Technical Session XII (Friday, August 25, 2017, 11:15 AM)

EARLIEST EVIDENCE OF TAIL REGENERATION IN A FOSSIL SQUAMATE

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Caudal autotomy, the ability to shed the tail, is common among lizards as a defense mechanism to escape predation. Caudal autotomy is a basal synapomorphy of Lepidosauria. About two-thirds of extant lizard families include species that retain the ability. Many can also regenerate the tail after shedding it. The oldest known fossil evidence of caudal autotomy in a reptile comes from early Permian captorhinids. Here I report the earliest and only documented evidence of caudal autotomy for Squamata, in a glyptosaurine specimen from the early middle Eocene Bridger Formation in the Bridger Basin of southwestern Wyoming.

I identified signs of caudal autotomy in this specimen based on disproportions in an intact 1.5-cm segment of the tail. The segment includes *in situ* imbricate osteoderms, a rare find. Two rings of larger osteoderms surround the anterior half, and three rows of osteoderms that are 50% smaller surround the posterior half. Autotomized tails in extant armored lizards also have smaller osteoderms on the regenerated portion of the tail, even when it has regrown to its full length. In the glyptosaurine specimen, the tail diameter past the breakage point is only 65% that of the original half. Extant lizards also exhibit an abrupt decrease in diameter between the original and the regenerating portions of the tail.

The specimen is assigned to Glyptosaurinae based on a characteristic bumpy surface texture that is present on the osteoderms. The specimen also includes a partial parietal with a similar texture, and right and left mandibles with square-cusped teeth that are diagnostic of Glyptosaurinae. The age and locality of the specimen warrant assignment to the common Bridgerian genus *Glyptosaurus*. Based on mandible length, I estimate that this individual had a snout-vent length of about 220 mm. This is only 33% of the maximum SVL that I have estimated for other individuals in this genus. This specimen represents either a subadult or a smaller species of *Glyptosaurus.*

Computed tomographic scanning reveals diagnostic morphology on the terminal caudal vertebra preserved within the osteoderms. The fracture plane runs between a pair of distally converging transverse processes. A medial groove present on the ventral side deepens toward the chevrons, which are fused to the vertebra. These features are consistent with extant anguid lizards, supporting placement of the Paleogene lizard group Glyptosaurinae within the extant anguid lineage.

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

INTEGRATING FILM, THEATER, AND DESIGN APPROACHES WITH PALEONTOLOGICAL PERSPECTIVES TO EXPLAIN SCIENCE

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Communication experts agree that the most effective way to engage an audience with new information is to frame the content within a story. Studies show that audiences process and recall new information more efficiently if the content is structured as a story. Stories also humanize the storyteller, which can help scientists counter pervasive public misperceptions that scientists are non-relatable. Effective storytelling benefits from narrative training that is often not included in science communication workshops.

In consultation with artists and educators at an animation studio, a museum, a data visualization company, and a theater company, I developed a series of workshops that adapt story strategies from film, theater, and graphic design for science communication. These workshops aim to 1) help scientists better articulate their research and career motivations, and 2) offer scientists practical tools to make their work accessible and engaging for any audience.

The first workshop unit focuses on principles of story development (e.g., character dynamics, conflict, stakes, and theme), applied to several common scientific narratives. The second unit explores methods of translating a science story, including data, into visual language through strategic use of color, shape, layout, and visual cues. Each unit includes hands-on exercises that help scientists translate their research into a cohesive and accessible presentation.

This approach is particularly effective for communicating historical sciences such as paleontology. Paleontological studies fit well into narrative frameworks because they follow unusual characters; chronicle dramatic events and changes; and evoke wonder in reconstructing lost worlds.

I have run workshops at university campuses for groups of 14 to 175 participants, and at a scientific meeting for a group of over 350 participants. The majority of participants in each workshop were graduate students in STEM degree programs. In post-workshop surveys, 93% of respondents indicated that they would use story strategies in future scientific presentations; 91% said that they would recommend the workshop to colleagues. Recommendations for improvement included 1) tools for using narrative structure in manuscripts and grants, and 2) strategies for addressing specific audiences. I will address these topics and continue to beta-test material in workshops scheduled at university campuses, museums, and scientific meetings over the next year. Ultimately, I plan to create an online platform for this material.

Technical Session VI (Thursday, August 24, 2017, 12:00 PM)

HETEROGENEOUS EVOLUTIONARY RATES IN LATE PALAEOZOIC-EARLY MESOZOIC AMNIOTES

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One of the greatest turnovers in vertebrate history was the replacement of synapsid/parareptile-dominated faunas by archosauromorph-dominated faunas in the Triassic. This turnover was presumably mediated by the end-Permian mass extinction and its key outcome was the rise of the dinosaurs. All three groups were characterized by a huge variety in body size, spanning several orders of magnitude. Body size is considered a crucial biological trait as it correlates with physiology, life history and ecology. The capability of a clade to make rapid changes to its body size range and associated ecological niches could therefore be of fundamental importance for its success.

We present the first comprehensive exploration of body size evolution in all major amniote clades during the Permo-Triassic (PT). Using phylogenetic comparative methods that allow for rate variation we examined evolutionary rates in parareptiles, archosauromorphs and therapsids.

Models that allow for rate variation between different branches outperform homogeneous rate models for Parareptilia. Early diverging parareptiles experienced low evolutionary rates but rates increased to normal with the emergence of the first Ankyramorpha, as expected from a Brownian model of evolution. Evolutionary rates accelerated further with the appearance of the pareiasaurs and peaked within procolophonids at the PT boundary. Rates then plateaued in the Triassic, being an order of magnitude higher than normal rates.

A heterogeneous rate model is also favoured for Therapsida. Early diverging members of the clade were characterized by rates close to normal background. Rates increased substantially during the late Permian, reaching a peak before the Permo-Triassic mass extinction event (PTME). Middle to Late Permian members of the speciose clade Dicynodontia exhibited considerably higher rates than other contemporary therapsids. Following the PTME, rates remained high, albeit lower than just before the PT boundary.

Conversely, a homogeneous rate model is favoured for archosauromorphs. This indicates that elevated evolutionary rates were not necessary for Archosauromorpha to replace Therapsida as key players in terrestrial ecosystems. The results further suggest that elevated evolutionary rates do not necessarily confer long-term success of clades, as shown by both parareptiles and therapsids. Short-term diversification events, however, appear to be associated with increased evolutionary rates.

Grant Information:
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Poster Session II (Thursday, August 24, 2017, 4:15 – 6:15 PM)

FIRST FOSSIL OCCURENCES OF THE *SPHENOMORPHUS* SPECIES GROUP (SQUAMATA; SCINCIDAE; LYGOSOMINAE) FROM THE LATE OLIGOCENE NAMBA AND ETADUNNA FORMATIONS OF SOUTH AUSTRALIA

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Scincidae (skinks) is represented by an impoverished fossil record in Australia. Despite the incredible diversity and abundance of extant skinks on the continent, fossil samples are surprisingly rare. Therefore, any fossils of their early evolution on the continent would be of great benefit to Australian paleoherpetology. Previously, the only extinct genus of Scincidae in Australia was represented by the *Egernia* species group skink *Proegernia palankarinnensis* of the Late Oligocene Etadunna Formation. Here, we detail three mandibular elements, all dentaries, two are from the Namba Formation of the Frome Sub-basin and the other is from the Etadunna Formation of the Tirari Sub-basin. Albeit incomplete, the sole character diagnosing these skinks as pertaining to the *Sphenomorphus* group is the presence of an open Meckelian groove, which is closed in the *Egernia* and *Eugongylus* species groups. A phylogenetic analysis via maximum parsimony shows that the two Namba skinks are sister taxa relative to the Etadunna specimen, which is a sister taxon to the Namba skink clade. We can determine that the two Namba skinks are at least different species, but whether they are different genera is still to be determined. The Etadunna *Sphenomorphus*-type skink (as is *Proegernia*) is from the Minkina Local Fauna (L.F.), which is the oldest and stratigraphically lowest local fauna from the Etadunna Formation. The two Namba *Sphenomorphus*-type skinks are both from the Pinpa L.F. which is the oldest and stratigraphically lowest local fauna from the Namba Fm. The Minkina L.F. and Pinpa L.F. are considered to be biostratigraphically correlated with each other in age, latest Oligocene (ca. 26 million years ago). These three new taxa, plus *Proegernia* are the oldest fossil skinks known from Australia, and their age is consistent with divergence times for the radiation of both the *Sphenomorphus* species group and the *Egernia* species group at 25 mya based on DNA sequence data of extant skinks.

Technical Session XV (Friday, August 25, 2017, 3:15 PM)

A NEW, EARLY RELATIVE OF SABER-TOOTHED SPARASSODONTS (METATHERIA: SPARASSODONTA: THYLACOSMILIDAE) FROM THE EARLY OLIGOCENE CACHAPOAL FAUNA, ANDEAN MAIN RANGE, CENTRAL CHILE

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Thylacosmilid sparassodonts are among the most iconic groups of endemic South American Cenozoic mammals due to their distinctive morphology and convergent resemblance to saber-toothed placental carnivorans. However, the early evolution of thylacosmilids and their relationships to other sparassodonts are poorly known, as this group is primarily represented by stratigraphically young, specialized taxa such as *Thylacosmilus*, *Anachlysictis*, and *Patagosmilus* from the mid-to-late Miocene and Pliocene. Here, we describe a new sparassodont specimen, SGO-PV 3490, from the Cachapoal Fauna of the Abanico Formation in central Chile that likely dates to the early Oligocene (?Tinguiririan SALMA). This specimen represents a senescent individual of a new, undescribed taxon that, based on direct observation and CT imaging, exhibits a combination of features resembling both thylacosmilid and proborhyaenid sparassodonts. Thylacosmilid-like features include: (1) an unfused symphysis (reversal from condition in "proborhyaenids"); (2) lack of longitudinal ridges on the roots of the canines (reversal, derived for thylacosmilids among borhyaenoids); (3) reduction of median canine sulci (reversal); (4) upper canines that are relatively laterally compressed compared to almost all other sparassodonts (derived); and (5) a short rostrum with a deep maxilla and shallow dentary (derived). "Proborhyaenid"-like features include: (1) three upper and lower premolars, with replaced DP3 (primitive); (2) lack of a mandibular flange (primitive);

(3); retention of a sulcus on the lingual face of the upper canines (derived for "proborhyaenids"); and (4) possibly open-rooted lower canines (derived for "proborhyaenids"). In particular, this specimen resembles IGM 251108, a putative basal thylacosmilid from the middle Miocene of La Venta, Colombia, in having more vertically implanted upper canines than other sparassodonts. Phylogenetic analyses recover the Chilean specimen as the sister taxon to the included thylacosmilids, with traditionally recognized "proborhyaenids" representing a paraphyletic series of successive outgroups to this group. These results support prior hypotheses of a close relationship between thylacosmilids and "proborhyaenids" and the paraphyly of "Proborhyaenidae".
Grant Information:
This research is supported by the National Science Foundation (DEB-0513476) and the Frick Fund, AMNH

Colbert Prize (Wednesday - Thursday, August 26-24, 2017, 4:15 – 6:15 PM)

INFERRING DIETARY ADAPTATIONS OF PALEOCENE SMALL MAMMALS FROM WALBECK (GERMANY) BY MOLAR RELIEF INDEX

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Walbeck is one of the most important Paleocene vertebrate localities in Europe and the only one from Germany. The karstic fissure filling was discovered in 1939 and yielded over 6000 mammalian remains of 16 different species from seven orders. The Walbeck assemblage is characterized by a low faunal diversity with few dominant species which indicate an open and unstable environment.

In order to infer dietary adaptations for the Walbeck small mammals the size-independent relief index was calculated for the molar dentition. The relief index is an indicator for the crown complexity and is calculated by dividing the 3D crown surface area by the 2D crown base area.

For this study, eight species from the following families were studied: Pseudorhyncocyonidae, Cimolestidae, Louisinidae, Adapisoricidae, Plesiadapidae, Adapisoriculidae. Their dentitions range from conservative to slightly modified tribosphenic morphologies. Despite some reworking during the Rupelian Transgression in the Oligocene, the majority of teeth from Walbeck is not water-worn and well suitable for functional analyses of the occlusal surface. Micro-CT scans of second lower molars (m2) were used to generate three-dimensional dental surface models for the calculation of the relief index.

The second molars (m2) of the Walbeck cimolestids show higher relief index values than the second molars of the other families, which all fall within the same range. A comparison with extant bat taxa with known dietary preferences suggests an insectivorous diet for the Walbeck cimolestids because high relief index values are associated with insectivory. The other studied taxa fall within the range of frugivorous and omnivorous bats. In comparison with previously published data on plesiadapids from other localities, *Plesiadapis walbeckensis* shows relatively low relief index values, which may reflect its the basal phylogenetic position. The open habitat which is assumed for Walbeck, rather suggests an opportunistic omnivorous diet for most taxa than a strictly frugivorous nutrition.

Grant Information:
DFG-Project number: MA 1643/21-1

Poster Session I (Wednesday, August 23, 2017, 4:15 – 6:15 PM)

TRACKING THE LAST MEALS AND MOVEMENTS OF AN ADOLESCENT *MAMMUTHUS COLUMBI* WITH STABLE ISOTOPE ANALYSIS OF ENAMEL AND VEGETATION

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Waco Mammoth National Monument (WMNM) is a Pleistocene vertebrate site in Waco, Texas. There are at least two bone-bearing strata at the site; the younger dates to ~53 ka and the older to ~67 ka. This older strata dates to Oxygen Isotope Stage IV (OIS IV) and is of primary interest, as it contains the remains of at least 16 female or juvenile Columbian mammoths (*Mammuthus columbi*) that died in a single event. It is the only known nursery herd of *M. columbi*.

Research at the site has focused on determining the kill mechanism or on using data from the site to shed light on Texas' climate during OIS IV. Less work has been done on the migratory and dietary habits of the herd. Stable isotope analyses were done on bulk samples of mammoth enamel from the site, but this produced time-averaged results that made detecting seasonal variation impossible.

This limitation can be avoided by using serial sampling. Cheek teeth in mammoths grow in height by accreting enamel over up to 15 years. By taking minute samples of aprismatic enamel along the height of a tooth plate, changes in $\delta^{13}C$ and $^{87}Sr:^{86}Sr$ reflect changes in the diet and location of the mammoth respectively. $\delta^{13}C$ reflects diet because plants using different photosynthetic pathways discriminate differently between carbon isotopes. This carbon is incorporated into structural carbonate in enamel. $^{87}Sr:^{86}Sr$ ratios reveal location because they vary in plants depending on the age and lithology of parent material in the soil where the plant grows. This Sr is also incorporated into the enamel's structural carbonate. $\delta^{18}O$ values reflect the evaporative balance the mammoth's water source. The balance varies over the course of the year, and is recorded in the enamel. Together these analyses reveal what the mammoth was eating, in what place, and in what season.

We applied this sampling and analysis strategy to a tooth from the adolescent mammoth "N" from the nursery herd at WMNM. Twenty-seven samples were taken from a single plate of this tooth. Each sample was 1.59 mm in diameter, producing a sample that time-averages over 43 days. The length of enamel measured was 89.5 mm, representing 6.62 years of tooth growth. The samples thus represent 43 day periods every 49 days.

The $\delta^{18}O$ calendar from the tooth roughly conforms to the time of deposition predicted from estimated growth rates. Changes occurred in the C3:C4 balance over the period measured, but correlation with seasons was not obvious. $^{87}Sr:^{86}Sr$ showed limited movement over the period measured, which is in keeping with what has been hypothesized by other researchers.

Technical Session XIX (Saturday, August 26, 2017, 2:30 PM)

BONE MICROSTRUCTURE AND HETEROCHRONY SHAPE FISH-EATING HABITS IN SPINOSAURS

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Spinosaurus aegyptiacus is one of the most enigmatic dinosaurs. The recent description of a neotype specimen provided new insights into the anatomy and ecology of this bizarre giant theropod. Here, we present novel research on the osteohistology of *Spinosaurus*. Several postcranial elements were sectioned: a neural spine, dorsal ribs, the fibula and the femur. The increasing organization of vascular canals toward the outer surface, the presence of Haversian systems, the decreasing spacing between LAGs and the absence of an EFS are observed in all of the sectioned bones. This is consistent with a sub-adult ontogenetic stage and provides an additional line of evidence, demonstrating that the neotype specimen represents a single individual of *Spinosaurus*, a taxon characterized by a shortened femur and reduced hind limbs.

Bone density analyses were performed to compare ecological adaptations in *Spinosaurus* and related megalosauroids to those in extant taxa. Using a broad dataset of 60 archosaur taxa, including extant crocodilians, non-avian dinosaurs and extant birds, the compactness of long bones was used as a proxy for ecological inference in extant and extinct taxa. Long bone compactness was quantified using Bone Profiler. Paleoecological profiles for different taxa were based on similarities in bone density values; these were assessed through morphometrics using R. *Spinosaurus* clusters with extant penguins, a result that is consistent with previous conclusions on its semiaquatic habits.

Finally, the role of heterocrony in patterning the anatomical characteristics present in spinosaurids was examined in the light of osteohistological data. Previous studies suggest that heterocrony plays an important role in secondary aquatic adaptations based on anatomical observations: it has been suggested that ichthyosaurs and tanystropheids underwent paedomorphic shifts during their progressive adaptation to aquatic lifestyles. We performed 2D geometric morphometrics on non-avian theropod skulls using 45 landmarks. We found a progressive peramorphic trend in Megalosauroidea shaping the crocodile-mimic skull morphology adapted for fish-eating, contrary to other clades of tetrapods with secondary adaptations for an aquatic or semiaquatic lifestyle. Moreover, we conclude that peramorphosis is a general driver for gigantism in Theropoda.

Romer Prize Session (Thursday, August 24, 2017, 11:15 AM)

LARGE VOLCANIC ERUPTIONS DRIVE LOCAL MAMMALIAN COMMUNITY CHANGE

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It is clear that ecosystems are devastated after a volcanic eruption coats the landscape with a layer of ash; however, the ecological recovery of mammalian communities after eruptions is poorly understood. Volcanic eruptions vary with magnitude and type and only a fraction of them have been analyzed for effects on mammalian communities. To better understand mammalian community recovery, I investigated how species richness, evenness, and similarity change across volcanic boundaries. Three volcanic systems were studied to investigate the impact of the size of eruption. The 1980 Mount St. Helens eruption sheds light on short term recovery after a moderate sized eruption. The 1914-1917 Mount Lassen eruption permits an analysis of long-term impacts from a relatively small eruption. The Picture Gorge Ignimbrite (28.7 Ma) within the Turtle Cove Member of the John Day Formation was a supervolcanic eruption associated with the Yellowstone hotspot. Vouchered occurrence data of modern and fossil mammals was used to calculate Chao richness, Shannon and Hurlburt indices of evenness, and for chord distance analysis of similarity. Richness and evenness remains unchanged in both Mount Lassen and the Picture Gorge Ignimbrite. Mount St. Helens saw an immediate drop in richness followed by an increase over five years to pre-eruptive levels, resembling succession. Chord distance analysis suggests no long term change in the Mount Lassen fauna, while the pre and post Mount St. Helens fauna are different from one another, with the post fauna being more similar to the fauna of neighboring regions. The pre and post Picture Gorge Ignimbrite faunal assemblages are also distinct. The pre-eruptive fauna shows more affinities for closed habitats while the post-eruptive fauna shows greater affinity for open habitats. It is clear from my results that larger eruptions tend to have a greater impact on mammalian community recovery than smaller eruptions. While richness and evenness may not change across volcanic boundaries, the species and their relative abundances do. It is clear that the size of the eruption matters when it comes to mammalian recovery, but ultimately, mammalian populations are robust and the presence of refugia is important for recolonizing devastated areas.

Preparators' Session (Thursday, August 24, 2017, 11:15 AM)

GEOCHEMICAL 'FINGERPRINTING' OF GOBI DINOSAURS; A TOOL FOR REPATRIATING POACHED DINOSAUR FOSSILS IN MONGOLIA

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Illegal poaching of vertebrate fossils from the well-known Cretaceous exposures in southern Mongolia has now reached epidemic proportions. Although a number of valuable specimens have now been repatriated, the question of provenance remains paramount for both scientific and legal reasons. To address this issue, we investigated the geochemistry of the Baruungoyot and Nemegt formations (both sediments and associated fossils), using X-ray fluorescence (XRF) in order to ascertain possible geochemical 'fingerprints' that could be used to differentiate formations and reassign poached specimens. Field data are representative of several localities across the Nemegt Basin (Nemegt, Khulsan, Altan Uul I-IV, Tsagaan Khushuu, Ulan Hushu). Additional XRF data were acquired from specimens housed at the Mongolian Palaeontology Centre in