m.DM), the hyoid arch muscle developed caudolateral to the glenoid, eventually becoming attached to RAP. On the other hand, in the chicken, the caudal end of the developing lower jaw became secondarily shifted medially to form the medial process on the angular. Subsequently, an additional process protruded caudally on the caudal end of the lower jaw to form the caudal process. m.DM developed on the ventrocaudal to glenoid and became attached to the caudal margin of the angular process. Based on this secondarily transformation of the caudal end, to which m.DM attaches, in the chicken, the angular process in birds is homologous with the RAP

of non-avian diapsids. Our observation further showed that, concomitant to this embryonic transformation of RAP in the chicken, the arrangement of the middle ear including the columella auris changed and the external auditory meatus (EAM) invaginated deeply, while EAM was shallow in the alligator and not recognizable in the turtle.

Second, we examined morphologies of lower jaws of non-avian theropods. RAPs of non-coelurosaurs extended caudally as in the alligator and turtle. On the other hand, in coelurosaurs except for the Oviraptorosauria, RAPs were oriented medially to the glenoid.

Therefore, medially-oriented RAPs would have evolved in the Coelurosauria, suggesting evolutionary changes in middle ear construction in the lineage towards coelurosaurs. In particular, according to our finding on the embryonic transformation of the RAP accompanying deep invagination of EAM, it is likely that the deep EAM seen in extant birds first evolved in coelurosaurs.

Funding Sources JSPS KAKENHI Grant no. 22H01341 and Sasakawa Scientific Research Grant from the Japan Science Society.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Taphonomic, stratigraphic, and morphological analysis of hadrosauroids from the lower Wahweap Formation (early Campanian): insights into the early evolution and ecology of Hadrosauridae in North America

Watkins, Madison S.¹, Titus, Alan L.², Knoll, Katja², Cassiano, Bryce³, Sertich, Joseph J.⁵, Shimer, Grant T.¹, Harrington, Arianna⁴

¹Geosciences Department, Southern Utah University, Cedar City, Utah, United States, ²Paria River District, Bureau of Land Management, Kanab, Utah, United

States, ³Geography and Environmental Studies, University of Colorado Colorado Springs, Colorado Springs, Colorado, United States, ⁴Department of Geosciences, Colorado State University, Fort Collins, Colorado, United States, ⁵Biology Department, Southern Utah University, Cedar City, Utah, United States

The early evolution of Hadrosauridae remains obscure, with identifiable materials currently restricted to the Milk River (Alberta), Menefee (New Mexico), Mooreville Chalk (Alabama), Aguja (Texas), and Wahweap (Utah) formations. Overall, the Wahweap Formation (Fm) has arguably yielded the largest volume of material, but diagnostic cranial material is rare. Redating of sediments were previously used to create a Bayesian model that projects the base of the Wahweap Fm at 82.17 Ma (uncertainty of +1.47/-0.63 Ma), placing these among the oldest North American hadrosaurids. In order to seek insight into hadrosaurid origins, we analyzed the stratigraphy, facies, taphonomy, and morphological diversity of eight hadrosauroid localities from the Last Chance Creek Member, with all localities restricted to the lower 50 meters of the formation. Most specimens share morphologic features with Brachylophosaurini, though also show characteristics of other early hadrosauroids. Six localities were mudstone-hosted, one was in a sandy mudstone, and one was in a channel sandstone, likely reworked from floodplain deposits, possibly indicating that lower Wahweap hadrosauroids preferred quiet water settings. There is scant evidence of pedogenic overprint at the localities, an atypical condition for most Wahweap Fm mudstones. Individual bones show very little wear or evidence of scavenging, but the degree of disarticulation, sorting, and current orientation at six localities indicates burial was not immediate postmortem. The vast majority of bones are WS 1 and WS 2 on the Behrensmeyer Scale. Six localities contain elements from Voorhies groups I and II. Two

localities contain material from all three Voorhies groups, although one locality only has minimal group II and III elements, suggesting most localities have been influenced by low to medium velocity currents. Bone orientations confirm current influence, with four localities showing moderate current alignment, two localities showing a strong current alignment, and one locality that was completely random with no current signature. The remaining locality was an articulated partial skeleton from which we could derive no current data. Our taxonomic identifications and sedimentary interpretations suggest that the early Campanian radiation of hadrosaurids in southern Laramidia consisted of members of both Brachylophosaurini and Kritosaurini that lived in or around persistent bodies of water large enough for moderate velocity currents.

Funding Sources Funding for this work was received from Southern Utah University's Walter Maxwell Gibson's College of Natural Sciences Gibson & Skaggs Undergraduate Research Grant.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Systematics of the Stenomylini, the North American, Oligocene-Miocene, Gazelle-like Camels (Mammalia: Artiodactyla: Camelidae: Stenomylinae: Stenomylini)

Watmore, Kristin I.¹, Prothero, Donald R.²

¹Earth Sciences, University of Southern California, Los Angeles, California, United States, ²Natural History Museum of Los Angeles County, Los Angeles, California, United States

The stenomylines, known as the “gazelle-like camels”, were a group of North American camels spanning the late Oligocene through the early Miocene. The subfamily Stenomylinae was comprised of 6 genera and

within the subfamily, the tribe Stenomylini included four of the more derived genera: *Stenomylus*, *Wyomylus*, *Blickomylus*, and *Rakomylus*. This research presents a systematic revision of the tribe Stenomylini, which has not had a full review since 1968. In particular, the eponymous genus, *Stenomylus*, needs to be re-assessed due to questionable separation of species within the genus. *S. gracilis* and *S. hitchcocki* were mostly distinguished on the basis of relative size. However, standard dentition measurements of the premolar-to-molar length ratios reveal considerable overlap between the two species and statistical tests do not support a significant difference between the two. Even more, they are both known from the lower beds of the Harrison Formation. We find that there is no justification for the separation of *S. gracilis* and *S. hitchcocki*, making the latter a junior synonym. Thus, we recognize the 4 original genera, each of which is monotypic, except for *Stenomylus*, consisting of *S. gracilis* and *S. keelinensis*. With the systematics of the Stenomylini revised, it will be necessary to update the various paleobiological databases.

Technical Session 22: Paleontological Practices: Education & Outreach (Saturday, November 2, 2024, 1:45 PM)

Paleoanthropology in the Central Highlands of Kenya: Education, indigene agency and knowledge co-production

Waweru, Veronica^{1,2}, Kirera, Francis M.⁴, Grossman, Aryeh³, Malit, Nasser R.⁵, Kinyanjui, Rahab⁶, Kinyua, Richard⁷

¹MacMillan Center, Yale University, New Haven, Connecticut, United States, ²Earth Sciences, National Museums of Kenya, Nairobi, Nairobi, Kenya, ³School of Medicine, Mercer University, Macon, Georgia, United States, ⁴Anatomy, Midwestern University, Glendale, Arizona, United

States, ⁵Anthropology, Suny Potsdam, Potsdam, New York, United States, ⁶Earth Sciences, National Museums of Kenya, Nairobi, Nairobi, Kenya, ⁷CHK project - affiliate, Community Member, Kieni, Nyeri, Kenya

Background: The role of hired local people in discoveries as a key component of paleontological research in Africa is only marginally acknowledged. Yet the study of new taxa or cultural remains of extinct hominins starts with their discovery, often by poorly educated ‘hired hands.’ In Africa, fossil remains are found in rural areas of individual or community-owned land where the economic activities of farming and grazing provide opportunities for the discovery of fossils. Due to a lack of knowledge, fossils go unreported and, oftentimes, are destroyed. How much faster would fossil discoveries occur if a few community members knew their cultural and scientific value? This paper presents findings from 3 years of knowledge co-production between local communities and paleoanthropologists in the Central Highlands of Kenya (CHK). We trained five community members in fossil and artifact identification and procedures to report findings to CHK researchers using photos of in situ fossils and artifacts without removing them from their contexts. Finds in danger of destruction were reported to the National Museum of Kenya. The five trained local members were also contact points for farmers to report skeletal remains and potential artifacts and fossils. This model has resulted in the discovery of over 30 sites spanning the late Miocene to the Holocene. The sites represent at least three hominin species, numerous extinct mammals, and a new bovid taxon, all located in tropical high-elevation sites. The discoveries in the CHK, 97 % of which are by locals, demonstrate the importance of high-elevation tropical sites to human evolution using the Central Highlands of Kenya (CHK). The CHK covers the area encircled by the Aberdare, Mathews, and

Kirisia ranges and Mt. Kenya. Based on newly discovered evidence from sites found here, these orographic features moderated local environments and hydrology, shaping evolutionary processes in the region.

Education: The work presented here aids in wider participation by locals, increases the uptake of research products, and promotes pride in ancient heritage found at the CHK. It demonstrates that involving locals is a productive and effective research model and simultaneously fosters education opportunities for students and adults in non-classroom settings.

Funding Sources Leakey Foundation

Wenner-Gren

Yale MacMillan Faculty Grant

Belo Osagie Grant

PAST

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

First glimpse into the life history of a Gondwanatherian mammal: The femoral histology of *Adalatherium hui*

Weaver, Lucas N.¹, Hoffmann, Simone², Curry Rogers, Kristina³, Panciroli, Elsa⁴, Newham, Elis⁵, Funston, Gregory F.⁶, Kulik, Zoe T.⁷, Krause, David W.⁸

¹Museum of Paleontology, University of Michigan, Ann Arbor, Michigan, United States, ²Department of Anatomy, New York Institute of Technology, Old Westbury, New York, United States, ³Biology and Geology Departments, Macalester College, St. Paul, Minnesota, United States, ⁴Natural Sciences Department, National Museums Scotland, Edinburgh, United Kingdom, ⁵School of Engineering and Materials Science & Institute of Bioengineering, Queen Mary University of

London, London, United Kingdom, ⁶Royal Ontario Museum, Toronto, Ontario, Canada, ⁷Division of Paleontology, American Museum of Natural History, New York, New York, United States, ⁸Department of Earth Sciences, Denver Museum of Nature & Science, Denver, Colorado, United States

Our understanding of Gondwanatheria, a group of allotherian mammals from the Late Cretaceous–Paleogene of the Southern Hemisphere, has grown substantially in the past decade thanks to two exceptional specimens from the Upper Cretaceous (Maastrichtian) Maevarano Formation of Madagascar. One of these specimens, the holotype and only known specimen of *Adalatherium hui* (UA 9030), consists of a nearly complete skeleton, representing the only articulated postcranial remains of a gondwanatherian. Here we present the first description of gondwanatherian bone histology by using synchrotron micro-computed tomography of the femoral midshaft of UA 9030. Several preliminary observations inform the life history of *Adalatherium*: (1) an external fundamental system is absent and sparse vascular canals open at the sub-periosteal cortex, supporting previous interpretations that UA 9030 was still actively growing and skeletally immature. (2) The cortex exhibits a distinct ‘sandwich’ pattern: from the medullary cavity to the sub-periosteal edge, endosteal lamellar bone grades into disorganized fibrolamellar bone in the midcortex, then a sharp reversal line separates that disorganized bone layer from a layer of mostly organized periosteal bone in the outer cortex. That same pattern is ubiquitous among latest Cretaceous–earliest Paleocene multituberculates and extant small-bodied (< 5 kg) placental mammals except primates and bats. It has been attributed to a placental-like reproductive strategy, whereby gestation is prolonged, neonates are relatively precocial, and nursing is abbreviated. (3) The femoral histology of UA 9030 differs from that of previously studied

multituberculates, however, in exhibiting (i) abundant vasculature throughout the cortex and potentially (ii) sparse secondary remodeling and two or more lines of arrested growth. The former likely reflects the larger body size of *Adalatherium* (~3.1 kg) relative to most multituberculates (< 1 kg), but the latter indicates a prolonged growing period beyond a year or more, which is unusual compared to most extant small-to-medium-sized mammals. Considering that gondwanatherians and multituberculates diverged from other allotherians in the Middle Jurassic, the histological similarities between *Adalatherium hui* (UA 9030), multituberculates, and placental mammals support the hypothesis that placental-like reproduction may have been ancestral for Allotheria and perhaps many groups of Mesozoic mammals.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

A case of hidden diversity: a new longirostrine ichthyosaur from the Anisian Fossil Hill Fauna of Nevada

Weeks, Audrey E.¹, Klein, Nicole³, Sander, Martin^{3,2}, Schmitz, Lars^{1,2}

¹Kravis Department of Integrated Science, Claremont McKenna College, Claremont, California, United States, ²Bonn Institute of Organismic Biology, University of Bonn, Bonn, Germany, ³Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States

Since the seminal work of John C. Merriam 120 years ago, the open marine Fossil Hill Fauna of the middle and late Anisian of Nevada has been recognized as one of the pre-eminent Triassic ichthyosaur faunas. Species described by Merriam from the Fossil Hill Member of the Prida Formation of the Humboldt Range include *Cymbospondylus petrinus*, mixosaurs (“*C. natans*” in Merriam)

and *Omphalosaurus nevadanus*. Fieldwork in the Fossil Hill Member of the Favret Formation in the Augusta Mountains since 1991 has yielded additional ichthyosaur taxa: two species of *Phalarodon*, further *Cymbospondylus* species (*C. nichollsi*, *C. duelferi*, *C. youngorum*), and the giant macropredator *Thalattoarchon*. Most ichthyosaur species from the Fossil Hill Fauna are large-bodied (>5 m body length) to giant (>15 m).

Large body size had already been noted by Merriam. However, he subsumed all large ichthyosaurs from the Humboldt Range under *C. petrinus*. It therefore came as a surprise that a fossil, UCMP 9943, assigned to and partially illustrated as *C. petrinus*, represents a rather different ichthyosaur. UCMP 9943 consist of a well-preserved longirostrine skull (length >1.16m) in close association with the cervical vertebral column. Merriam illustrated the cervicals as typical of *C. petrinus* and noted a ventral keel which subsequently has been scored as a *C. petrinus* character in phylogenetic analyses.

The skull of UCMP 9943 is distinct from *Cymbospondylus* and at least superficially reminiscent of *Besanosaurus* from the slightly younger Besano Formation of the southern Alps. The similarity arises primarily from the extremely slender and long snout. However, the postorbital region of the skull of UCMP 9943 is notably shorter, the postorbital does not reach the lateral embayment, and the coronoid region appears flat. Moreover, the jugal of UCMP 9943 features a strongly developed posteroventral ramus. The large orbit (230 mm in diameter) is the visually most striking feature of the skull, impacting size and shape of the circumorbital bones. Ongoing phylogenetic analysis will test possible sister group relationships with *Besanosaurus*.

UCMP 9943 adds to the diversity of large-bodied ichthyosaurs, and together with a new cymbospondylid ichthyosaur, brings up the

number of ichthyosauriform species in the Fossil Hill Fauna to ten. Ichthyosaurs clearly dominated the Fossil Hill Fauna, contrasting with the scarcity of other amniote taxa (the pistosaur *Augustasaurus* and a new archosauriform).

Funding Sources DFG Project number 470103987 to NK

DFG Project number 440685415 to PMS

DFG Project number 388659338 to PMS

Technical Session 9: Triassic Herpetology
(Thursday, October 31, 2024, 1:45 PM)

A new and large pseudosuchian from the mid-Norian (Late Triassic) lower Elliot Formation of South Africa

Weiss, Bailey M.^{1,3}, Benson, Roger B.^{4,1}, Chapelle, Kimberley (Kimi)^{8,1}, Dollman, Kathleen⁶, Barrett, Paul^{5,1}, Nesbitt, Sterling J.², Stocker, Michelle R.², Botha, Jennifer^{7,1}, Choiniere, Jonah¹

¹Evolutionary Studies Institute, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ²School of Geosciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa, ³Division of Paleontology, American Museum of Natural History, New York, New York, United States, ⁴Department of Anatomical Science, Stony Brook University, Stony Brook, New York, United States, ⁵Structure of Materials Group, European Synchrotron and Radiation Facility, Grenoble, France, ⁶Fossil Reptiles, Amphibians and Birds Section, Natural History Museum, London, United Kingdom, ⁷Department of Geosciences, Virginia Tech, Blacksburg, Virginia, United States, ⁸GENUS: DSI-NRF Centre of Excellence in Palaeosciences, University of the Witwatersrand, Johannesburg, Gauteng, South Africa

Southern Africa's Elliot Formation is one of the few terrestrial continental sequences spanning the Triassic–Jurassic transition. The Elliot Formation is divided into upper and lower portions, with the lower Elliot Formation (IEF) considered to be Norian–Rhaetian. Relatively few pseudosuchian fossils have been recovered from the Late Triassic portions of the formation, presenting an important gap in the understanding of these assemblages in southern Africa. In nearly 200 years of palaeontological exploration, only isolated skeletal elements have been referred to pseudosuchians, in marked contrast to other high-latitude Norian faunas (e.g., the Los Colorados Formation). Our continued collecting efforts in the IEF close to the village of Qhemegha (Eastern Cape, South Africa) have now provided an exceptional pseudosuchian specimen that helps address this knowledge gap. Its material consists of an associated, partial skeleton of a single large individual. The skeleton comprises a nearly complete, disarticulated skull and a substantial portion of the postcrania. Among the potentially diagnostic features of the specimen are an anteroposteriorly short, distally expanded facial process of the maxilla, a large posterolaterally directed process of the nasal, and the distal tibial condyles are subequal in their distal extent. Regressions based on femoral length and circumference identify it as one of the largest known suchians, with an estimated body mass of about 400 kg. Among pseudosuchians, the well-developed femoral head and crista tibiofibularis are derived features present in loricatans. More specifically, postcranial similarities with the loricatan *Fasolosuchus*, such as the shape and contact of the tibia and fibula, suggest that the new specimen likely occupies a similar phylogenetic position. The fragmentary nature of previously collected IEF pseudosuchian material has precluded precise taxonomic identification, phylogenetic analysis, body mass estimation, and broader ecological understanding. Our

new specimen provides an important step in revising our understanding of the IEF faunal assemblage, showing that with increased sampling its fauna may more closely resemble other high-latitude Norian faunas and revealing the anatomy of its largest known predators.

Funding Sources GENUS, National Research Foundation, Science Investment Fund, Palaeontological Scientific Trust, Stony Brook University funded this research.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Jackets, pedestals, and threats of disassociation: an analysis of tracking systems for unprocessed materials in museums

Westfall, Madison^{1,2}, Johnson, Eileen^{1,2}

¹Lubbock Lake Landmark, Texas Tech University, Lubbock, Texas, United States, ²Museum of Texas Tech University, Texas Tech University, Lubbock, Texas, United States

Unprocessed materials, such as field jackets and pedestals often are located separately from their collection and require additional treatment before joining their collection. The materials still accessioned and as a part of the museum collection require just as much collections management as any other part of the collection. Being left out of sound collections management practices can lead to problems such as disassociation (loss of an object, object-related data, or ability to retrieve or associate objects and data). Using the early Pleistocene Roland Springs Ranch Locality-1 collection housed at the Lubbock Lake Landmark as a case study, four steps have been undertaken to investigate whether using tracking systems with unprocessed materials can minimize disassociation and increase effectiveness in collections.

Tracking systems can be either databases, Excel spreadsheets, or other methods. As a first step, the extent of disassociation within the RSR-1 unprocessed materials has been determined by conducting an inventory of the materials and their associated documentation. Second, other institutions with unprocessed materials have been surveyed to determine the tracking systems used by these institutions and the efficiency of those tracking systems. Third, the current tracking system in place for the Roland Springs Ranch Locality-1 unprocessed materials has been assessed and revised. Lastly, an exercise of findability of the Landmark's old, current and revised tracking systems has been conducted to determine which tracking system was the most effective through timed tests and statistical analysis. The study has found that disassociation can happen even in collections with effective tracking systems, but without an effective tracking system, disassociation takes place to a much higher degree. The Landmark's revised tracking system significantly improves collection effectiveness. Tracking unprocessed materials, like field jackets and pedestals, is necessary for efficiency in collections as well as being vital to good collections stewardship.

Technical Session 20: SVP Saturday
Spectacular (Saturday, November 2, 2024,
1:45 PM)

Feeding habits of *Diplodocus* revealed through dental tribological analyses

Whalen, Niall S.¹, Grejtak, Tomas², Hunt, Tyler C.^{1,4}, Krick, Brandon^{3,4}, Erickson, Gregory M.^{1,4}

¹Biology, Florida State University, Tallahassee, Florida, United States, ²Materials Science and Technology Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, United States, ³National High Magnetic Field Laboratory, Tallahassee, Florida, United States, ⁴Mechanical Engineering, FAMU-FSU

College of Engineering, Tallahassee, Florida, United States

Since the discovery of *Diplodocus* over a century ago the dietary ecology of this Jurassic sauropod has been the subject of enduring debate. While sympatric sauropod contemporaries such as *Camarasaurus* are non-controversially considered mid-canopy browsers, their coexistence with *Diplodocus* is broadly thought to imply niche-partitioned, disparate feeding strategies. This concept is further supported by the distinct post-cranial and cranial anatomy of *Diplodocus*, particularly their numerous enigmatic dental characters. Their gracile, peg-like teeth did not occlude and possessed a relatively thick layer of wear-resistant enamel—yet were nonetheless substantially abraded and replaced remarkably quickly. Various hypotheses have been advanced to account for these traits and characterize *Diplodocus*' dietary niche. Proposed dietary habits include succulent plant cropping, aquatic plant straining, algal scraping, piscivory, molluscivory, cycad scraping, low-browsing branch stripping and ground-level grazing. Consideration of their distinctive dental wear facets may assist in interpreting their true feeding ecology. Enamel, the hardest vertebrate tissue, is generally worn only through interdental contact or interaction with materially harder ingested abrasives. Given *Diplodocus*' lack of dental occlusion, the majority of proposed hypotheses implicitly assume this abrasive was plant matter. Phytoliths, plant-borne silica deposits, are generally considered the primary causative agents of plant-induced dental wear. Here we develop a new mechanistic model of *Diplodocus* feeding through: 1) intensive examination of wear facet morphology; 2) empirical investigation of potential dietary abrasive material properties; and finally 3) direct biomechanical and tribological modeling of *Diplodocus* tooth wear. The results suggest phytoliths from plants comprising the

proposed *Diplodocus* diet lacked sufficient material hardness to directly wear enamel, thereby implicating exogenous, soil-borne grit as the most-likely source of dental wear. Following these analyses, we employ materials science and engineering methods to generate a model showing *Diplodocus* dental wear primarily originated from tooth-grit interactions at the sediment interface, producing wear patterns consistent with those observed in their teeth. This work illustrates the potential for modern tribological techniques to provide nuanced understanding of dental form, function, and feeding relevance in extinct vertebrates.

Funding Sources Oak Ridge National Laboratory Graduate Research Fellowship
Mario and Vanessa Fernandez Graduate Research Fund

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Extrinsic eye musculature in the green
iguana (*Iguana iguana*): an exploratory
study**

Whitlock, John A.^{1,2}

¹Biology, Mount Aloysius College, Cresson,
Pennsylvania, United States, ²Vertebrate
Paleontology, Carnegie Museum of Natural
History, Pittsburgh, Pennsylvania, United
States

All vertebrate animals, to some extent, have mobile eyes, with a series of skeletal muscles that produce said movements. The ability to move the eye has its origins in a pattern of saccades (fast movements) and fixations (stabilization of gaze) that enables an organism to quickly refocus on an object. In many visual predators, these muscles can produce more dramatic movements, including vergence pursuit. In a vergence, the eyes are manipulated in opposite (converging) directions, which provides the

organism with information about distance to an object; these movements are typical of predatory vertebrates. Even in organisms with limited visual acuity, these movements serve to reduce or eliminate the motion blur that would be present in mobile organisms with fixed eyes - the result of the relatively slow response time of photoreceptors.

In general, the conformation of the extrinsic eye musculature remains relatively stable across vertebrata with the same basic pattern of muscles occurring in anamniotes and amniotes alike, although some variation has been observed in both the number of muscles present and their attachment (and therefore potentially function). The majority of studies focus on innervation or embryonic development rather than gross anatomy, a number of studies of gross anatomy in post-embryonic stages do exist. However, with the exception of studies on the highly divergent serpentes, the most recent is 40 years old and many date from the 19th century. Additionally, the veracity of several of these studies, such as those on *Sphenodon* and *Lacerta* have been called into question. Furthermore, with limited exceptions, little is described about the attachment of these muscles to the chondrocranium. This, therefore, has the potential to be of interest to workers studying the behavior of fossil organisms, particularly those with notable derived features of the chondrocranium, where these muscles may be attached. In particular, a group of sauropod dinosaurs (the dicraeosaurids), are notable for a handful of prominent, autapomorphic features that may be related to modifications of this musculature.

Here, I describe the conformation, innervation, and attachment of the extraocular muscles in the green iguana (*Iguana iguana*), as part of a larger study of eye musculature including other squamates (*Anolis*), extant archosaurs (*Alligator*) and eventually part of a larger study on

chondrocranial adaptations in dicraeosaurid sauropods.

Regular Poster Session 1 (Wednesday,
October 30, 2024, 4:30 - 6:30 PM)

Activating the paleontological research potential of life history data in living collections: a case study at the Duke Lemur Center

Whitman, Karie L.¹, Riddle, L. Catherine¹, Mazza, Amanda², Heritage, Steven³, Neely, Kate¹, Yapuncich, Gabriel S.⁴, Borths, Matthew R.¹

¹Duke Lemur Center Museum of Natural History, Duke University, Durham, North Carolina, United States, ²Duke Lemur Center, Duke University, Durham, North Carolina, United States, ³Integrative Anatomical Sciences, Keck School of Medicine, Los Angeles, California, United States, ⁴Medical Education Administration, Duke University School of Medicine, Durham, North Carolina, United States

Interpretations of extinct vertebrate anatomy, behavior, and life history are built upon comparative anatomy data from neontological collections. Ideally, these interpretations are informed by metadata collected while the organism was alive such as diet, mass throughout life, social relationships, and reproductive history. Unfortunately, these data are not available for many specimens as natural history collections have focused on wild-caught individuals for which mass at collection, sex, and collection locality are typically the only associated data. In contrast, extensive life-history data are collected from organisms in sustained human care, but transferring these data from zoos to natural history collections is not standardized or prioritized. The Duke Lemur Center (DLC) has been designing a database that allows researchers access to morphological and life-history data derived

from animals that were part of the living research colony. The DLC is home to over 200 lemurs representing 16 different species. The colony has access to open air multi-acre habitats. For over 50 years the AZA-accredited DLC has been a platform for non-invasive research on strepsirrhine primates and the DLC Museum is the repository for DLC specimens and fossils related to the evolution of primates. The colony's breeding records, veterinary care, husbandry data, locomotor behaviors, and diets are recorded by researchers and staff. However, these data are disaggregated, making them difficult to explore. The DLC Data Team started by generating microCT scans of the osteology and frozen cadaver collection to make morphological data available on MorphoSource. Preserved specimens were rehoused and inventoried. Now we are using DLC-developed REDCap database management tools to network scans with life-history records, building a database that researchers can use to explore questions such as individual variation in tooth wear, osteological signatures of different pathologies, and individual biomechanical performance. The REDCap database is also used to store fossil metadata like field notes and specimen preparation records. Our goal is to make these database tools available to other living colonies and natural history collections, so life-history data can be shared and standardized across institutions. This effort – in collaboration with the ZooMu network – will ultimately make life histories accessible to researchers – including paleontologists exploring the fossil record.

Funding Sources NSF DBI 2023087

IMLS MA-245704-OMS-20

IMLS ARPML-250672-OMLS-22

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Long bone histology of *Lystrosaurus* and *Thrinaxodon* from Antarctica with insights into the evolution of synapsid seasonal physiology

Whitney, Megan¹, Sidor, Christian A.^{2,3}, Smith, Nathan D.⁴, Makovicky, Peter⁵

¹Department of Biology, Loyola University Chicago, Chicago, Illinois, United States, ²University of Washington, Seattle, Washington, United States, ³Burke Museum of Natural History, Seattle, Washington, United States, ⁴Natural History Museum of Los Angeles County, Los Angeles, California, United States, ⁵University of Minnesota, Minneapolis, Minnesota, United States

Extant mammals occupy a remarkably diverse range of habitats, including those that inflict extreme seasonality on their inhabitants. The capacity for mammals to occupy these extreme habitats while maintaining an energetically demanding physiology has resulted in a swath of adaptations. Mammals, however, are not the first synapsids to occupy extreme habitats, and the evolution of these predecessors has the potential to shed light on the evolution of seasonal adaptations more broadly within the lineage. Fossils of non-mammalian synapsid have been recovered from the Lower Triassic Fremouw Formation of Antarctica, one of the highest latitude and most dramatically seasonal Mesozoic localities known. The Fremouw Formation preserves an ecosystem that was more habitable than present day Antarctica, but nonetheless remained in the polar circle and inhabitants would have had to adapt to extreme daylight seasonality, including approximately 30 days of continuous darkness.

To test for adaptations in seasonal physiology in Fremouw synapsids, we sampled a femur, humerus, and tibia from the dicynodont *Lystrosaurus*, and a femur from the cynodont *Thrinaxodon*. The bone histology of these two synapsids is well-sampled in the non-polar

Karoo Basin of South Africa, which provides a baseline comparison for bone growth rates and patterns. While the high-sustained growth rates in *Lystrosaurus* appear to be largely similar between polar Antarctic populations and those in the non-polar Karoo Basin, *Thrinaxodon*—whose bone deposition rates, and by proxy overall somatic growth rate, are much more moderate—has increased remodeling, which may be a specific response to nutrient availability that is recurrently limited in a habitat with extreme daylight seasonality. These results suggest that synapsids with elevated physiological capacities, such as *Lystrosaurus*, likely had different adaptations to extreme seasonality that facilitated maintenance of ‘regular’ growth rates than those with lower metabolic demands, such as *Thrinaxodon*, whose bone physiology may have been more impacted by seasonal stress. These findings indicate that synapsids have evolved multiple responses to living in extreme seasons and this underlying plasticity may have played a pivotal role in establishing the modern diversity and plasticity of mammalian physiological responses to seasonality that is seen today.

Funding Sources NSF ANT-1341475, ANT-2040007, ANT-1341645, ANT-2001033. ANT-1947094 and ANT-2313242

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Paleobiology and evolution of early palaeognathous birds

Widrig, Klara E.

Earth Sciences, University of Cambridge, Cambridge, United Kingdom

Extant palaeognath diversity comprises the flightless ratites (ostriches, rhea, kiwi, cassowaries, and emu), as well as the partridge-like tinamous that utilize short-

distance burst flight but are incapable of long-distance flight. Molecular evidence shows that tinamous are phylogenetically nested within ratites, implying multiple transitions to flightlessness and gigantism. This, coupled with divergence dates in the Cenozoic, has overturned the previous consensus that ratites were the product of Gondwanan vicariance, instead implying that stem palaeognaths were capable overseas dispersers. Insight into the biology of early palaeognaths may help clarify numerous outstanding macroevolutionary conundrums such as the flight and dispersal capacity of ratite ancestors, and as the sister clade of all other crown birds (Neognathae), the biological attributes of the ancestral crown bird. A group of apparently volant palaeognaths from the Paleogene, the lithornithids, may hold the key to addressing these questions. I quantitatively investigated the flight style and ecology of *Lithornis promiscuus* using large extant datasets and methods that effectively predict these traits in living birds: the ratio of forelimb to hindlimb length, and geometric morphometric analysis of the sternum. The forelimb:hindlimb ratio is consistent with aerobic flapping flight and ground-feeding ecology, which may have contributed to their becoming flightless given suitable environmental conditions. Geometric morphometric analysis is not only consistent with aerobic continuous flapping flight while rejecting burst flight, but demonstrates that among extant birds the sternum is similar to taxa capable of long-distance flight, providing compelling insights into the dispersive capabilities of early palaeognaths. Flight muscle reconstruction in *L. promiscuus* based on an extant phylogenetic bracket provides additional support for long distance flight capability. The endocast of the related *L. vulturinus* provides the clearest insights to date into the neuroanatomy of early crown group birds, combining an ancestrally unflexed brain with a moderately enlarged telencephalon and optic lobes. This synthesis of methods

provides congruent insights into the biology of early palaeognaths that corroborate interpretations of lithornithids as ground feeding birds with “modern” neuroanatomy that were capable fliers, and contribute substantial new insight into the probable nature of the ancestral crown bird.

Symposium Session: Evolution of Mammalian Life Histories (Wednesday, October 30, 2024, 8:00 AM)

Fossil biomolecules reveal metabolic upregulation as a prerequisite for the evolution of mammalian pregnancy

Wiemann, Jasmina

Earth and Planetary Sciences, Johns Hopkins University, Baltimore, Maryland, United States

Mammals are one of only two extant lineages capable of metabolic thermoregulation (endothermy). In comparison to the convergent, avian approach exploiting membrane leakiness, mammals generate heat by directly upregulating the performance of their mitochondrial electron transport chain. Did elevated metabolic rates in mammals precede the evolution of internal pregnancy, a trait characterizing most crown mammals (eutherians), or are they the result of later selective optimization? Pinpointing the timing of metabolic upregulation events, however, requires the integrative analysis of modern and fossil samples: current isotopic, microstructural, morphological, and biogeographic approaches to thermophysiology are correlated with body temperature rather than metabolic rate, and thus cannot reveal minor metabolic changes.

Here, I comparatively analyze a novel time-integrative molecular metabolic signal capturing systemically precipitated oxidative markers that form as stoichiometric by-products of mitochondrial aerobic

respiration: as a requirement for the exploration of an evolutionary signal, our systematic analysis (500-3000 cm⁻¹, 10 replicates, Near-Infrared Raman spectroscopy) of >60 modern and fossil synapsid femora demonstrated that the quantity of metabolic oxidation markers in this sample is robustly correlated with the cellular metabolic rate (>80 % of proxy variance). The effect of fossilization is empirically captured, modelled *in vitro* (for modern tissue aliquots) and *in silico*, and corrected, allowing for the reliable integration of high-resolution metabolic signals across living and extinct synapsids. Tracing the evolution of metabolic rates across a time-scaled consensus phylogeny supports a Triassic mammaliamorph origin of endothermy and further revealed a key metabolic upregulation event in concert with the emergence of eutherian live birth (vivipary). Metabolic upregulation leading to efficient thermoregulation represents a prerequisite for the evolution of internal embryonic incubation.

Technical Session 15: Jurassic & Cretaceous Herpetology (Friday, November 1, 2024, 1:45 PM)

A new pepesuchine peirosaurid (Crocodyliformes, Notosuchia) from the Early Cretaceous of Mali

Wilberg, Eric¹, Hill, Robert V.², Roberts, Eric M.³, O'Leary, Maureen A.¹

¹Anatomical Sciences, Stony Brook University, Stony Brook, New York, United States, ²Science Education, Donald and Barbara Zucker School of Medicine at Hofstra/Northwell, Hempstead, New York, United States, ³Geology & Geological Engineering, Colorado School of Mines, Golden, Colorado, United States

Peirosauridae is an extinct group of Gondwanan crocodyliforms known from the

Aptian through the Maastrichtian. Their diversity is highest in South America, though the group is also known from Africa and Madagascar. Most peirosaurids possess broad oreinirostral snouts and were likely terrestrial, but a small subset (Pepesuchinae) with narrow platyrostral or nearly tubular snouts were likely semi-aquatic. All previously identified pepesuchines come from South American deposits. Phylogenetic relationships among peirosaurids are unresolved, with most analyses recovering different internal relationships. Part of this confusion likely results from the incomplete nature of most described peirosaurids, with a large number known primarily from mandibular material, while several others are known only from cranial material. The lack of overlapping elements hinders precise reconstruction of their relationships. Here we describe a new peirosaurid from the Lower Cretaceous “Continental Intercalaire” of Mali. The new taxon is represented primarily by cranial and mandibular material, but also includes two vertebrae, two osteoderms, a single metatarsal, and an ungual phalanx. It shares several characteristics with South American pepesuchines, including an anterior process of the prefrontal dividing the posterior margin of the nasal, and the presence of distinct alveolar couplets in the dentary.

To determine the phylogenetic position of the new taxon, we performed two analyses based on previously published datasets, selected for their broad sampling of peirosaurids. We added the new taxon and two taxa rarely included in phylogenetic analyses: the likely pepesuchine *Roxochampsia* from Brazil, and the enigmatic peirosaurid *Rukwasuchus* from Tanzania. Both analyses recover Peirosauridae including two major clades: Peirosaurinae and Pepesuchinae. The new taxon, *Roxochampsia*, and *Rukwasuchus* fall within Pepesuchinae. However, the internal relationships of Pepesuchinae are poorly resolved. Pepesuchinae is supported by

numerous synapomorphies including a unique configuration of dentary alveolar couplets with the 6th + 7th and 8th + 9th alveoli closely set and the 7th and 8th alveoli greatly reduced in size. Additionally, all members of the group possess diastemas between the 4th and 5th and 7th and 8th dentary alveoli. These analyses extend the range of *Pepesuchinae* into Africa with the new Malian taxon, and the recognition of the previously described *Rukwasuchus* as a *pepesuchine*.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Phylogenetic and biogeographic analysis of the Cretaceous squamate clade Polyglyphanodontia

Wilenzik, Ian¹, Simoes, Tiago R.²

¹The George Washington University, Washington, District of Columbia, United States, ²Ecology & Evolutionary Biology, Princeton, Princeton, New Jersey, United States

The Cretaceous saw major diversification of many groups of squamates, including the enigmatic group Polyglyphanodontia, also referred to as Borioteiioidea. These diverse, larger-bodied lizards possessed many dental and skull morphologies unique among Squamata, including labial-lingually broadened teeth in *Polyglyphanodon* and the reacquisition of the lower temporal bar in *Tianyusaurus*. Their diversity and disparity in the Late Cretaceous is underscored by a poor understanding of their phylogenetic positioning and their monophyly, making it difficult to contextualize their unique morphologies. Previous analyses place the clade as either a paraphyletic grade at the base of Laterata or a monophyletic group within Laterata. Many other analyses have placed the genus *Chamops* within Polyglyphanodontia, as the only genus to survive across the K-Pg boundary. We

reanalyzed their evolutionary relationships utilizing a revised character matrix from Conrad, 2008, including an additional taxon, under time-calibrated Bayesian inference in MrBayes. We used the resultant time-calibrated phylogeny in a biogeographic analysis utilizing BioGeoBEARS in R under six different models. The results of the phylogenetic analysis support the monophyly of the clade and their position within Laterata, closer to Teiidae than to the subclade containing Lacertidae and Amphisbaenia. Our results place *Chamops* outside of Polyglyphanodontia as a stem-teiid, suggesting polyglyphanodontians went extinct at the K-Pg boundary. Our biogeographic analysis selects for a DEC+J model that reconstructs an Asian ancestral range for the group, with a single dispersal into North America. With this time-calibrated phylogeny, future questions on trends within the clade can be explored in a phylogenetic context.

Funding Sources Funding for this project was provided by the Weintraub Fellowship and the Harlan Graduate Fellowship at the George Washington University

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

A proposed quantitative measurement system for describing distortion and completeness of appendicular and axial elements

Wilhite, Ray¹, Curtice, Brian²

¹Auburn University College of Veterinary Medicine, Auburn, Alabama, United States, ²Arizona Museum of Natural History, Phoenix, Arizona, United States

In vertebrate paleontology, fossils exhibit a wide range of preservation states, often described using phrases like "laterally crushed" or "missing the transverse process."

To provide a more quantitative approach to describing these preservation states, we propose two indices: the Deformational Index (DI) and the Completeness Index (CI). Both indices range from 0 to 5, where DI0 indicates an undeformed specimen and CI0 indicates a complete specimen. Conversely, DI5 represents a specimen deformed along two or more axes, and CI5 denotes an element so incomplete that it cannot be identified.

The Deformational Index (DI) for appendicular elements is based on deformation along individual axes. Deformation along the shortest axis retains the most morphological information, whereas deformation along the longest axis or multiple axes obscures most morphological details. For non-cranial axial elements, chevrons are characterized using the same criteria as appendicular elements. For vertebrae we separate deformation of the centrum from deformation of the neural arch and associated structures. Deformation of the laminae and spinal processes typically obscures more phylogenetic characters than deformed centra, so axial components receive two DI scores: one for the centrum and one for the neural arch and its processes reported as DI (neural arch)\DI (centrum).

The Completeness Index (CI) for appendicular elements evaluates how missing bone areas affect the overall morphological information. Small amounts of missing bone in the shaft of a long bone obscure less information than incomplete proximal and distal ends while deformation of the centrum generally has less impact than deformation of the processes and laminae in the axial skeleton. CI for vertebral elements is also reported as CI (neural arch)\CI (centrum).

To test these indices, we examined 100 random sauropod specimens from two quarries: Dry Mesa Dinosaur Quarry and Cactus Park Quarry. Each specimen was scored for both DI and CI. The averages of these scores provided an overall estimate of

distortion and completeness for each quarry. Our results showed that Cactus Park fossils are significantly more complete and less deformed than those from Dry Mesa on average.

We believe that the adoption and refinement of these indices can help convey preservation information in a quantitative manner. Incorporating these indices into the metadata of digital catalogs could also assist researchers in planning collection visits.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

What good is a halfway ear? Biomechanical modeling of sound conduction in *Thrinaxodon*

Wilken, Alec

Organismal Biology & Anatomy, University of Chicago, Chicago, Illinois, United States

Sensory structures play a crucial role in the survival and fitness of an organism by allowing it to navigate its environment. Because of this, the evolution of sensory structures raises questions about the fitness benefit of a transitional or “halfway” sensory organ. Answering these questions are difficult because most sensory organs do not fossilize. The bony middle ear is an exception to this. Mammal evolution is marked by transformations of the post-dentary jaw bones into a functional hearing apparatus. Key fossils such as the cynodont *Thrinaxodon* provide unique insights into the jaw-ear transition. How effective are the post-dentary bones of *Thrinaxodon* for hearing? What are the primary routes of sound conduction in transitional mammals? To address these questions I created a finite element model of *Thrinaxodon* and reconstructed a hypothesized tympanic membrane suspended by the post-dentary bones. I applied a sound pressure of 100 dB to

alternate routes of sound conduction through bone and through air. I ran a natural frequency and harmonic response analysis to evaluate stapes displacement in response to excitation from sound as a measurement of hearing functionality. I modeled jaw adductor muscle activity to evaluate the effect of jaw muscle on stiffening the mandibular middle ear. The dominant route of sound conduction is airborne sound received by the tympanic membrane. The largest stapes displacements occurred at low frequencies (between 700 and 1000 Hz). Modeling the temporalis as active reduces the amount of stapes displacement, implying jaw muscle activity could play a role in modulating hearing for *Thrinaxodon*. These data show that while bone conduction through the dentary is not a viable means of sound conduction, an airborne sound receiving tympanic membrane is possible for *Thrinaxodon*. Further phylogenetic comparative analyses hint that the tympanic ear was not functional in earlier synapsids. These data provide the first biomechanical evidence of a functional tympanic membrane in a non-mammalian synapsid. While appearing morphologically as a transitional phenotype, the mandibular middle ear of *Thrinaxodon* receives sound in remarkably mammal-like ways. This finding gives novel insight into the tempo and mode of sensory organ evolution.

Funding Sources NIH NINDS T32NS121763; University of Chicago OBA

Technical Session 1: Dinosaur Evolution, Soft Tissues, & Ornithischia I (Wednesday, October 30, 2024, 8:00 AM)

The influence of climate on dinosaur diversity and community structure throughout the Edmonton Group (Late Cretaceous) of Alberta, Canada

Wilkinson, Ryan D.^{1,2}, Evans, David^{1,2}

¹Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada, ²Natural History: Paleobiology, Royal Ontario Museum, Toronto, Ontario, Canada

The Edmonton Group in Alberta, Canada preserves the final ~7 million years of the Cretaceous period including the Campanian-Maastrichtian and Cretaceous-Paleogene boundaries. With over a century of paleontological collection and a detailed stratigraphic framework, the Edmonton Gp. has served as a study system for investigating dinosaur paleobiology during the lead-up to the end-Cretaceous mass extinction. Shifting climate conditions throughout the Edmonton Gp. have previously been correlated with distinct dinosaur assemblage zones and led to hypotheses of climate change-driven turnover, particularly among key megaherbivore species. However, the consequences that these turnover events had on the dinosaur community have not yet been investigated. Here we test the hypothesis that climate change events caused shifts in the community structure, richness, and diversity of dinosaurs throughout the Edmonton Gp. We constructed an extensive database of dinosaurs identifiable to genus-level and integrated it with previously published paleoclimate and chronostratigraphic data. Specimens were placed in stratigraphic bins defined by laterally continuous stratigraphic structures. Shareholder quorum subsampling was used to account for varying sample size. Ecological heterogeneity indices including richness, evenness, and diversity were calculated to test for ecological shifts through time and for correlation with paleoclimate variables. Correspondence analysis ordination and cluster analyses were performed to test for continuous or discrete shifts in the assemblage that co-occur with shifts in paleoclimate. These analyses were performed at the species and subfamily levels to test for trends at higher taxonomic levels or with respect to functional ecology. The correspondence analysis and cluster

analyses found that dinosaur assemblages were similar within paleoclimate regimes and were consistent with the previously defined dinosaur assemblage zones. However, we found no significant trends in the ecological heterogeneity indices associated with paleoclimate or shifts between climate regimes. This suggests that climate change throughout the Edmonton Gp. played an important role in shaping the dinosaur assemblage and turnover events, but did not affect the richness, evenness, or diversity of those communities. These results inform our understanding of long-term trends that shaped the structure of dinosaur communities during the lead-up to the end-Cretaceous mass extinction.

Funding Sources NSERC Canada Graduate Scholarship-Doctoral to RDW (CGSD-559033-2021). NSERC Discovery Grant to DCE (RGPIN-2018-06788).

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Mechanistically testing the relative influence of the Island Rule and Bergmann's Rule on the body size of island populations of *Mammuthus*

Williams, John¹, Liu, Yize², Zhang, Jinrui², Ma, Liang², Wang, Yue²

¹Geography, University of Wisconsin-Madison, Madison, Wisconsin, United States, ²School of Ecology, Sun Yat-Sen University, Shenzhen, Guangdong Province, China

Three rules make contrasting predictions about whether *Mammuthus* (mammoth) populations on high-latitude islands were characterized by reduced body sizes. The Island Rule predicts that species with large body sizes will adaptively reduce size when colonizing islands. Bergmann's Rule predicts

that cold environments favor large animals. Duration of isolation of island populations is an underexplored third rule. Here we test the relative strength of these rules via 1) mechanistic modeling of energy balance and forage availability using Niche Mapper and LPJ-GUESS and 2) reviewing the literature on *Mammuthus* fossils and body sizes from five islands across a latitudinal gradient: Wrangel, St. Paul, Sardinia, Crete, and the California Channel Islands. *Mammuthus* body size was most reduced on Crete (310 kg, *Mammuthus* present 3.5 Ma to 750 ka), Sardinia (750 kg, 750 to 29 ka), and the Channel Islands (900 kg, 165 to 11 ka). In the northern islands, body sizes may have reduced 30% to 50% on Wrangel (3000 kg, 10 to 3.5 ka), with no evidence for reduced body size on St. Paul (14.1 to 5.6 ka). For each island, we conducted Niche Mapper experiments in which temperatures varied from -12 to +6°C relative to present. These results mostly support a primacy of Bergman's Rule (and duration of isolation) over the Island Rule. First, body sizes were lower on Sardinia and Crete, yet food constraints were 10x more severe on the northern islands, which, under the Island Rule, should have created a stronger driver towards reduced body size. Maximum population sizes were highest for Sardinia, due to its large area and high productivity. Second, Niche Mapper simulations confirm a high temperature sensitivity of optimal body size and population size of *Mammuthus* of Wrangel and St Paul, with the coldest scenarios being unlivable for *Mammuthus* due to near-zero food supply. However, on low-latitude islands, optimal body size and population size are generally insensitive to temperature variations. These results thus suggest that the more limited evidence for reduced body size of *Mammuthus* on northern islands may be because these populations persisted too briefly and under cold conditions that favored larger body sizes. Conversely, smaller *Mammuthus* on southern islands is consistent with longer time for

evolutionary reduction in body size and low sensitivity of body size to temperature, thus allowing a stronger effect of the Island Rule.

Funding Sources This work was supported in part by the National Science Foundation (ARC-1203772).

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Advancing best practices in FAIR, CARE, and Ethical Open Science in paleoecology and zooarchaeology: A case study with the Neotoma Paleoecology Database, open context, and the Florida Museum of Natural History

Williams, John^{1,2}, Cradic, Melissa³, Emery, Kitty F.⁴, Goring, Simon^{1,2}, Hoffman, Nicholas⁵, Kansa, Eric³, LeFebvre, Michelle⁴, Lieberman, Leigh³, Blois, Jessica⁵

¹Geography, University of Wisconsin-Madison, Madison, Wisconsin, United States, ²Center for Climatic Research, University of Wisconsin-Madison, Madison, Wisconsin, United States, ³Open Context, San Francisco, California, United States, ⁴Florida Natural History Museum, Gainesville, Florida, United States, ⁵Department of Life and Environmental Sciences, University of California-Merced, Merced, California, United States

Paleontologists have long been at the forefront of advancing open data (represented by, e.g., the FAIR standard) for global biodiversity research, via efforts to assemble and share data on fossil occurrences, taxonomies, traits, and stratigraphic/age position. However, recent work has called attention to the legacies of colonialist inequities in paleontological and archaeological data distributions and has urged attention to Indigenous data sovereignty and governance rights, e.g. as

advanced by the CARE Principles and the Global Indigenous Data Alliance. In response, a network of Quaternary paleoecological and archaeological data resources, called Ethical Open Science (EOS) for Past Global Change Data, has launched to explore the ethical dimensions of open data, build new partnerships, engage in self-reflection, and take first steps towards refining internal practices. We have focused efforts via a case study, with three participating resources – the Neotoma Paleoecology Database, Open Context, and the Florida Museum of Natural History – that seek to advance internal best practices and to share information about this process and resultant changes with other interested groups. These resources cover a broad spectrum of data types archived, spatiotemporal scope, and digital vs. specimen-based curation. After a May 2023 launching workshop, initial effort focused on a self-guided reflection, in which leaders of each resource reflected on both personal and organizational practice and engagement with FAIR, CARE, and EOS. We have engaged in conversations with leaders of initiatives to advance Indigenous data governance and data science, with the goals of learning, building relationships, and aligning implementation of CARE standards with emerging cross-cutting initiatives. On-going efforts include internal data audits to identify data provenances, refining data intake processes to assess alignment of incoming data with CARE principles, enabling better accessibility of paleodata to Indigenous audiences by supporting e.g. searches of data within Indigenous land boundaries as established by NativeLands, and updating internal policies to set up processes to handle possible data disputes or raised concerns. We hope that these efforts will support and cross-pollinate with similar efforts by other scientists and resource leaders interested in advancing open, ethical data and science.

Funding Sources This work was supported by the US NSF FAIROS program (OAC 2226368, 2226369, 2226370, 2226373, 2226373)

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Description and morphometric comparison of early Pliocene deer (Cervidae) from the Gray Fossil Site of Northeast Tennessee to modern and fossil cervids

Williams, Olivia R., Samuels, Joshua X., Maden, Shay, Schubert, Blaine W.

Geosciences , East Tennessee State University, Johnson City, Tennessee, United States

The early Pliocene Gray Fossil Site (GFS) is well-known for its diverse and rich fauna and flora. Perissodactyls, including tapirs and rhinos, are by far the most common large mammals at the site. Artiodactyls noted from the site are rare remains of several peccary species and a few camelid specimens. Here we describe the first remains of deer from the site, which include a partial maxilla with dP4 and M1, partial humerus, 2 tibiae, astragalus, calcaneum, metapodial fragment, and 2 proximal phalanges. Both qualitative and quantitative comparisons have been made to a wide range of modern and fossil cervids, including early Pliocene *Eocoileus gentryorum* and *Bretzia pseudalces*, late Pliocene *Odocoileus brachyodontus* and *Capreolus constantini*, early Pleistocene *O. virginianus*, and extant *O. virginianus*, *O. hemionus*, *Cervus elaphus*, *Capreolus capreolus*, and *Mazama americana*. We have gathered 4 measurements from the upper dentition and 18 from postcranial elements. The GFS specimens are similar in both morphology and size to contemporaneous records of *Eocoileus gentryorum* from the early Pliocene of Florida. Characteristics of the GFS deer support taxonomic assignment

to the genus *Eocoileus*. The GFS M1 has a small entostyle between the lingual crescents, the posterior crest extending from the protocone is not bifurcated, and it is fused with the anterior crest extending from the metaconule early in wear, features also seen in some specimens from Florida. Similarity is also seen between GFS postcranial material and known specimens of *E. gentryorum*. Morphometric comparisons show the GFS deer falls within the range of *Eocoileus gentryorum* for nearly all measurements. Both *Eocoileus* from the early Pliocene of Tennessee and Florida are smaller than extant and fossil cervids in North and Central America studied here, with the exception of *O. virginianus clavium* and *Mazama americana*. Dated to 4.9-4.5 Ma, the GFS deer are among the earliest records of the family in North America, and combined with similar age occurrences from Florida and Washington these indicate deer dispersed rapidly in the early Pliocene. The overall similarity of the *Eocoileus* specimens to modern deer suggests they occupied similar niches, being versatile browsers well-suited to a broad range of habitats. The GFS deer records suggest they have filled a similar role in the forests of the Appalachian region for nearly 5 million years, persisting through dramatic changes in climate and biota over time.

Funding Sources ETSU Center of Excellence in Paleontology

Technical Session 2: Paleontological Practices: Preparation & Scientific Methods, Collections & Curation (Wednesday, October 30, 2024, 8:00 AM)

A class of its own: Paleontology lab techniques at Montana State University and the necessity for more courses like it

Williams, Scott A.^{1,4}, Hall, Lee^{2,3}, Scannella, John^{2,3}, Knight, Cassi^{2,3}, Varricchio, David J.³

¹Exhibitions, Museum of the Rockies, Bozeman, Montana, United States, ²Montana State University, Bozeman, Montana, United States, ³Paleontology, Museum of the Rockies, Bozeman, Montana, United States, ⁴Montana State University, Bozeman, Montana, United States

Several North American universities and colleges offer paleontology curricula featuring research and field collecting collaborations with museums. By contrast, very few have a college-level course in paleontological conservation techniques. For nearly two decades Montana State University (MSU) has offered a semi-annual 3-credit course (GEO 330 - Paleontology Lab Techniques) as part of its Earth Sciences - Paleontology bachelor's degree. The class was first taught by paleontology graduate students with varying fossil preparation experience. In 2019 MSU began to standardize and strengthen the course by hiring Museum of the Rockies (MOR) Paleontology staff as co-instructors. Coincidentally, increased demand overloaded the roster to over twenty students. GEO 330 was held Wednesday evenings with a one-hour lecture and two-hour lab session in the Varricchio Family Paleontology Laboratory on MSU's campus. The syllabus focused on technical aspects of fossil preparation skills including discerning fossil material from matrix, proper use of hand tools/pin vices, pneumatic tool operation and maintenance, air abrasion, microscope use, consolidant and adhesive use, basic molding and casting, and fabrication of conservation cradles. Fossils came from MOR's backlog of material collected from the Upper Cretaceous Two Medicine and Judith River formations, and the Upper Jurassic Morrison Formation. Students were grouped into teams of three to four due to lab space constraints and the element assigned. Groups prepared their specimens over fourteen weeks, finishing with conservation cradles by semester's end.

Other major grade components included a mid-term quiz, a class presentation, and a final paper detailing the preparation of their specimen. In 2023 registration remained over-capacity and both instructors were now from MOR's Paleontology staff. The curriculum evolved to focus on paleontological conservation, the importance of archival materials and reversibility, and added guest presenters with expertise in taphonomy, 3D scanning, photogrammetry, figure creation, and curation and collections management. In 2024 demand has compelled MSU to offer GEO 330 annually and relocate it to MOR's larger, newly renovated fossil preparation lab. The success of this course demonstrates both the growing need for course options featuring paleontological conservation and provides other universities a template for additions to their geology/paleontology curricula.

Technical Session 10: Fishes (Thursday, October 31, 2024, 1:45 PM)

Unexpected mosaic anatomy in a new genus and species of Early Carboniferous actinopterygian

Wilson, Conrad D.¹, Mansky, Chris F.², Anderson, Jason³

¹Earth Sciences, Carleton University, Ottawa, Ontario, Canada, ²Blue Beach Fossil Museum, Hantsport, Nova Scotia, Canada, ³Faculty of Veterinary Medicine, University of Calgary, Calgary, Alberta, Canada

Early actinopterygian evolution and diversity flux remains poorly understood. A direct reading of the fossil record implies that a profound shift occurred between Devonian and Carboniferous actinopterygian faunas. Devonian actinopterygians are known from a handful of lineages with a single bodyplan, but Carboniferous actinopterygians are diverse and morphologically disparate. This

transition has been interpreted as an explosive diversification enabled by a mass extinction of vertebrates. However, new fossil data from both sides of the Devonian-Carboniferous boundary, phylogenetic results suggesting substantial actinopterygian survivorship, and analysis of actinopterygian fossil record completeness have challenged this interpretation and suggest the transition is more complex than indicated by a direct reading of the incomplete actinopterygian fossil record.

Fossils from the Early Carboniferous (Tournaisian; late Tn2 to early Tn3 palynomorph stages) Horton Bluff Formation of Nova Scotia have helped to fill in the actinopterygian fossil record despite being significantly incomplete. We report an articulated actinopterygian skull, pectoral girdle, and fin, representing a new genus and species, from the Horton Bluff Formation at Blue Beach, Nova Scotia.

This new taxon has an unexpected combination of character states. For example, the pectoral girdle and fin appear plesiomorphic: an interclavicle is present, the cleithral notch for the pectoral fin is posteroventrally directed and overlain by a triangular process, and the pectoral fin endoskeleton is strongly reminiscent of *Moythomasia*. By contrast, the hyomandibula bears an opercular process, the lower jaw has a small coronoid process, and there appears to be a second intermediate element in the hyoid arch between the hyomandibula and the ceratohyal. This potential second intermediate element seems to contact the articular, and interpreting its identity could be critical in resolving controversy over actinopterygian hyoid arch evolution. In our phylogenetic analysis, this new taxon is recovered among a grade of otherwise Devonian taxa in an overall topology that implies significant actinopterygian survivorship across the Devonian-Carboniferous boundary.

Thus, our results continue to blur the distinction between Devonian and Carboniferous actinopterygians both in terms of morphology, by revealing an unexpected combination of character states, and phylogeny, by recovering an additional boundary-crossing lineage.

Funding Sources Research was supported by NSERC Discovery Grants 2017-04821 and 2023-04423 to Jason Anderson and an NSERC CGS M award to Conrad Wilson.

Romer Prize Session (Thursday, October 31, 2024, 8:00 AM)

Avialan utilization of polar ecosystems traces back to Cretaceous ornithurines: key insights from the Campanian Prince Creek Formation of northern Alaska

Wilson, Lauren N.^{1,2}

¹Department of Geosciences, University of Alaska Fairbanks, Fairbanks, Alaska, United States, ²Museum of the North, University of Alaska Fairbanks, Fairbanks, Alaska, United States

Modern polar regions are structured and enriched by birds, which nest there seasonally and play numerous vital ecological roles. After the breeding season, these birds and their offspring must either overwinter, enduring cold and dark conditions, or migrate, sometimes significant distances, to lower latitudes. Both strategies pose a suite of adaptive challenges that birds face in order to take advantage of seasonally abundant food resources. Despite the vast evolutionary implications associated with the origins of this behavior, little is known about when birds began utilizing polar ecosystems for nesting. In large part, this is due to the extreme rarity of avialan fossils from high latitudes. I assess a remarkable avifauna from the Campanian (~73 Ma) Prince Creek Formation (PCF) of northern Alaska, the

northernmost terrestrial fossil vertebrate locality known. The PCF was deposited at 80–85°N paleolatitude, where continuous summer daylight and high seasonal productivity would have lasted nearly six months. In contrast, up to three months of continuous winter darkness and freezing temperatures would have imposed severe environmental constraints on inhabitants. The new PCF avialan material was discovered as part of a decade-long analysis of rich vertebrate microfossil assemblages. Over 50 unassociated skeletal elements, representing every skeletal region, constitute one of the most comprehensive Late Cretaceous terrestrial bird fossil assemblages. High resolution micro-CT scans and comparative analyses reveal an exclusively ornithurine fauna, including confident referrals to *Ichthyornithes* and *Hesperornithes*. While referral to *Neornithes* based on unassociated material is problematic, the presence of neornithine synapomorphies in the PCF implies the presence of a highly crownward avialan, refining our understanding of when key traits of modern birds evolved. In addition, numerous perinatal fossils represent the youngest-known growth stages of Mesozoic euornithines, and provide the first glimpse of hallmark avian features in the Mesozoic, such as hatchling tarsometatarsi which already exhibit complete fusion. These new fossils demonstrate that the utilization of seasonal polar ecosystems for nesting originated in the Mesozoic ancestors of modern birds, millions of years before the radiation of crown group birds following the end-Cretaceous mass extinction.

Funding Sources National Science Foundation EAR 1226730 and EAR 1736515

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

80 years of the Chaparral Fauna, Colombia: Revisiting a pre-Laventan neotropical assemblage

Wilson, Oscar E.¹, Holroyd, Patricia A.², Parker, Abigail K.³, Rincon, Aldo⁴, Pujos, François⁵, Vallejo-Pareja, Maria C.^{6,7}, Saarinen, Juha¹

¹Department of Geosciences and Geography, University of Helsinki, Helsinki, Finland, ²Museum of Paleontology, University of California, Berkeley, California, United States, ³Department of Computer Science, University of Helsinki, Helsinki, Finland, ⁴Departamento de Física y Geociencias, Universidad del Norte, Barranquilla, Colombia, ⁵Instituto Argentino de Nivología, Glaciología y Ciencias Ambientales (IANIGLA), CCT–CONICET–Mendoza, Mendoza, Argentina, ⁶Florida Museum of Natural History, University of Florida, Gainesville, Florida, United States, ⁷Department of Biology, University of Florida, Gainesville, Florida, United States

In 1944, R.A. Stirton and J. Royo y Gomez conducted fieldwork near the town of Chaparral, Colombia. Their discoveries were described in the mid 20th century but have received limited attention since. We definitively assign *Lophiodolodus chaparralensis* to the Megadolodinae within Litopterna and a fragmentary upper molar, originally described as *Protheosodon* sp., to Proterotheriidae indet. A broken toxodontid upper molar, originally identified as *Proadinothierium* sp. is more conservatively assigned to Nesodontidae indet., though this does increase the evidence for a tropical nesodontine lineage, also identified in Venezuela and Brazil. The mammal assemblage shares taxa like *Xenastropotherium*, a megadolodine and a ground sloth with Middle Miocene neotropical assemblages like La Venta. Stirton originally suggested a Late Oligocene age for the Chaparral assemblage, but the mammal fauna is more consistent with the Early

Miocene. The herpetofauna of Chaparral includes at least two crocodilian taxa currently known only from isolated teeth, representing the Gavialidae and Alligatoridae, alongside a large anuran (only known from a femur of a similar size to that of an average *Rhinella marina*) and a podocnemid turtle with an estimated carapace length of 1.2m. The reptile assemblage is clearly consistent with the presence of freshwater habitats at the time of deposition, with no evidence of any marine incursion. Though limited, the evidence from mammalian dental ecometric trait analysis suggests that the terrestrial taxa lived in a rainforest habitat. All the fossils currently known from the Chaparral assemblage were collected 80 years ago in only seven days of fieldwork. There is therefore significant potential for further exploration in the area to further understand environmental and faunal change in the neotropics in the Neogene.

Funding Sources Funding for this work was received through Research Council of Finland grant NEPA - Non-Analogue Ecosystems of the Past [340775/346292].

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Paleoecology of Early Eocene *Homogalax* may have partly foreshadowed that of extant *Tapirus*

Winter, Rachel E.

Anthropology and Geography, Colorado State University, Fort Collins, Colorado, United States

Early Eocene *Homogalax* and *Hyracotherium* are representative of the earliest perissodactyls, and ancient soils (paleosols) in which their remains are found record paleoenvironments that provide clues indicative of their behavior. By comparing the localities from which extinct tapirs are found with knowledge of the behavioral characteristics of some modern tapirs, this

project seeks to contextualize the development of early tapir behavior through an evolutionary lens. Paleosol stages of development were used to determine local paleoenvironmental conditions where the fossils were found. Frequency of fossil tapir remains in each paleosol was ascertained from field data in order to identify patterns of distribution. These patterns were evaluated in comparison with the behavior patterns of modern South American tapirs with the aim of situating behavioral development within the realm of environmental and habitat transitions over an evolutionary time frame. Modern South American tapirs utilize well-worn networks of trails connecting feeding areas, water sources, and resting spots, and spend much of their time traveling in between these locations, but are generally settled when they arrive. If this behavior is reflected in the fossil record, it might be expected that higher concentrations of specimens were found in feeding, watering, and resting places, with a lower frequency of specimens found in transitional/intermediate areas. Initial results suggest that the paleoecology of *Homogalax* may reflect that of the extant South American tapir patterns of navigational behavior and habitat ranges.

Funding Sources N/A

Technical Session 18: Carnivora & Co (Saturday, November 2, 2024, 8:00 AM)

Comparison of fossil coyotes of Rancho La Brea to modern coyotes reveals differences in dental morphology

Witt, Benjamin R., Berger, Arin, Deutsch, Ashley R, Hartstone-Rose, Adam

Department of Biology, North Carolina State University, Raleigh, North Carolina, United States

Previous studies of the late Pleistocene locality of Rancho La Brea (RLB) have shown

how its carnivore guild was more diverse than is that of modern California. Although the iconic ice-age fauna from RLB has been studied extensively, the third most common RLB taxon (after sabertooths and dire wolves), its coyotes, regarded as conspecific with modern *Canis latrans*, have garnered less attention. However, because of the substantially different competitive guild structure that they existed in, we hypothesize that the dental morphology of the RLB coyotes will be significantly different than that of modern coyotes, reflecting different degrees of dietary specialization. Comparing mandibular post-canine teeth of 17 RLB coyotes from 8 different pits to samples of modern specimens from across the modern range with a substantial subsample of Californian specimens as well as other canids (both congeners and other Canina), we found that the RLB coyotes were significantly different than their modern counterparts: the RLB coyotes are larger than their modern conspecifics (PC1) and have a larger ratio of their premolars relative to their carnassial trigonids (PC2). The greater emphasis on premolars relative to the sectorial components of the carnassials in the RLB coyotes might indicate greater durophagy relative to their modern conspecifics – a finding that we are testing through examination of the radius of curvature and intercuspid notch scores of the same specimens. The larger premolars of RLB coyotes relative to their modern counterparts may explain the reduced levels of premolar tooth breakage previously observed in RLB coyotes compared to other carnivorans, suggesting a specialization for greater carcass utilization. It seems that, similar to other taxa at RLB, for the coyotes, Pleistocene La Brea was also a tough time.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Demographic assessment of the *Mylohyus* (Artiodactyla: Tayassuidae) from the Cutler Hammock site of Dade County, Florida with comments on the faunal assemblage and paleoecology

Woodruff, Aaron

vertebrate paleontology, University of Florida, Gainesville, Florida, United States

Cutler Hammock is a sediment-filled sinkhole deposit located in Dade County, Florida near Cutler Ridge southwest of Miami. While the locality is believed to have functioned as a predator den, very little research has been done on the fauna from the locality since its excavation in the mid-80s and much of the collection remains uncatalogued. In particular, the site yields an unusually large assemblage of the extinct peccary *Mylohyus*. Unlike other Rancholabrean sites which preserve both taxa, *Mylohyus* specimens greatly outnumber those of *Platygonus* at Cutler Hammock. The Cutler Hammock *Mylohyus*, referred under the species *M. fossilis*, is represented by over 600 catalogued specimens with many more yet to be processed, compared to only 10 identified *Platygonus* specimens. This large *Mylohyus* assemblage enables the study of population demographics and comparative morphology of this relatively rare taxon. Age profiles were obtained based on the state of tooth eruption from dentaries, showing an absence of very young juveniles. Non-overlapping age groups point to seasonal breeding behavior and size-based dimorphism appears to have been minimal. The teeth of *M. fossilis* from Cutler Hammock are smaller overall and less robust than those of individuals from Leisy Shell Pit, opening the possibility of multiple *Mylohyus* species in the state of Florida during the late Pleistocene. Furthermore, the *Mylohyus* population from Cutler Hammock compared to the much scarcer *Platygonus* challenges previous interpretations of the former being more solitary in its general habits than the latter,

with previously documented differences in numbers possibly being better attributed to differences in habitat preference or denning behaviors.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Heterocoely and the advent of preening in non-avian theropods: how a behavior contributed towards sexually selected feathers and the avian airfoil

Woodruff, Cary¹, Hone, David², Simon, Jade³, Evans, David⁴

¹Paleontology, Phillip & Patricia Frost Museum of Science, Miami, Florida, United States, ²School of Biological and Chemical Sciences, Queen Mary University, London, United Kingdom, ³Department of Ecology and Evolutionary Biology, University of Toronto, Toronto, Ontario, Canada, ⁴Department of Natural History, Royal Ontario Museum, Toronto, Ontario, Canada

Most prominent in avian cervical vertebrae, heterocoely is a complex articular morphology that allows for increased mobility while preventing torsion. Behaviorally, the act of preening is vital towards numerous forms of feather health and maintenance. As all crown birds preen, the genesis of this behavior likely arose from a preening, non-avian ancestor. Examining 211 non-avian theropods, we document that heterocoelous joints were only observed in maniraptoriform subclades that co-possessed pennaceous feathers. As preening is vital to feather upkeep in extant birds, we hypothesize that this behavior was equally vital in these theropod dinosaurs to allow for full-body access. Heterocoelous cervical vertebrae represent an additional morphology that solidifies the 'dinosaur-bird' relationship, and a further osteological feature supporting behavioral hypotheses in extinct taxa. While pennaceous feathers evolved prior to

heterocoely, enlarged or ornate display feathers do not appear in Theropoda until the evolution of heterocoely. Equally, the avian airfoil is composed entirely of pennaceous feathers, and its construct and necessary maintenance requires the high degree of cervical mobility only achievable via heterocoely. If heterocoely evolved as part of the biomechanical means to ultimately maintain a full-body pennaceous covering, sexually selected display feathers and flight may be a byproduct of full-body preening that evolved subsequent to heterocoely over c. 160 my.

Technical Session 17: Theropoda II (Saturday,
November 2, 2024, 8:00 AM)

Quantifying skeletal representation in the fossil record of birds and beyond: implications for using incomplete fossils in phylogenetic analyses

Woolley, Charles H., Cusack-Mercedez, Max, Smith, Nathan D.

Dinosaur Institute, Natural History Museum of Los Angeles County, Los Angeles, California, United States

Phylogenetic analyses incorporating fossil taxa tend to rely on the most complete fossil specimens for inferring evolutionary relationships. However, most animal fossil records are made up of fragmentary remains and disarticulated parts, and consequently, we are left with considerable uncertainty in the evolutionary relationships of most known fossil species. Maximizing the vast amount of evolutionary information available in incomplete fossils within natural history collections necessitates: 1) a quantitative characterization of the biases present in this record, and 2) knowing whether the phylogenetic data preserved in these incomplete samples are reliable and consistent. We compiled a dataset of 19,077 skeletal elements housed in six North

American museum collections to characterize the representation of different anatomical regions in the fossil record of the most diverse group of tetrapods on earth: birds. We find that bones from the pectoral girdle and forelimb account for 52.6% of all skeletal element occurrences, the pelvic girdle and hindlimb account for 42.0% of sampled fossil bird skeletal element occurrences, and the rest of the skeleton (e.g., skull bones, vertebrae, ribs) account for 5.4% of occurrences. These results differ from the distribution of characters across the avian skeleton in recent morphological phylogenetic datasets, in which the skull contains the largest proportion of characters (32.2%). This bias against character-rich cranial elements is similar to previously reported patterns in the second most diverse group of tetrapods: squamates (lizards, snakes, and their relatives). However, the overrepresented regions of the skeleton within the fossil record of birds and squamates differ. While the bird fossil record consists almost entirely of limb bones, the squamate fossil record consists mostly of tooth-bearing bones in the skull, vertebrae, and ribs. Thus, despite quantifiable differences in anatomical representation, the region of the skeleton with the most character data is virtually absent in the fossil record of the two most diverse groups of tetrapods. Therefore, measurements of phylogenetic signal in their biased fossil records are imperative to including more and more extinct taxa in analyses of evolutionary relationships. In sum, this study proposes a comparative framework for quantifying bias in the fossil record using a novel, phylogenetic approach.

Funding Sources NSF EAR-PF 2305564; NSF RaMP 2216721

Colbert Prize Session

Assessing anatomy, dimorphism, and possible biological implications of post-cloacal heterotopic bones in *Tanytrachelos ahynis* (Archosauromorpha, Tanystropheidae)

Workman, Gina M.^{1,2}, Pritchard, Adam C.¹

¹Paleontology, Virginia Museum of Natural History, Martinsville, Virginia, United States, ²Geosciences, Utah State University, Vernal, Utah, United States

Tanytrachelos ahynis is a small archosauromorph known from hundreds of specimens from the Upper Triassic of Virginia. These are known from many articulated skeletons, roughly half of which preserve large heterotopic ossifications posterior to the pelvic girdle. These bones, hypothesized to be connected to sexual dimorphism, have not been studied in detail. We describe the bones in a comparative framework and statistically assess possible size and proportional differences in the skeletons of the two morphs.

Heterotopic bones occur in both mature and juvenile individuals. Proportionally longer than the pelvic girdle, the heterotopics manifest as bilateral pairs of ossifications sitting lateral to the anterior caudal vertebrae. Each is roughly triangular, tapering to a sharp point anteriorly. Some *Tanytrachelos* individuals with soft tissue preservation and heterotopics do bear a sac-like structure located just anterior to the ossifications. Similar heterotopic bones occur in the tanystropheid genus *Tanystropheus*. Some studies hypothesized that the ossifications serve as support for brood pouches or male reproductive structures. Some squamates (e.g., gekkonids, pygopodids, xantusiids) possess proportionally smaller subcutaneous heterotopic elements than those in *Tanytrachelos*. The bones are present in both sexes in these squamates.

We took linear measurements from over one hundred well-preserved *T. ahynis* specimens.

We compared body size between samples with and without heterotopics, using femoral length and tibial length as body size proxies. The mean femoral length was slightly shorter in individuals with heterotopics than those without, whereas mean tibial length in the sample with heterotopics had slightly longer tibiae than those without. The differences in lengths between samples were not statistically significant, supporting comparability in body size.

We also explored possible proportional differences between the axial and appendicular skeleton by comparing ratios of trunk length to tibial length. Individuals with heterotopic ossifications had proportionally longer trunks than those without, and the proportional differences were statistically significant. Preservational artifacts need to be examined to re-assess this result, but our study suggests that the presence of heterotopic bones may correlate with other differences in the proportions of the skeleton, and thus other biological differences between the two morphs.

Funding Sources Funding for presenting at this year's annual meeting was received from the AWG Utah chapter's M. Lee Allison Professional Development Award.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

Marine mammal occurrences, distribution, and paleoenvironmental interpretation at Late Miocene sites of Cerro Ballena and Mina Fosforita, Bahía Inglesa Fm., Chile

Worrell, Whitney E.¹, Clementz, Mark T.¹, Carrapa, Barbara⁴, Gutstein, Carolina S.^{2,3}, Hasiotis, Steven T.⁵, Martinez, Priscilla R.⁴

¹Geology & Geophysics, University of Wyoming, Laramie, Wyoming, United States, ²Department of Geosciences, University of Arizona, Tucson, Arizona, United

States, ³Departamento de Biología, Red Paleontológica U-Chile, Santiago, Chile, ⁴Paleo Consultores, Santiago, Chile, ⁵Department of Geology, University of Kansas, Lawrence, Kansas, United States

The Bahía Inglesa Formation, Atacama Region, Chile (27°S), contains highly fossiliferous Late Miocene-Pliocene marine mammal fossil sites, here we aim to reconstruct the paleoenvironment and provide new interpretations for two sites. We focused the recently correlated sites of Cerro Ballena and Mina Fosforita, which are highly fossiliferous; Cerro Ballena contains in situ, highly articulated baleen whales and other marine megafauna, whereas Mina Fosforita specimens are more diverse but disarticulated, abraded, and highly time averaged. Marine mammal faunas from each site consist of a mix of highly-specialized, extinct taxa (e.g., *Odobenocetops* sp.) and early members of extant families found in these waters today (e.g., Balaenopteridae). Cerro Ballena is a shallowing-upward sequence with the highest diversity of well-articulated specimens from the marine vertebrate assemblage concentrated near the base of the section where the water would have been the deepest. Up section, water depths shallowed and the fossils are increasingly disarticulated, fragmented, and restricted to primarily rorqual whales apart from a single occurrence of the aquatic sloth *Thallasocnus natans* near the top of the sequence. The Bahía Inglesa Formation at Mina Fosforita, 15 kilometers south of Cerro Ballena, is exposed over a larger area and contains a more diverse fossil record. The bulk of the marine vertebrates at Mina Fosforita occur as disarticulated, fragmented, and abraded remains in phosphatic and carbonate hardground deposits. Sediments at Mina Fosforita represent a marine transgression, with a greater accumulation and diversity of fossils found in the deeper water deposits at the top of the section than in the shallow water deposits at its base. The

hardground deposits developed on the shelf and represent a lag deposit that concentrated and reworked the remains during storms. Layers of diatomite at Mina Fosforita indicate an increase in surface water marine productivity in the Late Miocene, which may have contributed to the high diversity of coastal marine vertebrates in the area. The marine vertebrates in the Bahía Inglesa Formation represent an important contribution to our understanding of Late Miocene ecosystem shifts, in particular the appearance of modern taxa and the extinction of highly specialized marine megafauna.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Osteohistological assessment of Cretaceous-Paleogene crocodylomorphs

Wosik, Mateusz¹, Householder, Mindy L.²,
Boyd, Clint A.²

¹Biology, Misericordia University, Dallas,
Pennsylvania, United States, ²North Dakota
Geological Survey, Bismarck, North Dakota,
United States

The osteohistology of vertebrates provides a reliable method for extracting biological information, particularly related to growth and development. Research on the osteohistology of Pseudosuchia is relatively sparse and usually focuses on living species. In this study, we histologically sectioned six long bones (e.g., humeri, femora) from five extinct associated crocodylomorphs to assess ontogenetic age. These specimens originated from localities in North Dakota, spanning from the Cretaceous to the Paleogene.

All thin-sections revealed a lamellar bone matrix with minimal vasculature, typically in a longitudinal orientation, and preserved varying amounts of growth marks with

distinct formation of Lines of Arrested Growth (LAGs). The two femora (NDGS 18001, 18002) from the Hell Creek Formation (Late Cretaceous) were both actively growing with no evidence of an External Fundamental System (EFS). NDGS 18002 is referred to *Brachychampsa* based on its large size and recovery of numerous elements of similar size from the same locality, including a partial skull that is diagnostic for *Brachychampsa*. The taxonomic identity of the smaller specimen, NDGS 18001, is currently uncertain, but the growth mark data indicate that it is younger than NDGS 18002, suggesting that it may be a younger individual of *Brachychampsa*. The Ludlow Formation (Paleocene) specimens (NDGS 1205, 16200), were concluded to be mature adults based on the presence of a distinct EFS in each thin-section. Their taxonomic identity is also unknown, but both are part of associated skeletons from potentially two novel alligatoroid species based on preliminary morphological data. The Golden Valley Formation (Eocene) specimen (NDGS 16140) was the smallest in the entire sample and revealed a distinct EFS, indicating near-complete skeletal maturity. This specimen was the most surprising and may represent another new species.

This study provides a framework for interpreting the life history of Pseudosuchia, shedding light on the evolutionary history and ontogenetic growth of extinct crocodylian lineages. Furthermore, the exploratory nature of this research suggests the potential discovery of new species and confirms the ontogenetic ages of several specimens, many of which attained skeletal maturity, validating their inclusion when assessing character states in phylogenetic analyses.

Funding Sources Misericordia University
Summer Research Grant

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

**Evolution and development of the furcular
epicleidium and acrocoracoclavicular joint
of birds**

Wu, Qian^{1,2}

¹University of Chinese Academy of Sciences,
Beijing, China, ²Institute of Vertebrate
Paleontology and Paleoanthropology,
Chinese Academy of Sciences, Beijing, China

The acrocoracoclavicular joint is absent in non-avian theropods and considered to be the last step to form the triosseal canal, a critical structure of the power flight of birds. The evolution and development of the acrocoracoclavicular joint, however, is unclear, impeding our understanding of bird flight. The processus acrocoracoideus clavicularae on the furcular epicleidium forms the acrocoracoclavicular joint with the acrocoracoid process in extant volant birds. Here we analyzed the morphology, articulation, and development pattern of the avian furcular epicleidium through x-ray computed tomography scanning and histochemical staining in both fossil and extant bird exemplars. The results show that the process acrocoracoideus clavicularae is absent in non-avian theropods and Mesozoic birds, then independently evolved in many neornithine bird taxa. Histology analysis results show that the process acrocoracoideus clavicularae is a secondary endochondral ossification in the furcula, which is separated from the intramembranous ossified main furcula by connective tissue and fused with the furcula during postnatal development and forms the articular surface of the acrocoracoclavicular joint. Our discoveries suggest that the left and right process acrocoracoideus clavicularae is formed by the fusion of a sesamoid with the respective furcular ramus and evolved convergently among different neornithine lineages; this unique structure of furcular

would not only increase the morphological diversity of the acrocoracoclavicular joint of neornithine birds, but also lay the foundation for their complex and diverse flight styles.

Funding Sources National Natural Science Foundation of China under grants 42302012 and 42288201.

Regular Poster Session 2 (Thursday, October
31, 2024, 4:30 - 6:30 PM)

**A closer look into the Middle Mississippian
Ste. Genevieve Formation microvertebrate
chondrichthyan fossils of Mammoth Cave
National Park**

Wurtz, Alyssa L.¹, Hodnet, John-Paul M.²

¹Geosciences, Mississippi State University,
Starkville, Mississippi, United
States, ²Archeology, Maryland-National
Capital Parks and Planning Commission,
Upper Marlboro, Maryland, United States

The majority of Mammoth Cave National Park consists of three geologic formations: St. Louis Formation, Ste. Genevieve Formation, and Girkin Formation. The various rock layers that make up the Mammoth Cave System were deposited on the shallow sea floor of the southeasternmost part of the Illinois Basin in the Mississippian approximately 340-330 million years ago. The sea level during the Mississippian was a lot higher than it is today, with much of what is now the central United States submerged in shallow seawater. The Ste. Genevieve Formation contains most cave passages in the Mammoth Cave System in southcentral Kentucky, USA. The Ste. Genevieve of Mammoth Cave is about 35 m (115 ft), containing thin-bedded limestones and dolomites with a few shaly beds. During the Mississippian, following the drastic extinction of placoderm fishes and several other major fish groups, the chondrichthyans (cartilaginous fish) underwent an extensive radiation, leading to vast diversification, with

many species filling ecological niches now occupied by Osteichthyes (bony fish).

In a cave system, it is very easy to miss fossils even when diligently searching. Often, microfossils get overlooked if macrofossils are present. Combine these two conditions, and the microfossils of Mammoth Cave deserve a closer examination. Roughly 5.5 liters of sediment were collected from various sites, targeting areas where chondrichthyan fossils have been previously found at Mammoth Cave to examine for microvertebrate fossils. The collection process was deliberate and minimal to try and preserve the cave as much as possible. Preliminary screenwashing has resulted in the recovery of several millimeter-scale specimens. These early findings show the potential to develop a deeper understanding of the newly discovered diverse Mammoth Cave chondrichthyan assemblage and warrants further investigation. Microvertebrate analysis may provide new insights into the paleoecology and biodiversity of this ancient marine environment. Our ongoing analysis aims to classify these specimens and expand our knowledge of the Mammoth Cave System, contributing to a more comprehensive understanding of the region's paleontological history.

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Evidence for a spatial range expansion of the Miocene-aged heteromyid *Schizodontomys harkseni*: implications for the biogeographic ranges of Heteromyidae (Rodentia)

Wyatt, Megan R.¹, Calède, Jonathan J.^{2,3}, Smiley, Tara M.¹

¹Ecology and Evolution, Stony Brook University, Stony Brook, New York, United States, ²Section of Vertebrate Paleontology,

Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, United States, ³Department of Earth Sciences, University of Oregon, Eugene, Oregon, United States

The rodent family Heteromyidae includes extant pocket mice, kangaroo rats, and their relatives, as well as many extinct species from the Oligocene onward. The fossil record of heteromyids shows the Middle Miocene harbored many species and morphological forms not observed today. There is evidence from the modern record that both topography and climate are related to diversification and trait variation in heteromyids. Continuing to study fossil heteromyids from the Miocene can help us further understand the processes shaping diversity and trait evolution in this family. In this study, we micro-CT scanned a *Schizodontomys* specimen not yet identified to species (UWBM 48593), with a complete skull and articulated jaw. The scan enabled us to study the diagnostic anatomy otherwise covered with sediment. The specimen displays all the diagnostic features of the genus *Schizodontomys* and its skull morphology confirms that the specimen belongs to *S. harkseni*. The specimen comes from the Haystack Valley Member of the John Day Formation in eastern Oregon; it is between 25 and 18 million years old. This new specimen shows that *S. harkseni* was present on both the western and eastern sides of the Rocky Mountains during the Miocene. Fossil occurrences of *S. harkseni* on both the eastern and western sides of the Rocky Mountains challenge our understanding of biogeographic patterns within the group because the Laramide orogeny predates the first heteromyid and acts as a major biogeographic barrier to heteromyids today. Together with our existing knowledge of the heteromyid fossil record, this new fossil suggests that past topography and climate influenced Miocene heteromyid distributions differently than today. We hypothesize that the presence of *S. harkseni* on both the

eastern and western sides of the Rocky Mountains is related to a broader trend of warming climate in the Middle Miocene allowing small mammals to move upslope and cross mountains more easily than in cooler climates. The distribution of other heteromyid species shows that more species indeed had populations on both the eastern and western sides of the Rocky Mountains during the Miocene (about 40% of known species) than today (less than 5% of extant species). Our unexpected findings illustrate the importance of systematic analyses of museum specimens. In this study, identifying a fossil heteromyid has furthered our understanding of the relationship between mountains, climate, and biogeography in deep time.

Funding Sources NSF PRFB-Biological Collections DBI #1612002 & NSF SGP #2041895 (TMS)

Regular Poster Session 3 (Friday, November 1, 2024, 4:30 - 6:30 PM)

Behavioral implications of a tyrannosaurid tooth embedded in an articulated skull of *Edmontosaurus* from the Hell Creek Formation, Montana

Wyenberg-Henzler, Taia C.¹, Scannella, John²

¹Biological Sciences, University of Alberta, Edmonton, Alberta, Canada, ²Museum of the Rockies, Bozeman, Montana, United States

Tooth marks, particularly those that include embedded teeth, can provide valuable information regarding carnivore behaviour. Here we present on an articulated *Edmontosaurus* skull (MOR 1627) from the uppermost Cretaceous Hell Creek Formation with a theropod tooth embedded in the dorsal surface of the nasal. Preserved mesiodistal and apicobasal dimensions of the tooth and mesial and distal denticle densities indicate the embedded tooth is from a medium to

large bodied tyrannosaurid. Observed denticle characteristics are consistent with this identification. Based on the slight curvature of the tip and the ovoid shape of the cross-section from CT scans, the embedded tooth is likely a maxillary tooth from a middle or posterior tooth position. No reactive bone textures were observed in the area around the embedded tooth to indicate healing. This suggests that the tooth became embedded by a bite directed from the front that occurred at or near the time of death. Alternatively, the lack of healing is consistent with the hadrosaur being scavenged by the tyrannosaurid. Based on observations of modern carnivores, bites to the snout are typically inflicted as a means of prey capture or carcass manipulation. In the case of MOR 1627, the directionality of the bite, the number and relative positioning of tooth marks, and the level of articulation of the rest of the skull are more consistent with a bite inflicted during an attempt to control the struggling *Edmontosaurus* or deliver a killing blow, rather than during carcass manipulation or consumption.

Funding Sources Fieldwork supported with funding by the Smithsonian Institution and donors to the Hell Creek Project.

Technical Session 3: Sauropodomorpha (Wednesday, October 30, 2024, 1:45 PM)

The difference in range of motion between manus and pes of the sauropodomorph inferred from trackways

Yamaguchi, Kohei¹, Kubo, Tai², Kubo, O., Mugino¹

¹Graduate School of Frontier Sciences, The University of Tokyo, Kashiwa, Chiba, Japan, ²Waseda University, Tokyo, Japan

The terrestrial locomotion of the extant animals is constrained by large body sizes. Sauropodomorph dinosaurs are the largest

terrestrial animals ever existed on the earth, with their body weight being an order of magnitude greater than that of other animals. Therefore, the relationship between body size and locomotor pattern of sauropodomorphs is important in understanding how extremely large body sizes constrain locomotion and adaptations to overcome these constraints. Abundant trackway records left by sauropodomorphs provide information on their locomotion. Also, the temporal change in their trackways can provide evidence of their locomotor evolution independent from body fossils. In this study, we investigated the relationship between the track morphology and the locomotor pattern based on the data collected from described sauropodomorph trackways (N=690) that consist of 2197 footprints. In this analysis, we specifically focused on the rotation angle of the manus and pes footprints against the trackway midline. In most trackways, manus footprint rotation was greater in both inward and outward than that of pes. Therefore, variance of manus footprint rotation angle was greater than that of pes (F-test, $p < 0.0001$). These results suggest the possibility that sauropodomorph dinosaurs had a greater range of motion in their forelimbs compared to their hindlimbs. Additionally, these angles and variance decreased as the footprint length (the proxy of body size) increased and the angles converged to around 20-40 degrees outward for both manus and pes. It means that as body size increases, the range of motion of the sauropodomorph limbs decreases. We compared the rotation angle among the epoch from the Lower Jurassic to the Upper Cretaceous. A temporal change was observed in the forelimbs during the Cretaceous period, with an increase in inward-directed manus footprints (Kruskal-Wallis test, $p = 0.003$), whereas there were little changes in the rotation angle of the pes.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Why do some flightless birds maintain feathers adapted for flight?

Yamazaki, Yusuke¹, Yamasaki, Takeshi²

¹Japan Bird Research Association, Kunitachi, Japan, ²Yamashina Institute for Ornithology, Abiko, Japan

The primary flight feathers in extant birds exhibit a trailing vane that is wider than the leading vane, creating an asymmetrical shape. This shape has been considered an adaptation for flight due to its known increase in lift. However, some flightless species also maintain asymmetrical primary flight feathers. This feature has been explained by the relatively short period since evolving flightlessness. However, it is also possible that the aerodynamic function of asymmetrical primary flight feathers is important for ecological characteristics other than flight. For example, even flightless birds may benefit from the aerodynamic function of asymmetrical primary flight feathers when arboreal species descend from trees or strong territorial species run on the ground for defense. To test this latter hypothesis, we analyzed the relationship between the asymmetry of primary flight feathers and the presence or absence of flight capability, arboreality, and territoriality in 51 species of Rallidae using phylogenetic comparative methods. The results revealed that not only flight capability but also the interaction between arboreality and territoriality significantly influenced the asymmetry of primary flight feathers. This suggests that asymmetric primary flight feathers in flightless species are actively maintained by natural selection rather than being merely vestigial.

Funding Sources Part of this work was supported by the Japan Society for the Promotion of Science KAKENHI (grant numbers 22H02689 and 23K23952 to T.Y.).

Technical Session 4: Mesozoic Mammals, Xenarthra, & Afrotheria (Wednesday, October 30, 2024, 1:45 PM)

Strontium isotope mapping of elephant enamel supports a combined workflow of micro-sampling and modeling to reconstruct ancient migrations

Yang, Deming^{1,2}, Podkovyrov, Katya^{1,5}, Uno, Kevin^{1,4}, Bowen, Gabriel¹, Fernandez, Diego P.¹, Cerling, Thure E.^{1,3}

¹Department of Geology and Geophysics, University of Utah, Salt Lake City, Utah, United States, ²Division of Anthropology, American Museums of Natural History, New York, New York, United States, ³Institute of Ecology and Evolution, University of Oregon, Eugene, Oregon, United States, ⁴Department of Human Evolutionary Biology, Harvard University, Cambridge, Massachusetts, United States, ⁵School of Biological Sciences, University of Utah, Salt Lake City, Utah, United States

Strontium isotope ratios ($^{87}\text{Sr}/^{86}\text{Sr}$) of incrementally grown tissues have been used to study movement/migration in extinct megaherbivores. Despite growing interest in this tool, two challenges remain. The first is how the same primary input signal is recovered from different archives, such as tooth enamel and dentin, with different sampling methods. The second is how to account for processes of signal attenuation, such as the slow Sr turnover, enamel maturation, and sample averaging, that influence measured $^{87}\text{Sr}/^{86}\text{Sr}$ in enamel. With the known movement history of a zoo elephant named Misha, we addressed challenge one by measuring $^{87}\text{Sr}/^{86}\text{Sr}$ ratios in tusk dentine and molar enamel using different analytical methods including *in situ* laser ablation (LA-ICP-MS), conventional drilling, and micromilling techniques to inform best sampling practices. We compared $^{87}\text{Sr}/^{86}\text{Sr}$ data from different

substrates using incremental growth rates and timeline reconstructions. LA-ICP-MS mapping showed remarkable spatial $^{87}\text{Sr}/^{86}\text{Sr}$ heterogeneity consistent with enamel apposition geometry. Enamel maturation overprint affects $^{87}\text{Sr}/^{86}\text{Sr}$ in the outer enamel. Conventional drilling and micromilling produced attenuated $^{87}\text{Sr}/^{86}\text{Sr}$ records due to the inclusion of outer enamel and sample averaging. Caution should be taken when interpreting $^{87}\text{Sr}/^{86}\text{Sr}$ data from conventionally drilled enamel, which may bias reconstructions of movement/migration. Our forward model suggests that LA-ICP-MS of the innermost enamel can best recover the primary $^{87}\text{Sr}/^{86}\text{Sr}$ turnover history, but biological turnover of $^{87}\text{Sr}/^{86}\text{Sr}$ is the primary source of input signal attenuation. To address the second challenge, we recommend micro-sampling methods such as LA-ICP-MS to minimize the influences of enamel maturation and sample averaging, and inverse modeling to account for biological turnover. We demonstrated that this combined workflow can quantitatively estimate $^{87}\text{Sr}/^{86}\text{Sr}$ intake histories from molar enamel and tusk dentine. This approach can provide robust interpretations of animal seasonal movement/migration histories and answer new questions about the life history of extinct taxa.

Funding Sources NSF EAR-2202880, DBI-1565128, DBI-1759730, EAR-0819611, BCS-0621542; the University of Utah; the Vetlesen Foundation. The American Museum of Natural History.

Regular Poster Session 1 (Wednesday, October 30, 2024, 4:30 - 6:30 PM)

Mulberry paper and mammoths: A new, reversible method to prepare *Mammuthus columbi* specimens using archival, radiolucent materials at Waco Mammoth National Monument (Texas, USA)

Yann, Lindsey T.^{1,2}, Butler, Dava K.²

¹Waco Mammoth National Monument, National Park Service, Waco, Texas, United States, ²Geosciences, Baylor University, Waco, Texas, United States

Waco Mammoth National Monument preserves ~20 *Mammuthus columbi* alongside fragmented remains of numerous other taxa. Most large fossils are highly fractured due to compaction and/or weathering, and further damage occurred when the bones were left exposed *in situ* for 10+ years before removal in jackets. Periodic flooding caused many bones to fully fracture along planes of weakness and transport down a ravine. Float fragments are organized by year salvaged (if known) to aid restoration. Most specimens remain in jackets, but loose elements are organized by individual mammoth. In the current state of the collection, it is difficult to accurately assign bones to individuals.

Initial research has focused on determining MNI and describing paleopathologies, requiring reconstruction of specimens. The reconstruction of a humerus involved fragments identified in five different museum cabinets, becoming a six-month project. Additional pieces will likely be found as work continues, so reversible techniques are needed. B-72 in acetone is a successful adhesive for smaller specimens, but the 80.5 cm humerus collapsed due to a large, pathological cavity within the diaphysis.

A variety of archival materials were used to create bandages, struts, and shims. Weak connections were reinforced with bandages of 9 or 41 gsm weight Kozo paper impregnated with B-72. Fraying the paper's edges ensured the best contact, and additional layers could be added as needed. The hollow section required weight-bearing internal support. To create struts, Acrylite rods (~1 cm thick) were wrapped in 41 gsm Kozo paper with a ~2 cm allowance on each end, soaked in a 50% B-72 and acetone solution, then allowed to dry. The excess ends

were cut lengthwise into 4 flaps and then flared. A piece of 9 gsm paper was glued on to maintain the flare's shape. The resulting struts, which resembled exploded cigars, could be strategically glued in place within the cavity. Rolled tubes of 41 or 60 gsm Kozo paper impregnated with B-72 served as shims to fill gaps too wide for bandages but too small for struts. The shims were packed into gaps and sealed by layers of 41 gsm Kozo paper.

These methods were successfully used on a humerus, ulna, and radius while maintaining integrity for both X-ray and CT scanning. While this work focused on *M. columbi* limbs, Kozo paper and Acrylite rods can be used as structural struts to prepare large specimens while being both completely reversible and semitransparent in radiographs.

Funding Sources National Park Service; Bryce C. Brown Research Fellowship Program at the Mayborn Museum.

Colbert Prize Session

The oldest fossil peafowl recovered from Late Miocene China

Yu, Tingyu, Li, Zhiheng, Zhou, Zhonghe

Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Extant peafowls (*Pavo* and *Afropavo*), represented by three species, are distantly separated from each other on two continents, presenting a biogeographic puzzle regarding their evolutionary distribution. Given the limited occurrences of peafowl fossils, they may have had a broader distribution in Africa and Euroasia, at least during the Late Neogene. Here, we report a partially associated skeleton representing a new species of peafowl from the late Miocene Liushu Formation in China. Despite being incomplete, the specimen is the first and

earliest articulated skeleton, including both pectoral and pelvic elements found in Asia.

The new specimen can be referred to Galliformes by a well-projected spur on the tarsometatarsus and a crista deltopectoralis cranially deflected on the humerus. Through a comprehensive comparison with living Galliformes skeleton, especially within Phasianidae, multiple shared features of new specimen with extant peafowl are revealed. These include a moderate long and wide processus craniolateralis on the sternum, pronounced triangle-shaped apophysis furculae and a similar length of femur and humerus. The autapomorphies of the new species include wide caudal margin of the sternum and strongly developed fossae pneumotricipitalis on the proximal humerus. Furthermore, phylogenetic analysis using a previously published dataset has grouped the new species within a clade composed of extant peafowls.

The smaller body size and better-developed pneumatic fossae on the humerus indicate its strong flight ability, which might explain the widespread distribution of peafowls in the Neogene. Additionally, the new fossil provides a new calibration for the divergence of peafowls and enhances a strong link between African and Eurasian bird fauna in the late Miocene.

Regular Poster Session 2 (Thursday, October 31, 2024, 4:30 - 6:30 PM)

**Early Paleogene skeletons of
Cypriniformes and Siluriformes (Teleostei)
from the Arabian Carbonate Platform,
Northern Saudi Arabia**

Zalmout, Iyad S.¹, Memesh, Abdullah M.¹, Al-Masary, Abdo¹, Najjar, Mohammed I.¹, Bahameem, Ahmed A.¹, Fadani, Mohammed L.¹, Haptari, Mohammed¹, Friedman, Matt²

¹Survey and Exploration Center, Saudi Geological Survey, Jeddah, Makkah, Saudi Arabia, ²Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor, Michigan, United States

The early Eocene Neotethyan record from the Arabian Carbonate Platform in northern Saudi Arabia is only known from poorly preserved invertebrate remains. Vertebrates from this geological period have never been reported before, reflecting a lack of field information or biased collecting strategies. Here we report the first teleostean assemblage preserved within the upper middle beds of the early Eocene Ru'us Formation exposed 60 km west of At-Timyat town (700 km northwest of Riyadh), in the Northern Borders Province of Saudi Arabia. The Ru'us Formation is a transitional unit from a basal sequence best known as the Umm Radamah Formation (Paleocene-early Eocene), in which the latter was shoaled into isolated environments in lagoonal and supratidal settings resulted in the deposition of the Ru'us Formation. The Ru'us Formation is represented here by a 32-meter-thick isolated hill made of alternations of crystalline limestone, partially dolomitized limestone, silicified limestone, chert, and thin beds of clays and evaporites. Articulated fossils of teleosts were imbedded within two or three white to pinkish, varved and platy limestone horizons weathered at the summit of this hill. Siluriformes and possibly Cypriniformes are the main faunal components, with most specimens ranging in length between a few cm and 15 cm. Most are negative imprints (some with relatively deep cavities) lacking actual skeletal material due to post-depositional geochemical and diagenetic processes; a few specimens retain original skeletal material. Imprints are compressed either dorsoventrally or mediolaterally. Imprints include crania, vertebrae and fins. The siluriform specimens show well-developed fin spines bearing barbs, while other fossils are tentatively identified as cypriniforms based on aspects

of their postcranial anatomy. Although it appears to represent a low diversity assemblage, this new fauna from Saudi Arabia represents an important addition to our understanding of early Eocene fishes from both a paleogeographic and paleoenvironmental perspective.

Funding Sources 1- Survey and Exploration Center, Saudi Geological Survey, Jeddah
2- Department of Earth and Environmental Sciences, University of Michigan, Ann Arbor-Michigan

Colbert Prize Session

First fossil shark rostral node described from Florida: Assessment of taxonomic placement based on internal anatomy

Zbinden, Samantha P.^{1,2}, Riegler, Mitchell^{2,4}, Narducci, Rachel E.², Naylor, Gavin J.³, Bloch, Jonathan I.²

¹Integrative Biology, University of Texas at Austin, Austin, Texas, United States, ²Vertebrate Paleontology, Florida Museum of Natural History, Gainesville, Florida, United States, ³Geological Sciences, University of Florida, Gainesville, Florida, United States, ⁴Ichthyology, Florida Museum of Natural History, Gainesville, Florida, United States

The fossil record of sharks (Chondrichthyes, Elasmobranchii, Selachii) largely consists of enamel-bearing teeth and heavily calcified vertebrae, with most of the skeleton lacking the durability necessary to fossilize. However, hypercalcified rostral nodes (HCRNs), or calcified concretions that surround the cartilaginous tripodal rostrum in shark chondrocrania, have been recovered from the fossil record. HCRNs rarely occur within extant shark taxa, being most often found in lamniforms, with little research available on the comparative morphology or function of this hypercalcification. The infrequency and

unique morphology of tripodal rostra hypercalcification in extant taxa means HCRN fossils are seldom identified accurately or curated in repositories. Here, we describe a fossilized HCRN (UF 550000) collected from the Tamiami Formation (Miocene-Pliocene) in the Peace River, DeSoto County, representing the first description of an HCRN from Florida. UF 550000 was high-resolution X-ray Computed Tomography (CT) scanned and compared to HCRNs of extant taxa and previously described fossil specimens. UF 550000 compares most favorably with that of the extant *Lamna ditropis* (salmon shark) and a previously described HCRN from Lee Creek Mine, North Carolina, which was likened to *Otodus megalodon*. After an extensive review of the fossil shark teeth collected from the Peace River and, more broadly, the Cenozoic of Florida, we confirm that no *Lamna* spp. shark teeth have been recovered, making it unlikely that UF 550000 belonged to *Lamna* spp. In addition, the CT scan data of UF 550000 revealed concentric growth rings, similar to those observed in shark vertebrae, an observation not previously reported in fossil specimens. While likely serving as a minimum age estimate, these rings demonstrate that the Peace River shark was at least six years old. As such, based on tripodal rostra size in extant sharks, UF 550000 is too small to have belonged to a ~six-year-old *O. megalodon*. Of the remaining shark taxa recovered from the Peace River, only extant *Isurus* spp. are known to have an HCRN. However, CT scans of the first *Isurus oxyrinchus* growth series show that UF 550000 is morphologically incongruent with that of an *Isurus* taxon. UF 550000, in combination with the Lee Creek Mine HCRN and two others from Florida, demonstrates the possible occurrence of a cryptic and undescribed shark taxon or the plasticity of hypercalcification in the tripodal rostra of sharks.

Funding Sources Funding provided by the Florida Museum Undergraduate Internship Program and an Endowment made to the program of Vertebrate Paleontology by Wright, Tucker, and Fite.

Technical Session 3: Sauropodomorpha
(Wednesday, October 30, 2024, 1:45 PM)

A new non-sauropodan sauropodiform specimen from the Lower Jurassic of Yuanmou County, Yunnan Province, China

Zhang, Qian-Nan, You, Hai-lu

Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China

The Lower Jurassic of Yunnan Province in southwestern China has yielded a diverse sauropodomorph assemblage, of which most common dinosaurs belong to Massospondylidae and early-branching Sauropodiformes. However, the Lower Jurassic of Yunnan, even China, has fewer well-provenanced associated or articulated late-branching sauropodiforms that are key to understanding the evolution of morphological and biological innovations of Sauropoda. Here we describe a new specimen excavated from the Lower Jurassic Fengjiahe Formation of Chuxiong Basin (age is equivalent to Lufeng Formation of Lufeng Basin), whose remains consist of a partially preserved skull with complete lower jaw, and associated postcranial skeleton of a large, skeletally mature individual.

We have used comparative anatomy and phylogenetic analyses to investigate the new specimen. The new specimen is greatly different from other non-sauropodan sauropodomorphs from the Lower Jurassic of Yunnan Province through morphological and comparative studies. Our preliminary phylogenetic analysis recovers the new specimen as a member of late-branching

sauropodiform, adjacent to the base of node Sauropoda. The new specimen is close to *Gongxianosaurus* that was collected from the Lower Jurassic Ziliujing Formation (age is equivalent to Lufeng Formation and Fengjiahe Formation) of Gong County in Sichuan Province, but the specimen of the latter was lost due to lack of effective protection. However, it is clear that the new specimen can be distinguished from *Gongxianosaurus* based on both cranial and postcranial characters, and the two fossil sites are very far apart, more than 700 kilometers. So the new specimen is believed to represent a new taxon, the latest record of non-sauropodan sauropodiforms from Yunnan Province, and reflecting a transitional stage in the evolution towards Sauropoda spanning the Early to Middle Jurassic.

Funding Sources This research was supported by the Beijing Natural Science Foundation (5224037) and the National Natural Science Foundation of China (42288201, 42372030).

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

New materials of *Propterodon* (Hyaenodonta: Hyaenodontidae) from the middle Eocene of the Erlan Basin of Inner Mongolia, China

Zhang, Xinyue^{1,3}, Bai, Bin¹, Wang, Yuan-Qing^{1,3}, Tseng, Z. Jack²

¹IVPP, Chinese Academy of Sciences, Beijing, China, ²University of Chinese Academy of Sciences, Beijing, China, ³UC Berkeley, Berkeley, California, United States

Propterodon is a genus of hyaenodont distributed in the middle Eocene of Asia and North America. Recent phylogenetic analyses suggest that *Propterodon* occupies the basal position of Hyaenodontinae, but usually appears as a polyphyletic genus. Field work

has been carried out since 2004 in the Erlian Basin of Inner Mongolia, China by IVPP crews, resulting in the discovery of many Paleogene fossil mammals, including creodonts. Here we report some new material of *Propterodon*, which comprises a broken cranium, some incomplete maxillae and several mandibles of both adults and juveniles, from the middle Eocene of the Irdin Manha Formation in Irdin Manha, Huheboerhe, Chaganboerhe and Duheminboerhe area. It is the first report of a well-preserved cranium and maxillae of *Propterodon*, which provides more important and previously unknown information of this genus. *Propterodon* is a medium-sized hyaenodont with dental formula of 3.1.4.3/3.1.4.2. The morphology of its cheek teeth indicates the tendency of hypercarnivorous adaptation: the high crown of its carnassial M2 and m3, reduced metaconid and talonid on m1-m3, much reduced protocone on M1-M2, shearing facets for slicing flesh on M1-M2 and m1-3. However, the occlusal wear facets on P4-M1 and p4-m2 suggest that *Propterodon* could also consume hard materials. Its cranium reveals many typical characters of Hyaenodontidae, including the presence of well-developed postorbital process, the suture between the frontal and parietal, and the constriction before the braincase. In addition, the eruption sequence of the lower teeth in *Propterodon* can be inferred from juvenile materials. Compared with the eruption sequence of the more derived relative *Hyaenodon*, *Propterodon* resembles Asian and European *Hyaenodon* in having the eruption of p4 later than p3 or m3 eruption rather than North America ones, indicating that *Propterodon* could either be closer to Asian and European *Hyaenodon* than North America forms, or there may be developmental convergence in the former two taxa. Based on the phylogenetic position of *Propterodon*, it is also suggested that the later eruption of p4 could be a plesiomorphic character of Hyaenodontinae.

Funding Sources Funding for this work was received from National Natural Science Foundation of China 42272011.

Technical Session 19: Lepidosauria (Saturday, November 2, 2024, 8:00 AM)

Tylosaurine diversity informed by morphological variation in extant *Varanus*

Zietlow, Amelia R.^{1,2}

¹Richard Gilder Graduate School, New York, New York, United States, ²American Museum of Natural History, New York, New York, United States

Phylogenetic hypotheses of fossil organisms are potentially influenced by the unintentional inclusion of ontogenetically immature specimens. Conversely, *a priori* decisions of taxon or specimen exclusion on the basis of perceived ontogenetic differences can be equally confounding. Recent work synonymized the tylosaurine mosasaur *Tylosaurus kansasensis* with the sympatric *T. nepaeolicus* because it purportedly possesses immature characters; I test this hypothesis informed by embryology of extant reptiles and a dataset of over 500 mosasaur and varanoid specimens. Paleobiologists are limited to making species delimitations based on skeletal morphology. Ideally, these are informed by comparison to an extant relative, as the null hypothesis is that extinct taxa were subject to the same developmental patterns as extant taxa and followed a conserved sequence of major morphogenic events. To understand the biological underpinnings of mosasaur variation and test the hypothesis that differences between *T. kansasensis* and *T. nepaeolicus* are ontogenetic, I review prior work on skeletal ontogeny in extant varanoids and other lizards, augment with my own observation of extant *Varanus*, and make comparisons to

patterns seen in specimens referred to the better-sampled *T. proriger*.

I find that extant lizards do not undergo the kinds of ontogenetic changes to skeletal morphology previously proposed in *Tylosaurus*, and some (e.g., migration of parietal eye) are biologically impossible. In extant taxa, diagnostic features are present at all stages of post-hatching ontogeny, and minor intraspecific differences are attributable to bone growth. *T. proriger* follows this trend: I identify a subset of specimens that differ consistently from the holotype paradigm across a range of sizes, indicative of a new species. The quadrate bone is preserved in both *T. nepaeolicus* and *T. kansasensis* holotypes and, despite being the same size, differs in each with respect to several features, including the shape of the suprapedial process. Like in *T. proriger*, I find that other features previously attributed to ontogeny are consistent across a range of sizes, and identify a third group of specimens likely representing another cryptic species overlooked in prior webs of ontogenetic hypotheses. I conclude that *T. kansasensis* is a valid species and identify at least two new unnamed *Tylosaurus* species, a result that is indicative of underestimation of mosasaur diversity broadly.

Funding Sources This work is supported by the National Science Foundation Graduate Research Fellowship Program under Grant No. 1938103 and the Richard Gilder Graduate School.

Regular Poster Session 4 (Saturday,
November 2, 2024, 4:30 - 6:30 PM)

Flying through the air with the greatest of ease? Evaluation of glide capability in basal maniraptoran theropods

Zoller, Norah¹, Miller, Kierra¹, Habib, Michael B.³, Larsson, Hans C.², Dececchi, Thomas A.¹

¹Biology, Dakota State, Vermillion, South Dakota, United States, ²UCLA, Los Angeles, California, United States, ³McGill University, Montreal, Quebec, Canada

Paravian theropods, bats and pterosaurs are the only three lineages of tetrapods known to have evolved powered, flapping flight. A much more common form of aerial locomotion is gliding flight or parachuting having evolved several dozen times over the past 250 million years including in the scansoriopterygians, a unusual clade of theropods whose phylogenetic position is uncertain. Given its frequent occurrence and relative ease of achievement, gliding has often been suggested as a prerequisite intermediate on the path from terrestrial non-avian theropods to flying early birds followed by repeated occurrences of derived flightlessness. If accurate, previous suspected “stepping stones” to powered avian flight are actually vestigial remnants of a gliding ancestor. Here we investigate the claim that gliding flight using a feathered aerofoil can be plausibly reconstructed outside of Paraves and could this be a crucial intermediate stage explaining the origin of the avian wing. This type of wing is fundamentally different from the membrane based one used scansoriopterygians and extant gliders, suggesting that it marks a different bauplan for making a wing. In lineages outside scansoriopterygians, patagia are relatively reduced, thus indicating that feathers not membrane was the main lift generating surface. Using feathered wing area estimates based on either a maniraptoran (*Caudipteryx*) or paravian (*Anchiornis*) model we modeled over 50 specimens of small coelurosaur theropods (femur length less than 165 mm with a reconstructed mass or 7 kg or less). We find that wing loading values greatly exceed those of any known extant or extinct gliding tetrapod until we reach Paraves, and then is still at the upper end of the range for most taxa within that clade. Even assuming a parachuting behavior with a feathered wing

would be unlikely in non-paravians taxa or those above 3 kg. Descent velocity estimates for non-paravian taxa are exceedingly high, often greater than 20 m/s. Even accounting for estimates of different atmospheric densities in the Late Jurassic and Early Cretaceous this is not enough to overcome these deficiencies. These findings coupled with previous evidence for the lack of arboreal features seen in non-scansoriopterygians coelurosaurs suggest gliding was not a pathway to flapping flight in this lineage. Thus, patterns in feathering and wing structure present in basal Maniraptora likely had other non-volant drivers for their origin and evolution.

Technical Session 14: Paleobiology:
Evolution, Ecosystems, Taphonomy, & Traces
(Friday, November 1, 2024, 1:45 PM)

Documenting tiny feeding traces on small bones from vertebrate microfossil bonebeds, Upper Cretaceous Judith River Formation, Montana

Zugschwert, Lily, Luft, Marisa, Curry Rogers, Kristina, Rogers, Raymond

Geology Department, Macalester College,
Saint Paul, Minnesota, United States

Small (mm- to cm-scale) vertebrate fossils recovered from vertebrate microfossil bonebeds (VMBs, also known as microsites) yield novel insights into the faunal composition and paleoecology of ancient vertebrate communities and often afford the only record of small-bodied taxa such as mammals, lizards, and amphibians. In this study we analyzed a collection of vertebrate microfossils from the Upper Cretaceous (Campanian) Judith River Formation (JRF) of north-central Montana with the goal of documenting surface modifications, including gouges, pits, punctures, linear tooth marks, gnaw marks, and edge punctures. These surface modifications yield potential

evidence of predation and scavenging and are herein collectively referred to as feeding traces. Several VMBs in the JRF are included in this on-going study of ancient feeding ecology, and all have yielded samples that include hundreds to thousands of resilient bioclasts that accumulated in lacustrine paleoenvironments. We studied ~2,500 specimens from three sites using standard light microscopy, and ongoing work will employ scanning electron microscopy to further characterize the nature of the traces. Data indicate that feeding traces are abundant on both cm-scale and tiny mm-scale elements. Traces are notably common on fragments of long bones, and they have also been documented on vertebral centra and ossified tendons. Approximately 29% of the sample exhibits modifications consistent with feeding, and the majority of these traces (~65%) are in the tiny mm size range, which is suggestive of modification driven by very small-bodied scavengers and predators. Most traces are simple linear grooves or pits, but some traces exhibit distinctive patterning that may make it possible to identify the trace makers. Some bones and gar scales in the sample also exhibit evidence of mastication, ingestion, and digestive corrosion. Potential predators/scavengers in the Judith River ecosystem that could generate the feeding traces under investigation include theropod dinosaurs (large and small), crocodiles, champsosaurs, gar to minnow-sized fish, amphibians, and invertebrates (e.g., crayfish). Future work will focus on identifying diagnostic criteria that may make it possible to link certain modifications to specific feeding behaviors and taxonomic groups. This ongoing taphonomic study promises to shed new light on Late Cretaceous freshwater paleoecology.

Funding Sources Funding for this project provided by the Keck Geology Consortium, National Science Foundation, Macalester College, and the David B. Jones Foundation.