ONTOGENY OF THE EARLY TRIASSIC THRINAXODON LIOHRUS (THERAPSIDA, CYNODONTIA). DENTAL MORPHOLOGY AND REPLACEMENT ABDALA, Fernando, Bernard Price Institute for Palaeontological Research, Johannesberg, South Africa; JASINSKI, Sandra, Department of Zoology, Cape Town, South Africa; FERNANDEZ, Vincent, Bernard Price Institute for Palaeontological Research, Johannesberg, South Africa

The non-mammalianiform cynodont Thrinaxodon liohurus is one of the most common representatives of the post-Norian-extinction fauna of the Lystrosaurus Assemblage Zone of the South African Karoo Basin. Thrinaxodon is also one of the best known Triassic cynodonts with a well-known cranio-dental and postcranial anatomy. Here we present a detailed study on variation of the dental morphology and replacement in Thrinaxodon liohurus. For this study we analysed five specimens ranging from 37 to 87 mm in skull length using micro computed tomography (μCT) scanning techniques, which were supplemented by detailed anatomical analysis of 41 specimens with a basal skull length of approximately 30 mm to 96 mm. Our results confirm the alternate replacement of the postcanines and the posterior migration of the postcanine series (including the loss without replacement of the anteriormost postcanines). Even when most of the observations point to a posterior-to-anterior replacement wave, the evidence is not clear-cut. A new classification was designed to describe accurately the morphology of postcanines, taking into consideration the number of sectorial cusps, presence and pattern of the lingual cingulum, and presence of labial cingulum cusps. The lower postcanines are clearly more complex (and more numerous) than the upper postcanines; only the lower postcanines have more than three sectorial cusps and a cingular collar on the lingual margin. Complexity of the postcanines increases from the smallest individual to specimens of 75 mm of skull length, but complexity decreases in larger specimens. On several specimens, erupting canines can be observed through the replacement pit while the complexity of the replacement pattern was assessed using X-ray micro-computed tomography. The virtual extraction of functional replacement teeth permitted us to conclude that in most of the cases, the upper canines were replaced anteriorly while lower canines were replaced posteriorly. The presence of two simultaneous replacements of the upper canine tooth was observed in two small juveniles, suggesting a higher rate of canine replacement at younger age. Incisors also had a sequential replacement pattern, and more replacement teeth were present in medium-sized individuals.

CROCODYLIFORM DIVERSITY FROM THE EARLY CRETACEOUS TRINITY GROUP (APTIAN-ALBIAN) OF TEXAS, WITH THE DESCRIPTION OF NEW TAXA FROM THE TWO MOUNTAINS FORMATION ADAMS, Thomas L., Natural Sciences Department, San Antonio College, San Antonio, TX, United States

Crocodyliforms have been recognized as some of the most abundant tetrapods in the Early Cretaceous Trinity Group (Aptian–Albian) of Texas. However, their remains have typically been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequately described, been fragmentary, with several tooth morphologies and osteoderms being assigned to Pholidosauridae, Aetosauridae, and Goniopholididae. Most are inadequate...
the following two crania: Alphananosmilus jourdani IPS49575 from Abobador de Can Mata sector C8-B/C (Vallés-Penedès Basin, Spain; ca. 11.5 Ma, Aragonian, Middle Miocene), housed at the Institut Català de Paleontologia Miquel Crusafont (Spain); and Barbourofelis morrisi AMNH FAM 61870 from the Leptacanthus Quarry (Merritt Dam Member, Ash Hollow Formation, Nebraska, USA; ca. 11.5–8.5 Ma, Clarendonian, Middle to Late Miocene), housed at the American Museum of Natural History (AMNH, USA). On morphologic grounds, Alphananosmilus and Barbourofelis differ from extant felids and resemble the more primitive barbourofelid Sansanosmilus in several features, such as displaying two main neocortical sulci (coronolateral and suprasylvian). Moreover, compared to extant felids, the two barbourofelids studied here display a higher rhinal fissure and less developed simoid gyri, indicating the possession of lower auditory abilities and a smaller portion of the neocortex devoted to processing postcranial somatic and motor inputs. Finally, our brain volume measurements (78 cm³ for A. jourdani and 112 cm³ for B. morrisi) and the body mass estimates based on the length of these crania (46 and 61 kg, respectively) confirm that barbourofelids displayed a lower degree of encephalization compared to both carnivores and felids. Barbourofelis especially contrast with machairodontines, which appear slightly more encephalized on average than extant felids. Overall, our results confirm the hypothesis that barbourofelids differed in neuroanatomical traits and associated cognitive features from sabertooth felids.

Technical Session VII (Thursday, October 18, 2:45 - 2:55 pm)

SIMPLE EQUATIONS FOR ESTIMATING BODY MASS IN MAMMALS (AND DINOSAURS)

ALROY, John, Macquarie University, Sydney, Australia

Body mass is a major topic of paleobiological research, but it is notoriously difficult to estimate. Methods that are relevant to dinosaurs tend to either focus on one limb element at a time or require reconstructions of entire skeletons. Most of the former methods extrapolate from scaling patterns in mammals, which is problematic because scaling relationships among elements are generally different in dinosaurs. Such methods are also unable to handle tradeoffs in limb lengths across different locomotor categories, with equations for bipedal taxa being virtually free of data. All such methods ignore the scapula. However, a comprehensive new data set shows that scapula length is actually the best single predictor of body mass in terrestrial mammals. The relationship is not only tight but close to isometric (linear correlation coefficient r=0.999). The new equations are not intended to replace estimators that are put aside the new equations yield no systematic differences across clades. Estimates are accurate even for primate species, with strepsirrhines demonstrating higher scores for PC1. Shape changes associated with higher PC1 scores include: decreased superior-inferior height of the braincase, a decrease in the length of the brain base flexion, increase in the length and rostral projection of the olfactory bulb, and a more caudal placement of the cerebellum relative to the cerebral poles. PC1 scores were found to have a high degree of phylogenetic signal (lambda=1.0). Scores on this axis are not significantly correlated with log centroid size (p=0.69), or species means for log endocast volume (p=0.19) and log body mass (p=0.99); however, PC1 scores are correlated with relative brain size, even when phylogenetic effects are controlled for (p=0.0002). PC2 accounts for an additional 20% of the variance, and is primarily driven by the maximum breadth of the cerebrum and cerebellum. PC2 fails to distinguish modern taxonomic groups. PC2 scores are not significantly correlated with residual endocast volume (p=0.83), and are marginally related to log body mass (p=0.057).

These data provide support for qualitative observations that differences in encephalization are associated with endocast shape differences between strepsirrhine and anthropoid primates. This analysis further suggests that geometric morphometric methods will be useful for quantifying the distribution of endocast shape across primate evolution, and inferring functionally and phylogenetically important shifts in brain proportions in the primate fossil record.
not exist, restoration is untenable because hind limbs are not preserved, crushing makes it impossible to measure circumferences, or standard published measurements are the only available information.

Technical Session XIV (Saturday, October 20, 8:45 am)

NEW INSIGHTS INTO THE ORIGIN OF EXTANT AMPHIBIANS FROM THE FOSSIL RECORD AND HIGH RESOLUTION COMPUTED TOMOGRAPHY
ANDERSON, Jason S., University of Calgary, Calgary, AB, Canada; MADDEN, Hillary C., Harvard University, Cambridge, MA, United States; WILSON, Sian C., University of Calgary, Calgary, AB, Canada; PARDO, Jason D., University of Calgary, Calgary, AB, Canada

The origin of frogs, salamanders, and caecilians (collectively Lissamphibia) has been contentious question for a number of years. This controversy stems from the fact that extant amphibians and various archeozoic fossil groups share numerous overlapping features. Most of the morphology of lissamphibians are highly derived with respect to characters found in archeaic fossils, and the fossils are not available for molecular work. With the publication of the stem batrachian Gondwaraichus, many of the morphological gaps were spanned at least between frogs and salamanders and one group of fossil amphibians, the amphibiamid temnospondyls. However, that study hypothesized that caecilians were sister group to another group, the brachytelechid lepospondyls. This topology, assuming the consensus placement of lepospondyls as sister group to amniotes and their stem is correct, is at odds with all molecular studies, which find support for a monophyletic origin of lissamphibians. Subsequent to this study, work has continued to test this lepospondyl-caecilian relationship, primarily though the exploration of internal braincase anatomy in extant and fossil amphibians using micro-Computed Tomography (micro-CT). Our work has extensively documented the range of variation within the braincase of caecilians, and has found a number of morphological characters that are congruent with current molecular phylogenies of this group. Work on the morphology of caecilian inner ears has highlighted previous studies that suggest that there is a progressive regression, and ultimate loss, of sensory epithelia related to both high-frequency tympanic and low-frequency opercular bearing pathways, which would be inconsistent with a lepospondyl origin for caecilians. Detailed micro-CT studies of lepospondyls have demonstrated some new potential characters linking microsaurs and caecilians, but the preponderance of characters linking these two groups is correlated with fossorial locomotion. Further research has documented tooth development and replacement patterns in a taxonomically comprehensive sample of fossil and extant amphibians. Our results also raised a series of new questions about the fossil record with the conclusion that there are large ontogenetic and clade-specific patterns. Dubielzig et al. (2012) have established the 3D morphometric change during ontogeny of the salamander cranium as a baseline for comparisons with other salamanders with different life history strategies.

Technical Session XVII (Saturday, October 20, 3:45 pm)

DID MARINE MAMMALS OUTCOMPETE GIANT DIVING BIRDS?
ANDO, Tatsu, Ashoro Museum of Paleontology; Ashoro, Japan; FORDYCE, Robert E., University of Otago, Dunedin, New Zealand

The demise of “giant” flightless wing-propelled divers (Sphenisciformes, Plotopteridae, Mancallinidae, and Pinguinus) is one of the unresolved questions in their evolutionary histories. Contrary to “Cope’s Rule”, the largest species have disappeared from the lineages of those diving birds. “Giant penguin” indicates any fossil species of penguin. The demise of “giant” flightless wing-propelled divers (Sphenisciformes, Plotopteridae, Mancallinidae, and Pinguinus) is one of the unresolved questions in their evolutionary histories. Contrary to “Cope’s Rule”, the largest species have disappeared from the lineages of those diving birds. “Giant penguin” indicates any fossil species of penguin. “Giant penguin” indicates any fossil species of penguin. “Giant penguin” indicates any fossil species of penguin. “Giant penguin” indicates any fossil species of penguin. These results suggest that the evolution of marine mammals might explain extinction through competitive displacement. Such an idea is here assessed via diversity trends reported in the Paleobiology Database. At global to basin scales, flightless divers and marine mammals indeed show contrasting patterns of diversity from Chattian to Aquitanian, with diving birds decreasing in diversity with increase in marine mammal taxa, especially Odontoceti. However, a closer comparison reveals that long-term pattern are compositionally different from local trends. The changes in marine mammals did not clearly cause the extinction of “giant” divers. Large body size is suited to long-distance swimming and to deep-diving; it seems possible, then, that the extinction of large diving birds might reflect changes in profile of continental shelves and/or location of upwelling regions, in turn governed by global tectonics, sea level, and climate.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

MIOCENE SHARK FAUNA FROM NOSY MAKAMBY (MAHAJANGA BASIN, NORTHWESTERN MADAGASCAR)
ANDRIANAVALONOA, Tsitary H., University of Antananarivo, Antananarivo, Madagascar; RAMIHIANGHIAJASON, Tolona N., University of Antananarivo, Antananarivo, Madagascar; RASOAMIARANANA, Armand, University of Antananarivo, Antananarivo, Madagascar; WADWELL, David, The Natural History Museum, London, London, Great Britain; SAMONDS, Karen E., University of Queensland, St. Lucia, Australia

Madagascar is well known for producing exceptional fossils. However, the selachian fossil record remains relatively poorly known because research is largely lacking on Malagasy marine organisms, despite the presence of all of the island’s Cenozoic rocks are mapped as marine. Malagasy selachians are currently reported from the Late Cretaceous deposits of the Mahajanga Basin and a few reports of isolated teeth from the Eocene and Miocene. Here we report the first comprehensive fossil selachian assemblage from the Miocene of Madagascar from Nosy Makamby, a small island off the northwest coast of Madagascar offshore of the delta of the Mahavavy River, approximately 50 km west along the coast from the regional capital of Mahajanga. Very little geological information has been reported from Nosy Makamby and surrounding areas; the only comprehensive description of the island’s fossils is the result of reconnaissance work done in the early part of the century. The age of the section is currently under investigation but is thought to be early or middle Miocene. Based on isolated teeth, seven genera have been identified, including Carcharinus, Galeocerdo, Neocarcharodon, Rhizoprionodon and Sphyra (Carcharhinidae), Hemipristis (Hemigaleidae), and Squatina (Squatiniidae), marking the first description of Rhizoprionodon, Squatinus and Carcharhinus from Madagascar’s fossiliferous formations. In association with these specimens, fossils remain of foraminifers, bivalves, gastropods, echinoids, bony fish, non-diagnostic reptiles (turtles and crocodylians), and sirenian mammals were also recovered. The vertebrate-bearing horizon is underlain by sandstone containing the giant teredinid shipworm, Kuphus and overlain by cross-bedded sands and oysters. All suggest shallow water brackish or close-shore marine conditions; the presence of Kuphus is usually indicative of mangrove swamps. In the vertebrate-yielding level, the presence of sirenian remains and plates of the crinoid Baradus concurs further support a shallow-water marine depositional environment.

Technical Session X (Friday, October 19, 8:00 am)

DO TETRAPOD HERBIVORES MATTER? ECOSYSTEM ROBUSTNESS, OLSON’S COMMUNITY TYPES AND THE PRIMACY OF INSECTS
ANGIECZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; ROOPNARINE, Peter D., California Academy of Sciences, San Francisco, CA, United States

A major transition in tetrapod communities occurred in the Permian, as high-fiber herbivores diversified and became abundant. Using data from the Karoo Basin, we have shown that communities with low tetrapod herbivore diversity can display low robustness in the face of disturbances, with even small perturbations often causing high levels of extinction. These observations raise the possibility that ecosystem robustness was an important factor in the replacement of communities with low tetrapod herbivore diversity by those with higher herbivore diversity. To test this hypothesis, we used the Cascading Extinctions on Graphs (CEG) model to investigate the robustness of two communities with low tetrapod herbivore diversity: the fauna of the Carboniferous Upper Freeport Coal and the fauna of the Permian Wellington Formation. Despite both having few or no tetrapod herbivores, the two communities show divergent responses to perturbation: the Upper Freeport Coal fauna displays very low robustness, whereas the Wellington Fm. community is highly robust. Experimental manipulation of the communities shows that their levels of robustness do not stem directly from their tetrapod herbivore diversities. Instead, the Wellington Fm. community is stabilized largely by its diverse assemblage of insects, particularly herbivorous insects. The Upper Freeport Coal community also has a diverse insect assemblage, but the majority are detritivores or carnivores that appear not to have the same stabilizing effect. Taken together, these results suggest that the diversification of tetrapod herbivores may have had only limited effects on ecosystem robustness; instead the radiation of insect herbivores may have been much more important in this regard. In his seminal work on terrestrial community ecology, Everett Olson classified communities into three types based on the relative diversities of tetrapod herbivores and whether sources of primary productivity were dominantly terrestrial or aquatic. Based on its tetrapod fauna, the Wellington Fm. community should be a Type I community (characterized by low terrestrial herbivore diversity) in Olson’s classification, but functionally it appears much more like a Type III community (with insect herbivores forming a key link between terrestrial producers and consumers). This raises the possibility that all of the classic Lower Permian faunas upon which Olson based his concept of Type I communities may not represent this community type at all, and that true Type I communities will need to be sought earlier in the fossil record (the Upper Freeport Coal may be an example).
Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:15 am)

CENOZOIC MAMMALS FROM AMAZONIA: DIVERSITY, ENVIRONMENT, AND BIOGEOGRAPHY

ANTOINE, Pierre-Olivier, University Montpellier 2, Montpellier, France

The Amazon Basin constitutes more than one third of South America’s emerged areas. Essentially covered by tropical rainforests and a dense river network, this area is today a major biodiversity hotspot, notably for mammals. Yet, the mode and timing of the settlement of the corresponding mammalian guilds are far from being well known, due to the virtual lack of well-constrained data, notably for the Pliocene epoch. Although dramatically under-investigated, pre-Holocene Cenozoic deposits from Western Amazonia contain a wide array of fossil mammals, most of them being highly relevant to test major evolutionary and/or biogeographic hypotheses.

The earliest Cenozoic mammals from Amazonia are middle Eocene in age (~41 Ma). They were recently recovered nearby Contamana, eastern Peru, and consist of both endemic groups (gondwanatherians, marsupials, xenarthrans and native ungulates of high latitude affinities) and early immigrants from Africa (South America’s earliest rodents). Another locality of eastern Peru, Santa Rosa (Late Eocene-early Oligocene), yielded a somewhat similar mammalian guild, as well as a ‘possible bat’. A new locality, nearby Contamana, documents the late Oligocene period, with affinities to both Santa Rosa and Salla, Bolivia. In the Madre de Dios Basin, southern Peru, a new early Miocene locality provides the earliest low-latitude platyrhine primate. By contrast, several middle and late Miocene faunas discovered in the last decades, from western Brazil (Acre and Juruá) and eastern/southern Peru (‘Fitzgerald Local Fauna’; Madre de Dios), yield much more diversified mammalian guilds, including marsupials, xenarthrans, native ungulates, caviomorph rodents, primates, bats, aquatic placental (river dolphins and trichechid sirenians), and perhaps an early proboscidean of North American origin. Younger faunas, late Pleistocene-Holocene in age, widely postdate the Great American Interchange (~3.5 Ma), and accordingly include Northern invaders, such as perissodactyls, artiodactyls, proboscideans, carnivores, and murid rodents, together with xenarthrans and toxodontid ungulates.

Paleontological data as a whole point to the presence of tropical rainforests in Amazonia throughout the Cenozoic period, at least during mammal-yielding intervals, with obligate arboreal marsupials, rodents, and primates co-occurring with terrestrial hoofed ungulates. However, Western Amazonia hosted peculiar environments in the late early-late Miocene interval, with marine immigrations and the settlement of the long-lived marine-like Pebas megalaque. This episode played a pivotal role in the biotic differentiation of southern/northern South American ecosystems and corresponding mammalian guilds, as earlier faunas show relatively low degrees of endemism.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIVERSITY OF THE HESPERORNITHIFORMES (AVES) FROM THE UPPER CRETACEOUS PIERRE SHALE IN SOUTHERN MANITOBA, CANADA

AOTSUKA, Keiichi, The University of Tokyo, Tokyo, Japan; HATCHER, Joseph, Canadian Fossil Discovery Centre, Morden, MB, Canada; JANZIC, Anita-Maria, Canadian Fossil Discovery Centre, Morden, MB, Canada; SATO, Tamaki, Tokyo Gakugei University, Tokyo, Japan

Hesperornithiformes (Aves; Ornithurae) is a group of Cretaceous foot-propelled diving birds. Their remains are most commonly reported from Campanian deposits in North America where the Western Interior Seaway existed during the Cretaceous, and numerous hesperornithiform fossils have been collected from the Pierre Shale (Campanian) between South Dakota (USA) and Manitoba (Canada). Hesperornis regalis was the only species of the Hesperornithiformes from the Pierre Shale for many years, but since 2002, an additional five species (H. chowi, H. bairdi, H. macdonaldi, H. mengeli and H. regalis) have been described from South Dakota and Manitoba and stored in the Canadian Fossil Discovery Centre in Morden since 1972, but these fossils have not been studied since 1989. This study follows previous taxonomic studies in which the diagnosis of most species of Hesperornis is based on the morphology of the tarsometatarsus and tibiotarsus. Consequently, five species of two genera (Hesperornis regalis, H. chowi, H. sp. A, H. cf. rossicus, Baptornis advenus) were identified in this study. H. sp. A likely represents a new species because it displays unique characters in the shaft and proximal view of the tarsometatarsus; the shaft is strongly constricted at midshaft and the proximal articulation displays a nearly D-shaped outline. Results indicate that the genus- and species-level diversity of the Hesperornithiformes in Manitoba is much higher than previously recognized. This study also demonstrates the wider geographic range of two hesperornithiform species; H. rossicus and H. chowi were previously known only from South Dakota and Kansas respectively. In addition, H. rossicus was previously reported from Russia and Sweden but not reported from North America, and the H. cf. rossicus specimen from Manitoba possibly indicates a wider geographic distribution of this species as well.

Technical Session XI (Friday, October 19, 3:00 pm)

LATE JURASSIC THEROPOD EMBRYOS FROM PORTO DAS BARCAS, LOURINHÃ FORMATION, PORTUGAL

ARAUJO, Ricardo, Southern Methodist University and Museu da Lourinhã, Dallas, TX, United States; CASTANHINHA, Rui, Instituto Gulbenkian de Ciência and Museu da Lourinhã, Lourinhã, Lisboa, Portugal; MATEUS, Octávio, Faculdade Ciências e Tecnologia da Universidade Nova de Lisboa and Museu da Lourinhã, Lourinhã, Portugal; MARTINS, Rui, I/ST/Instituto Tecnológico Nuclear, Universidade Técnica de Lisboa, Centro de Física Nuclear da Universidade de Lisboa and Museu da Lourinhã, Lourinhã, Portugal

A clutch of several crushed eggs and embryos from the Late Jurassic (near the Kimeridgian-Tithonian boundary), Lourinhan Formation, Portugal contains a complete maxilla, erupted and scattered teeth, and presacral vertebrae. The maxilla bears four teeth separated by individualized interdental plates, the dorsal process of the maxilla is confluent with the maxillary body, the ventral rim of the antorbital fossa is parallel to the tooth row, and the anterior border of the maxilla forms a right angle with the ventral margin. The teeth are conical and recurved distally with caniniform mesial and distal sides. The vertebrae are amphiplatyacent, with a ventral pair of neurovascular foramina and heavily pitted articular facets. These fossils allow unambiguous association of basal theropod osteology (Megalosauroidae) with a new eggshell morphotype. Synchrotron micro-computed tomographic scanning (SRµCT), scanning electron microscopy, and thin-sections under polarized and normal light revealed that the outer ornamentation of the eggshell is composed of annular grooves (rims and ridges and sinuous lamellar layers) and an inner structure of concentric lamellae, suggesting higher taxonomic diversity of the Hesperornithiformes from the Pierre Shale. The current study aims to update the taxonomic and geographic distributions of these fossils have not been studied since 1989. This study follows previous taxonomic studies in which the diagnosis of most species of Hesperornis is based on the morphology of the tarsometatarsus and tibiotarsus. Consequently, five species of two genera (Hesperornis regalis, H. chowi, H. sp. A, H. cf. rossicus, Baptornis advenus) were identified in this study. H. sp. A likely represents a new species because it displays unique characters in the shaft and proximal view of the tarsometatarsus; the shaft is strongly constricted at midshaft and the proximal articulation displays a nearly D-shaped outline. Results indicate that the genus- and species-level diversity of the Hesperornithiformes in Manitoba is much higher than previously recognized. This study also demonstrates the wider geographic range of two hesperornithiform species; H. chowi and B. advenus were previously known only from South Dakota and Kansas respectively. In addition, H. rossicus was previously reported from Russia and Sweden but not reported from North America, and the H. cf. rossicus specimen from Manitoba possibly indicates a wider geographic distribution of this species as well.

Technical Session XV (Saturday, October 20, 12:00 pm)

A NEW ANKYLOSAURID DINOSAUR FROM THE UPPER CRETACEOUS BARUNGOYOT FORMATION OF MONGOLIA: NEW CRANIAL CHARACTERS FOR ANKYLOSAURINE ANKYLOSAURIDS AND A REASSESSMENT OF ANKYLOSAURID POSTCRANIAL SPECIMENS FROM MONGOLIA

ARBOUR, Victoria M., University of Alberta, Edmonton, AB, Canada; BADAMGARAV, Demchig, Paleontological Center, Mongolian Academy of Sciences, Ulaan Baatar, Mongolia; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The Upper Cretaceous sediments of the Gobi Desert, Mongolia, have produced several ankylosaurid taxa with distinctive bulbous, pyramidal cranial ornamentation, including Baruungoyot (from the Nemegt Formation) and Saichania (from the BarunGoyot Formation). Although a third taxon, Minotaurusaurus ramchandramani, is of unknown provenance, it bears a strong similarity to both Tarchia and Saichania and may also derive from the Upper Cretaceous of Mongolia. A new ankylosaurid skull (Mongolian Paleontological Center [MPC] D100/1388) from the BarunGoyot Formation at Khermeen Tsav can be differentiated from Saichania and Tarchia based on the unusual double-layered ornamentation of the squamosal horns and the presence of ornamentation posterior to the orbit. Several new ankylosaurid cranial characters are identified, including the presence or absence of a constriction behind the narial osteoderms, squamosal horn shape, the shapes of domed cranial osteoderms, number of discrete malar osteoderms, presence or absence of small osteoderms on the premaxilla between the narial osteoderms, and the shapes of the lateral edges of the supraorbital bars. The presence of a second potentially distinct ankylosaurid taxon in the BarunGoyot Formation necessitates a reevaluation of postcranial material referred to Saichania, previously the only known ankylosaurid in the formation. The holotype of Saichania (MPC 100/151) includes the skull and anterior part of the postcraniad skeleton. A nearly complete skeleton with in situ osteoderms, but lacking a skull and cervical rings (MPC 100/1305), has been referred to Saichania, but no synapomorphies have been used to support this referral. The humerus of MPC 100/1305 appears to have a similar proximal concavity lateral to the humeral head, present in the holotype of Saichania but absent in other ankylosaurids, which may support the referral of MPC 100/1305 to this genus. Although ankylosaur postcranial remains are abundant in the Gobi Desert, postcranial remains associated with diagnostic skull and postcranial material are rare, hindering efforts to identify additional characters for phylogenetic analyses. A revised phylogenetic analysis of the ankylosaurine ankylosaurids using updated character codings and the new characters identified here shows a close relationship between MPC D100/1388, Minotaurusaurus, and Psicarasaurus grangeri. Saichania is more closely related to Psicarasaurus mephistopheles than to MPC D100/1388. However, bootstrap supports for ankylosaur interrelationships are low, highlighting the need for additional characters (possibly from the postcranial skeleton) to help resolve relationships within this clade.
NEW ADDITIONS TO THE ELASMOBRANCH FAUNA FROM THE MIocene OF JABAL ZALTAN, LIBYA

ARGYRIOU, Thodoris, University of Alberta, Edmonton, AB, Canada; COOK, Todd D., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

In 2010, excavations and prospecting in the early-middle Miocene deposits of Maradah Formation in Jabal Zaltan, Libya, yielded a sizable and diverse faunal sample. The collected material corresponds to a mixture of environmental associations of both terrestrial (e.g., proboscideans, rhinoceroids, bovids etc.) and aquatic nature (marine and freshwater fish, aquatic mammals, turtles, crocodylians etc.). A small but informative surface collection of elasmobranch remains was also made. The presence of fossil sharks and rays had been first noted almost 40 years ago, with the recognition of Carcharias (Odontaspis) acutissima (Odontaspidae), Carcharodon sp. (Lamnidae), Hemipristis serra (Hemigaleidae), Pliosiptis sp. (Pristisidae) and Myliobatis sp. (Myliobatidae). The Material allows us to confirm the presence of seven genera, five of which were previously unreported from the site. Lamniforms appear to be scarce as only one slender crowned tooth, attributed herein to Carcharias sp. (Odontaspidae), was found. Carcharhiniforms, on the other hand, appear to be better represented in our sample, as eleven teeth belonging to four genera were recovered. Three specimens are attributed to Galeocerdo sp. cf. G. mawenzeni (Carcharhinidae) on the basis of their similarity with specimens described from the lower Miocene of Cabinda and Bololo in Western Africa. Carcharhinus sp. (Carcharhinidae) is represented by one upper jaw and one lower jaw tooth. The upper jaw tooth bears a peculiar, strong serration pattern that is not seen in any Miocene representatives of the genus, but resembles C. holochenis from the late Eocene of Pakistan. Three specimens identified herein as Negaprion sp. (Carcharhinidae) were also collected. Moreover, two teeth allow us to ascertain the presence of Hemipristis serra (Hemigaleidae) in the site. The Jabal Zaltan batoid fauna is also enriched by the identification of Aetobatus sp. and Rhinoptera sp. (both Myliobatidae) based on three and one dental elements respectively. Unfortunately, no Carcharodon, Pliosiptis or Myliobatis remains were recognized, a fact that could be attributed to our small sample size and collection bias. The elasmobranch finds, and their field association with other marine and terrestrial vertebrate fossils, are in accordance with the presumed depositional environment that corresponds to shallow estuarine to deltaic conditions.

Technical Session VII (Thursday, October 18, 3:45 pm)

PATTERNS OF DENTAL ERUPTION AND VARIABILITY IN MAMMALS

ASHER, Robert J., University of Cambridge, Cambridge, United Kingdom; PATTINSON, David, University of Cambridge, Cambridge, United Kingdom; TABUCE, Rodolphe, Universite Montpellier II, Montpellier, France; GHEEHRBRANDT, Emmanuel, Museum National d’Histoire Naturelle, Paris, France; HAUTIER, Lionel, University of Cambridge, Cambridge, France

Mammals are very conserved in their patterns of dental eruption. Nearly all known living and fossil mammals have no more than two generations at any given tooth locus. In addition, mammals typically undergo most replacement of their deciduous teeth prior to or close to sexual maturity and the attainment of adult body size. Their eruption order is also conserved, with anterior molars erupting early. Major exceptions to these generalizations are found among afrotherians and armadillos (the only living xenarthrans that exhibit diphyodonty). Both groups tend to erupt fewer than half of their permanent cheek teeth by the time they reach adult body size; both show a relatively high level of variability in dental eruption order. In order to test the hypothesis that afrotherians and xenarthrans share late eruption of adult teeth as a synapomorphy, we present new data quantifying the relationship between skull size and proportion of fully erupted, permanent teeth in mammals. We also compare eruption sequences to test if dental eruption order is more variable in afrotherians and xenarthrans than in other groups. Our results show that in addition to afrotherians and diphyodont xenarthrans, late eruption of adult teeth is common among terrestrial artiodactyls and perissodactyls, and characterizes some feliforms and lemurs. In contrast, our sample of marsupials, Erinaceus, caniforms, basal feliforms, scandentians, and most primates show extensive overlap between their period of growth and the eruption of most permanent cheek teeth, suggesting that these taxa erupt their permanent dentitions earlier in ontogeny than afrotherians and armadillos. Furthermore, we discuss material of Eocene afrotherians, including proboscideans as adult body size with few or no fully erupted, permanent cheek teeth. Mapped onto recent phylogenies of mammals, “late eruption” optimizes an afrotherian, possibly atlantogenatan, synapomorphy despite homoplasy elsewhere in the mammalian tree of life. Finally, our results indicate that chirocheloides (Afrotheria) are among the only mammals to deviate from early eruption at the first molar locus. Perhaps relatedly, afrotherians and xenarthrans show relatively high variation in eruption order across cheek tooth loci. We conclude that dental ontogeny is less constrained in both afrotherians and xenarthrans compared to other mammals, and may result from their shared ancestry.

Technical Session XIII (Friday, October 19, 2:45 pm)

EXTRINSIC AND INTRINSIC FACTORS IN THE EVOLUTION AND EXTINCTION OF NORTH AMERICAN FOSSIL PRIMATES

ATWATER, Amy L., Oregon Clark Honors College, Eugene, OR, United States; HOLROYD, Patricia A., University of California Museum of Paleontology, Berkeley, CA, United States; DAVIS, Edward B., Department of Geological Sciences and Museum of

Natural and Cultural History University of Oregon, Eugene, OR, United States

The North American Eocene fossil record has unequivocal preservation of the diversification of early mammal groups as well as the extinction of many lineages through a period of climatic changes that include fluctuations in temperature and precipitation. Early primates are a particularly well-understood group, and we focused on omomyid primates, whose evolutionary history is well documented in the context of regional climate change and that have been characterized diachronically. Our study investigates possible drivers of omomyid evolution and extinction in North America, documenting the different evolutionary trajectories of different omomyid clades and the role of changing body mass in differential diversification rates. As a proxy for body mass, we gathered measurements of lower m1 area from more than 750 specimens representing 28 genera and 51 species that range from earliest Eocene to late Middle Eocene in age. We then analyzed these data in a phylogenetic framework to assess the relative importance of the different potential drivers of body mass change, and using differences in geologic age as an alternative to branch length in reconstructing ancestral body mass. Our results indicate that multiple factors, including intermammalian competition, climate change, and ecosystem evolution, affected the diversification and extinction of these primates in the Paleogene. We study highlights the importance of understanding and considering both intrinsic and extrinsic factors in developing models for diversification and extinction. The detailed characters of omomyid extinction can be used to inform a new primate extinction, which is a phenomenon of efforts for extant organisms that share similar ecological niche spaces with Eocene primates.

Technical Session I (Wednesday, October 17, 4:15 - 6:15 pm)

DENTAL WEAR AND FEEDING ECOLOGY IN NORTH AMERICAN LATE MIOCENE RHINOCEROTIDAE, APHELOPS AND TELEOCERAS

AYOU, Michael, New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States; MIHLBACHER, Matthew C., New York College of Osteopathic Medicine at the New York Institute of Technology, Old Westbury, NY, United States

Rhinos have varied ecomorphologies and feeding ecologies but no living species have geographically overlapping distributions. The fossil record offers the only opportunities to study the comparative paleoecology of sympatric rhinos. Two rhinos, Teleoceras and Aphelops, were abundant megafauna in the North American Miocene. They co-occur in many localities and have distinctly different ecomorphologies, with Teleoceras more closely resembling a grazer and Aphelops a browser. We examined rhino denticles (N=158) from late Miocene Mixson and Love Bone Beds, Florida, and the Long Island Rhino Quarry, Kansas, using mesowear and dental microwear analysis. For comparison, extant browsing (Diceros) and grazing (Ceratotherium) African rhinos (N=101) were examined.

Grazer microwear commonly differs from browser microwear by excessive numbers of microscratches, possibly due to higher concentrations of abrasive particles (phytoliths, sand) ingested by grazers. However, browsing and grazing extant rhinos have similar scratch and pit frequencies, suggesting that the relationship of dental microwear and diet are not simple. Diceros and Ceratotherium microwear differs most dramatically in the degree of intratooth heterogeneity. Diceros molars exhibit a lower scratch/pit ratio on the ectoloph than the protocone. Ceratotherium intratooth microwear distribution is more homogeneous. In living and extinct rhinos, high labial scratch/pit ratios accompany blunt low-relief cusps (Ceratotherium) and low labial scratch/pit ratios accompany sharper and higher-relief cusps (Diceros).

Aphelops and Teleoceras dental wear patterns are consistent with low-abrasion diets. Teleoceras and Aphelops have higher degrees of intratooth microwear heterogeneity than extant rhinos, with very low labial scratch/pit ratios. Likewise, both fossil rhinos have sharper, higher relief cusps than Diceros and Ceratotherium. Teleoceras and Aphelops microwear patterns are broadly similar to each other and when multiple localities are compared, the minor differences between Aphelops and Teleoceras microwear are stochastic and possibly represent differences between localized habitats rather than systematic differences in dietary preference. The shortened limb proportions of Teleoceras have occasionally been interpreted as a short grass grazing adaptation. Stable isotopes suggest that Teleoceras consumed some grass, while Aphelops did not, although dental microwear does not suggest major differences in dietary abrasion among the paleopopulations investigated. Despite the hypothesis that Teleoceras is a grazer and Aphelops a browser, the microwear evidence is somewhat equivocal. Evidently, the feeding ecologies of both fossil species were non-analogous to extant browsing and grazing African rhinos.

Technical Session VIII (Thursday, October 18, 2:15 pm)

DIVERSITY DYNAMICS OF MAMMALS IN RELATION TO LANDSCAPE ELEVATION GRADIENTS FROM NORTH AMERICA

BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; FINARELLI, John A., University College Dublin, Dublin, Ireland

Here we evaluate the hypothesis that changes in landscape history that increase topographic complexity promote diversification of mammals at the regional scale. Tectonic uplift or erosion can increase topographic complexity, decreasing the physiographic continuity of bioclimatic zones, promoting fragmentation of species’ geographic ranges, and increasing elevational gradients. Global climatic changes can magnify or reduce these landscape gradients. Regional topographic heterogeneity, compared to nearby topographically homogeneous regions, supports high species diversity today for mammals and many
other groups. This biogeographic pattern can be explained through either greater rates of diversification or greater species accommodation in topographically complex regions.

We compared Neogene diversification of rodents for three regions in North America. The Columbia Basin of the Pacific Northwest and the northern Rocky Mountains were tectonically active over much of the Cenozoic and feature high topographic complexity today. The northern Great Plains have been tectonically quiescent with low relief over the Cenozoic. These three regions have distinctive geologic histories and substantial, well-documented fossil records. All three regions showed significant changes in diversity and faunal composition over the Neogene. Rodent faunas from the three regions differed in composition almost completely at the species level, although most families and many genera were shared among the regions, indicating greater provincialism than in modern faunas.

In the two montane regions, originations and extinctions peaked at the onset and close, respectively, of the Miocene Climatic Optimum (17-14 Ma), with significant changes in faunal composition accompanying these episodes of diversification. In the Great Plains, rodent species overlapped considerably despite lower diversity (i.e., lower number of taxa with no change in species diversity). The highest Neogene diversity occurred during the cooling that preceded the Miocene Climatic Optimum. These histories suggest that climatic changes interacting with topographic complexity intensify macroevolutionary processes. Moreover, the middle Miocene and modern elevational diversity gradients appear to be unusual biogeographic configurations for the Neogene, suggesting caution in inferring past ecogeographic patterns from modern distributions.

The processing of food causes distinct patterns of microscopic wear on tooth enamel, and these microwear features of seven species of carnivorans from the late Pleistocene asphalt lake at Rancho La Brea, California, were examined. The microwear features were recorded as prominent surface depressions; the depressions were distinguished as of a much earlier phylogenetic position—a pattern congruent with a host of other character complexes historically identified with birds (e.g., feathers, furcula). The acquisition of a "flight-ready" brain at a more inclusive position on the tree is congruent with the possibility of avian powered flight. The intricacies of what may be a dynamic and complex transformational pattern, however, are poorly understood and cannot be established without dense and detailed sampling of the phylogenetically long avian stem. We undertook this task by concentrating on volumetric patterns of endocranial change within Coelurosauria, especially in the relatively narrow portion of the tree bracketing the origin of avian flight. Our novel approach uses high-resolution computed tomography to divide the endocranial cavity into homologous neuroanatomical partitions. These partitions correspond closely to the major regions of the brain, including the olfactory bulbs, cerebrum, optic lobes, cerebellum, and brain stem. Using a recent hypothesis of coelurosaurian relationships we inferred patterns of volumetric change, not only with regards to how these individual partitions are transforming relative to body size but relative to each other. This greatly expands on previous attempts whose scope was limited either to total endocranial volume or to most any two regional partitions (cerebrum and non-cerebrum).

Our results confirm previous findings that total endocranial volume relative to body size does increase dramatically along the coelurosaurian backbone of the avian stem. We also found that this trend is driven primarily by at least three phases of cerebral volumetric expansion, none of which coincide with a phylogenetic position typically associated with the origin of avian flight. When the fossil record is considered, a volumetrically avian brain is not readily discernable between the volumes of endocranial laminae—well-established at a much earlier phylogenetic position—a pattern congruent with a host of other character complexes historically identified with birds (e.g., feathers, furcula). The acquisition of a "flight-ready" brain at a more inclusive position on the tree is congruent with the possibility that other non-avian paravians may have been capable of some type of volant activity.

The causes and timing of the Cretaceous mass extinction have been the subject of much debate for decades. Preservational, geographic and taphonomic biases render trends in biodiversity difficult to assess, and complicate the coupling of these trends with abiotic drivers. Here a multidisciplinary approach is used to elucidate spatial and temporal relationships between vertebrate diversity and paleoenvironment during the last 300,000 years of the Cretaceous period. Stratigraphic surveys of the latest Maastrichtian (65.5Ma) Frenchman Formation in Grasslands National Park, SK, Canada reveal three distinct, successive depositional cycles. Each cycle is considered a 'time slice' across which vertebrate diversity and palaeoecological signals can be assessed. From these time slices, some 8,000 fossils from twenty-eight vertebrate microsites were collected. A further 7,000 fossils were recovered from nine microsites near Eastend, SK (ca. 200km west) for use in spatial diversity analysis. Fossils were identified and catalogued, and this data was used to calculate abundance-based diversity metrics. Paleotemperature fluctuations were determined using stable δ¹⁸O isotope data, while palaeoecological data was estimated from plant macrofossil assemblages. Vertebrate diversity was found to be highest in the oldest time slice. Diversity declined sharply in the middle time slice, then recovered to a second peak at the base of the youngest time slice. Overall, the diversity was greatest below the K-Pg Boundary. Following this peak, there was a marked decrease in diversity towards the boundary. Sites with the highest diversity were often found in mudstones, associated with paleoecological indicators such as fossil leaf impressions, charcoal deposits and desiccation horizons. Analyses of isotope data linking temperature fluctuations to the peaks in diversity are as of yet inconclusive. Spatially, the Eastend sites had consistently higher diversity than contemporaneous Grasslands sites. These results demonstrate that biodiversity does not show a consistent decreasing trend towards the K-Pg extinction.
Boundary, but suggests spatial and temporal differences were driven primarily by local scale (<200 km) environmental conditions.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:45 am) TIME-SCALING TREES IN THE FOSSIL RECORD BAPST, David W., University of Chicago, Chicago, IL, United States As phylogenetic approaches to paleobiology become increasingly common, it is necessary that we consider the impact of our choice of methodologies on results. The temporal scaling of paleontological cladeograms is a critical step in applying tree-based analyses of trait evolution and diversity. There are several routines that have been applied previously to time-scale phylogenetic branches but there has been no synthetic work comparing these methods. I present a new sampling rate conditioned method for time-scaling trees which uses an estimated sampling rate to create random samples of time-scaled trees, in order to bracket the uncertainty in branching times for a given set of taxa. This method can also consider possible ancestor-descendant relationships and resolve polytomies with better accuracy than random. This method is included in the software package “paleotree” for the open-computing language R, along with an extensive toolbox for simulating diversification in the fossil record. Using these simulations to model realistic paleontological datasets, I tested how the choice of time-scaling methods affected the fidelity of various phylogeny-based analyses of macroevolution. To summarize, sampling-rate conditioned method performed best for estimating the rate of continuous trait evolution and had similar performance as other methods for fitting models of trait evolution. Estimates of phylogenetic signal had poor fidelity for all time-scaling methods. For estimating lineage richness, the time-scaling method with the most fidelity depended on the question being addressed.

Technical Session XIX (Saturday, October 20, 4:00 pm) PRELUDE TO THE ANTHROPOCENE: TWO NEWLY-DEFINED NORTH AMERICAN LAND-MAMMAL AGES BARNOSKY, Anthony D., University of California, Berkeley, CA, United States; IB286, WORKING GROUP, University of California, Berkeley, CA, United States We propose criteria to recognize two new North American Land-Mammal Ages (NALMAs). Our goal is to clearly characterize (for North America) the progression of anthropogenically-driven biotic transitions that lead into the Anthropocene. By way of background, “Anthropocene” is an informal term now widely used to identify the period of Earth history that begins when Homo sapiens become a geological-scale force for planetary change. Discussions are underway about whether to formally recognize the Anthropocene as a new geological epoch, the beginning of which would be placed sometime between 1750 and 1950 A.D., depending on the particular criteria agreed upon. However, dramatic pre-18th century human influences on the global ecosystem also are clearly visible in the paleontological record as faunal changes associated with anthropogenically-driven dispersal events. On the global scale these are diachronous, spanning tens of thousands of years, and correspond with human influences on the global ecosystem. These are diachronous, spanning tens of thousands of years, and correspond with human influences on the global ecosystem. Also are clearly visible in the paleontological record in North America south of 55° N, and would also define the end of the last interglacial and the beginning of the Holocene. The older one, characterized by co-existence of Equus ferus caballus and Capra hircus, and the latter by lack of both Pleistocene megafauna and non-native domestic mammals. The later NALMA (the “Saintaugustinean”) and characterized by widespread occurrence of imported domestic Equus ferus caballus, which would also define the beginning of the youngest NALMA, informally referred to as the “Saintaugustinean” and characterized by widespread occurrence of domestic domestic species such as Sus scrofa, Bos taurus, Ovis aries, and Capra hircus. The LMA concept can be independently applied to characterize different sequences of change (both taxonomic and temporal) that lead up to the Anthropocene on other continents, although we do not do so here.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 8:00 am) A NEW ORNITHISCIAN DINOSAUR FROM THE VENEZUELAN ANDES BARRETT, Paul M., The Natural History Museum, London, United Kingdom; BUTLER, Richard J., Ludwig Maximilian University, Munich, Germany; IRMIS, Randall B., Utah Museum of Natural History, Salt Lake City, UT, United States; SCHEYER, Torsten M., Paläontologisches Institut und Museum, Zurich, Switzerland; SÁNCHEZ-VILLAGRA, Marcelo R., Paläontologisches Institut und Museum, Zurich, Switzerland Low paleolatitude dinosaur assemblages are relatively rare, especially in northern Gondwana, and localities in these areas have the potential to offer critical new biogeographic information as well as the opportunity of yielding new taxa. The La Quinta Formation crops out in the Venezuelan Andes and yields a significant, but so far briefly described, northern South American dinosaur assemblage. Determining the age of the La Quinta Formation has been problematic, however, with biostratigraphic correlations based on palynomorphs and paleoecological and palynological palaeofiles suggesting deposition of this unit sometime during the Late Triassic–Middle Jurassic. We report previously undescribed cranial and postcranial material from a bonebed within this unit that indicates the presence of a small, primitive ornithischian dinosaur. With the exception of rare shed theropod teeth and several possible theropod postcranial elements, all other material from this locality bears ornithischian synapomorphs or is otherwise consistent with attribution to a single taxon from this clade. Many elements are represented by multiple examples (e.g., scapulae, femora) and they display little variation, further supporting the hypothesis that only one ornithischian taxon is present. Consequently, this site represents the earliest-known monodominant ornithischian bonebed. We recognize this material as a new taxon that can be diagnosed on the basis of its unusual dental morphology, and features of the maxilla and astragali. The taxon lacks cerapodan synapomorphies and possesses similarities to Leptosuchus and heterodontosauroids, suggesting that it is a very basal ornithischian. The specialised nature of this new taxon provides some circumstantial support for a Late Triassic–Early Jurassic age for the La Quinta Formation. The bone histology of several specimens was also analysed, revealing well-vascularised, parallel-fibred bone tissue in all samples. Based on the size ranges of the specimens and the presence of lines of arrested growth, one individual was determined to be a juvenile, another a skeletally mature adult, and the remaining samples as belonging to still growing subadult animals. Through ontogeny the long bone samples showed that the overall longitudinal canal arrangement changes towards a reticulat pattern dominated by laminar organization. True fibroblast bone was not present in any element.

Technical Session IV (Wednesday, October 17, 3:45 pm) A CLADISTIC APPROACH TO UNDERSTANDING DINOSAUR EGG DIVERSITY AND THE EVOLUTION OF REPRODUCTIVE TRAITS WITHIN DINOSAURIA: PRELIMINARY RESULTS BARTA, Daniel E., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States Only a small percentage of fossil eggs contain identifiable embryonic remains. Consequently, knowledge of eggshell structure and reproductive strategies remains incomplete for many dinosaur clades. Most previous cladistic analyses of dinosaur eggs and their focus on dinosaur eggshell (ophiotherid) with identified eggs have been based on the goal of understanding the evolution of avian reproductive traits. In order to better assess the evolution of eggshell, and reproductive attributes across all dinosaurs and to assess the apparent temporal and phylogenetic bias in dinosaur eggshell preservation, we undertook a comprehensive cladistic analysis of representatives of each major dinosaur ophiology. Using
two turtles as an outgroup, analysis produced a phylogeny with Megaloolithidae recovered as the basal-most dinosaur oofamily. Spherooolithids and a polytomy of Dendroolithidae and Faveoloolithidae (with or without Dictyoolithidae, depending on the level of consensus examined) are recovered more inclusively within the dinosaur clade. Strong support exists in consensus trees for a clade of derived maniraptorans, including modern avians, within the dinosaur clade.

In this study, as in past efforts, cladistic analysis of eggshell remains complicated by a limited number of characters and extensive homoplasy between some ootaxa. For example, the polytomy of Faveoloolithidae through Dendroolithidae contains eggs variously assigned to sauropods (Faveoloolithidae), therizinosaurids (Dendroolithidae), and theropods (Dictyoolithidae) by previous authors. Homoplasy or the expression of shared ancestral dinosaurian eggshell features may account for the consistent recovery of this clade in consensus trees in this study. The grouping of hadrosaur eggshell (Spherooolithidae) with that of sauorischians also suggests homoplasy or the expression of dinosaurian synapsomorphies. Independent evolution of hard-shelled eggs within hadrosaurs could potentially explain the long absence of identified ornithischian eggshell in the Mesozoic fossil record, though taphonomic bias should temper this interpretation. The topology of the derived maniraptoran and extant avian eggshell clade broadly concurs with existing phylogenies based on skeletal data.

This study highlights possible convergences in egg and eggshell microstructural characters that complex taxonomic assignments of ootaxa that remain unidentified on the basis of embryonic remains. The phylogeny presented here provides additional support for the initial evolution of some avian reproductive traits within derived maniraptorans, but demonstrates that relationships among ootaxa outside this clade remains difficult to resolve as they conflict with established phylogenies based on skeletal characters.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

SCAPHOLUNATUM, OR SCAPHOID AND LUNATUM. THAT IS THE QUESTION. THE CASE OF HYAENODON

BASTL, Katharina, Institut für Paläontologie, Vienna, Austria; NAGEL, Doris, Institut für Paläontologie, Vienna, Austria

The most obvious structural feature in the manus of Carnivora is the scapholunatum, which is not present in other Eocene/Oligocene predators (e.g. hyaenodonts); in those forms the carpals stay separate as scaphoid and lunatum. This unused state is present in North American Hyaenodon. Interestingly, this observation was contradicted in the early literature with a description of a scapholunatum in European Hyaenodon. In order to address the question of whether this dramatic difference exists, the European skeletal material was reviewed. The study focused on a specimen from the late Eocene locality La Débruge (France) on which the statement was based. The morphology of the metapodials (broad, short and diverging), the terminal phalanx (not split) as well as the distal articulation facet of the scapholunatum (ursid-like) indicate that the specimen belongs to Carnivora and certainly not to Hyaenodon. Additionally, the carnivore Cynodictis is found in the same locality. Further material attributed to Hyaenodon and identified as scapholunatum could not be confirmed concerning their classification concerning the taxon and the element. Up to now, no carpus of a European Hyaenodon is known, but based on the distal radial facet, it should have articulated with a scaphoid and a lunatum as in North American taxa. Misidentifications lead to an enigmatic divergence that can now be refuted.

Technical Session XIII (Friday, October 19, 4:00 pm)

THE COLONIZATION OF AF RICA BY EARLY CENOZOIC ANTHROPOID PRIMATES: NEW DATA FROM THE EOCENE PONDAU NG FORMATION OF MYANMAR

BEARD, K. C., Carnegie Museum of Natural History, Pittsburgh, PA, United States; CHAIMANEE, Yaowalak, Université de Poitiers, Poitiers, France; CHAVASSEAU, Olivier, Université de Poitiers, Poitiers, France; LAZZARI, Vincent, Université de Poitiers, Poitiers, France; JAEGER, Jean-Jacques, Université de Poitiers, Poitiers, France

Reconstructing the origin and early evolutionary history of Anthropoidea is a current focus of primate paleontology. Although classical hypotheses have typically supported an African origin for the anthropoid clade, the more recent discovery of basal members of the anthropoid clade in China and Myanmar suggests that the group originated in Asia. The latter result agrees with the recorded distribution of Tarsiiformes, the sister group of Anthropoidea. Given the Oligocene-Recent history of African anthropoids, the colonization of Africa by early anthropoids hailing from Asia was a decisive event in primate evolution. However, the fossil record has previously failed to constrain the nature and timing of this pivotal event. Recent fieldwork in the late middle Eocene Pondaung Formation of Myanmar has yielded four new anthropid taxa that are highly similar to, but more primitive than, the roughly contemporaneous North African anthropid Afrotritops. Phylogenetic analysis suggests that the new Burmese taxon and Afrasialus are sister taxa within a basal anthropoid clade that also includes Eosimias, Bahinia and Phenocephalus. Current knowledge of phylogenetic relationships within this basal anthropoid clade and its distribution through space and time suggest that close relatives of Afrotritops dispersed from Asia to Africa sometime during the middle Eocene, shortly before Afrasialus first appears in the African fossil record. These two taxa and their nearest fossil relatives are likely to be specially related to Afrotritops, suggesting that Africa was colonized by two or more Asian anthropoid clades during the latter part of the Eocene. A similar phylogenetic

Technical Session XVI (Saturday, October 20, 8:15 am)

COMPARISONS OF LIGHT MICROSCOPY-BASED DENTAL MICROWEAR AND DENTAL MICROWEAR TEXTURE ANALYSIS: IMPLICATIONS FOR TESTING HYPOTHESES OF FEEDING ECOLOGY IN EXTINCT VERTEBRATES

BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; MIHLBACHLER, Mathew C., New York College of Osteopathic Medicine, Old Westbury, NY, United States

Dental microwear is increasingly used to test hypotheses about feeding ecology, yet too little is understood about the causal nature of observed dental wear features (e.g. pits and scratches). Tooth wear is an accumulation of many small contact events on a three dimensional surface in which size, shape, hardness and fracture toughness of dental materials and introduced abrasives are all important. Such damage is constantly being overprinted and is subject to chemical erosion and differences in enamel microstructure. Awareness of these variables is important to determining how one might best visualize discrete contact events and light microscopy dental microwear (LDM) and dental microwear texture analysis (DMTA) “see” these variables in non-analogous ways. LDM records data on discrete contact events that result in the formation of microwear features. Such features can be easily distinguished from wear due to chemical erosion and other aspects of occlusal relief caused by enamel microstructure, such as vertical Hunter-Schreger bands. Although DMTA is less prone to observer error due to the inconsistencies of microwear feature identification during LDM, DMTA doesn’t recognize discrete microwear features and cannot yet distinguish microwear features from other effects, such as erosive wear and enamel microstructure effects. Although we anticipate these limitations may be surmountable in the future, care needs to be taken when employing DMTA to avoid these potential confounding variables.

To further compare the ability of LDM and DMTA in discriminating the feeding ecology of ungulates, we collected microwear data from the same tooth regions of the same fifteen specimens from four species with different feeding ecologies (Equus, Alces, Giraffa, and Diceror). DMTA analysis of the same teeth was done using a white light confocal microscope at the University of Arkansas, with variables of anisotropy, complexity, scale of maximum complexity, textural fill volume, and heterogeneity. When DMTA variables of anisotropy and complexity are compared to LDM variables pits and scratches, we find that DMTA, although prone to higher rates of observer error, is more successful at discriminating animals of different feeding ecologies. More data are needed using both methods to better assess how useful they are in discriminating ungulate ecology and that of other vertebrate groups. Despite the data suggesting that LDM would more effectively discriminate ungulate diets, both methods measure the same surface in non-analogous ways, making a combination...
of both methods more likely leading to robust results and more insightful interpretations of feeding ecology.

Technical Session V (Wednesday, October 17, 3:00 pm)
FIRST EVIDENCE OF REMINGTONOCETIDAE (MAMMALIA, CETACEA) OUTSIDE INDO-PAKISTAN: NEW GENUS FROM THE EARLY MIDDLE EOCENE OF EGYPT
BEBEJ, Ryan M., Calvin College, Grand Rapids, MI, United States; ZALMOUT, Iyad S., University of Michigan, Ann Arbor, MI, United States; ABED EL-AZIZ, Ahmed A., Egyptian Environmental Affairs Agency, Wadi Al-Hitan World Heritage Site, Fayum, Egypt; ANTAR, Mohammed Sameh M., Egyptian Environmental Affairs Agency, Wadi Al-Hitan World Heritage Site, Fayum, Egypt; GINGERICH, Philip D., University of Michigan, Ann Arbor, MI, United States
Remingtonocetids are semiaquatic archaeocete cetaceans known for their elongated narrow skulls, long necks, and robust pelves and hind limbs. The family currently includes five genera (Attockicetus, Remingtonocetus, Dalanistes, Andrewsicetus, and Kuthecetus), which are known principally from the middle-to-late Lutetian Domanda Formation of Pakistan and the late Lutetian Harudai Formation of India. Some specimens have been recovered from other formations; however, all previous occurrences have been restricted to the Lutetian of Indo-Pakistan. A new genus of remingtonocetid cetacean has been recovered from the late Lutetian Midawara Formation of Egypt. The specimen includes a left innominate with a complete ilium, ischium, and acetabulum; a nearly complete left femur; a four-vertebra sacrum; and partial lumbar and anterior caudal vertebrae. The long, broad ilium and near closure of the acetabular notch compare closely with the innominate of other remingtonocetids, though the ischium is much broader and flatter. The femur is generally similar in size and shape to known specimens of Remingtonocetus, but has a more vertically aligned head and a shaft with a more circular cross-section that has a conspicuous lateral keel. The sacrum is composed of four vertebrae, three of which are at least partially fused together as in other remingtonocetids, with very large dorsal sacral foramina. A well-preserved lumbar vertebra has curved zygapophyses, reniform epiphyses, and short transverse processes with only a modest degree of anterior or ventral inclination, comparing closely with lumbar vertebrae of Remingtonocetus. However, partial neural arches suggest that lumbar neural spines were inclined posteriorly rather than anteriorly. The new specimen increases the known taxonomic diversity of Remingtonocetidae, illustrates additional variation in the morphology and locomotor repertoire of the group, and provides the first evidence of the family in Africa.

Technical Session X (Friday, October 19, 8:30 am)
MORPHOLOGIC INDICATORS OF FOSSORIALITY AND THE EVOLUTION OF BURROWING IN DICYNODONTS (AMNIOTA: SYNAPSIDA)
BECK, Allison L., Augustana College, Rock Island, IL, United States; SCHECKEL, Jessica, University of Michigan, Ann Arbor, MI, United States
Among the extinct ancestors of mammals, the Dicynodontia is a clade easily recognized by characteristic turtle-like beaks, toothless except for a pair of large tusks. Dicynodonts were among the extinct ancestors of mammals, the Dicynodontia is a clade easily recognized by characteristic turtle-like beaks, toothless except for a pair of large tusks. Dicynodonts were

Technical Session X (Friday, October 19, 12:00 pm)
A COMPREHENSIVE GENUS-LEVEL PHYLOGENY OF LIVING AND EXTINCT MARSUPIALS BASED ON CRANIODENTAL AND MOLECULAR DATA
BECK, Robin M., University of New South Wales, Sydney, Australia; VOSS, Robert S., Department of Mammalogy, American Museum of Natural History, New York, NY, United States; JANSÁ, Sharon A., Department of Ecology, Evolution, and Behavior, J. F. Bell Museum of Natural History, University of Minnesota, Saint Paul, MN, United States
Comprising approximately 6% of extant mammalian species, and with a rich fossil record, Marsupialia represents a diverse and successful mammalian clade, such as the, to the Niobrara Formation of western Kansas represents one of the most famous mosasaur-bearing localities in the world. The relative abundance of mature mosasaurs compared to juveniles in the Niobrara Formation has been interpreted as evidence of catastrophic mortality events in this ecosystem. The Niobrara Formation of western Kansas represents one of the most famous mosasaur-bearing localities in the world. The relative abundance of mature mosasaurs compared to juveniles in the Niobrara Formation has been interpreted as evidence of catastrophic mortality events in this ecosystem.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)
TWO NEONATE MOSASAURS (SQUAMATA) FROM THE NIOBARRA FORMATION
BEHLKE, Adam D., Department of Geology and Geophysics, Yale University, New Haven, CT, United States; FIELD, Daniel J., Department of Geology and Geophysics, Yale University, New Haven, CT, United States
The Niobrara Formation of western Kansas represents one of the most famous mosasaur-bearing localities in the world. The relative abundance of mature mosasaurs compared to juveniles in the Niobrara Formation has been interpreted as evidence of catastrophic mortality events in this ecosystem. The Niobrara Formation of western Kansas represents one of the most famous mosasaur-bearing localities in the world. The relative abundance of mature mosasaurs compared to juveniles in the Niobrara Formation has been interpreted as evidence of catastrophic mortality events in this ecosystem.

Technical Session XIX (Saturday, October 20, 3:30 pm)
THE IMPACT OF MASS MORTALITY ON THE LAND SURFACE BONE ASSEMBLAGE OF AMBOSELI PARK, KENYA
BEHRENSMUEYER, Anna K., Smithsonian Institution, Washington, DC, United States; WESTERN, David, African Conservation Center, Nairobi, Kenya; BAGDLEY, Catherine, Museum of Paleontology, Ann Arbor, MI, United States; MILLER, Joshua H., Florida Museum of Natural History, Gainesville, FL, United States; ODOCK, Fredrick L., Kenya Wildlife Service, Kitale, Kenya
The partial collapse of the mammalian herbivore community in Amboseli National Park, Kenya, in 2009 provided an opportunity to compare catastrophic mortality with the atrial skeletal record previously documented in this ecosystem. Mass mortality occurred during the dry season of 2009, when over 11,000 individuals (primarily grazers) died in a period of 8 months. Amboseli has large permanent springs and swamps, and herbivores died from starvation rather than thirst. Taphonomic surveys documented skeletal remains on 20 established transects. The number of drought deaths far exceeded the initial recyling capacity of local scavengers, mainly spotted hyena. In 2010, skeletons were relatively complete and scavenger impact was low, with characteristic patterns of damage to particular
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skeletal parts. Drought-death carcasses occurred in all habitats and were concentrated near the swamps, but there were no piles of skeletons representing bonebed accumulations. Relatively few juveniles and many prime adults were recorded in the drought death bone sample, thus demographic profiles of affected species did not match the standard model for a standing crop biomass. Skulls are found almost exclusively in the deeper layers of the stratigraphic succession. Dental remains are re-evaluated. Cranial, dental and postcranial material from near the type locality and surrounding wetland; a dinosaur bone bearing paleosol containing calcareous concretions that was beset by periodic wildfires. The AAS preserves a fossil rich peat from a marine-basin that includes

**THE QUADRATOMAXILLARY LIGAMENT AND ITS IMPLICATIONS FOR THE EVOLUTION OF CRANIAL FENESTRATION IN REPTILES**

BEVER, Gabriel S., New York College of Osteopathic Medicine, Old Westbury, NY, United States; LYSON, Tyler R., Yale University, New Haven, CT, United States; BHULLAR, Bhar-Anjan S., Harvard University, Cambridge, MA, United States

The characteristic absence of temporal fenestration in turtles has long influenced the hypothesis that the group originated outside the diapsid radiation that includes crown Dinosauria and Archosauria. Recent phylogenetic analyses almost invariably reject this hypothesis, with the implication that the anapsid skull of turtles reflects a derived loss of fenestration rather than the conservation of the ancestral reptile condition. Though a closing of the temporal region at some point along the turtle stem is a requirement of current molecular-dominated matrices, the only direct anatomical evidence professed to support such a transformation is an observation made in the 1920s that extant turtles express a quadratojugal lamina (QML). This structure is well known in crown squamates where it delineates the ventral margin of the lower temporal fenestra and is widely accepted as the unossified homolog of the diapsid lower temporal bar. Considering the historical importance placed on pinpointing the annectant temporal region and the possibility of strengthening the consensus between paleontology, soft-tissue anatomy, and molecular-based phylogenetics, we investigated the implications of the QML by addressing two basic questions. 1) Is a homolog of the squamate QML present in turtles and if so, what is its distribution within the turtle crown? 2) Is it justified inferring that the presence of the QML structures the geologic ground plan of a diapsid skull?

Based on our dissection of a series of crown turtles, mammals, squamates, and archosaurs, we conclude that 1) the ancestral crown turtle did contain a QML, 2) the turtle QML is homologous to that of squamates and delineates the ventral margin of the cheek as a distinct thickening of the temporal fascia, and 3) a homologous QML is also present in crown archosaurs but apparently not in crown mammals. This distribution supports the QML as a unique feature of reptiles; however, narrowing its origin to Diapsida depends on its absence in extinct parareptiles, which may be unknowable. It is becoming increasingly probable that the ancestral parareptile had some form of temporal opening, which means that regardless of whether turtles originated within Diapsida or Parareptilia, their completed anapsid morphology likely derived. We also critically reevaluated osteological characters of the temporal region with the goal of restricting assumptions of process. Preliminary results, not surprisingly, indicate high homoplasy. The most elevated levels were recovered when the origin of turtles was constrained to the lepidosaur stem as opposed to within Parareptilia or to the stem of Archosauromorpha.

**Complex Social Structure in Proboscidea From A Remarkable Late Miocene Trackway Site in the United Arab Emirates**

BIBI, Faysal, Museum für Naturkunde, Berlin, Germany; KRATZ, Brian, Western University of Health Sciences, Pomona, CA, United States; CRAGG, Nathan, Independent Scholar, Balboa Island, CA, United States; BEECH, Mark, Historic Environment Department, Abu Dhabi Tourism & Culture Authority, Abu Dhabi, United Arab Emirates; HILL, Andrew, Yale University, New Haven, CT, United States

Evidence for social behavior, group size and structure in the fossil record is generally limited to rare and exceptional fossil finds. Living elephants are an example of a group that exhibits complex and well-studied social behavior. Despite a rich proboscidean fossil record going back to the Early Eocene, evidence on the antiquity of characteristic elephant behavior has remained virtually unknown. We here present on the exceptional fossil trackway site of Mleisa 1, from the late Miocene Baynunah Formation (8–6 Ma) of the United Arab Emirates. Mleisa 1 preserves long trackways of a herd of proboscideans transected by that of a solitary individual. We used kite aerial photography to image the site and produce an orthographically-corrected photososaic from which the trackways were mapped and measured.

Living elephant societies are sex-segregated and multi-tiered, centered around matriarchal female units and solitary or loosely associated adult males. The trackways at Mleisa 1 provide direct evidence that herds of probably sex-segregation were also present in late Miocene proboscideans. The tight grouping, sub-parallel alignment, and low incidence of intersection or overlap in the main group of trackways indicates the herds of individuals walking together. Site mapping indicates there were no less than 13
individuals in the herd, and stride length profiles and resulting body mass estimates reveal a diversity of sizes including at least one small juvenile individual. This is commensurate with the size of modern elephant family units, and represents a rare example of social group size determination in the fossil record. In comparison, stride lengths for the solitary trackway are the largest recorded at the site, indicating that they were most likely made by a solitary elephant bull.

Though phylogenetic inference already indicated that elephant-like behavior should exist in the later Miocene, Mleisa 1 preserves some of the longest continuous trackways known for fossil vertebrates anywhere, with that of the solitary individual traceable over a distance of 260m. The study of Mleisa 1 also demonstrates the efficacy of kite aerial photography for the scientific study of sites of large magnitude.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

**LATÉ CRETACEOUS MARINE FISHES FROM THE UPPER GREENHORN LIMESTONE IN SOUTHEASTERN NEBRASKA, U.S.A.**

BICE, Kelly N., DePaul University, Chicago, IL, United States; SHIMADA, Kenshu, DePaul University, Chicago, IL, United States; KIRKLAND, James I., Utah Geological Survey, Salt Lake City, UT, United States

The Greenhorn Limestone is an Upper Cretaceous rock formation deposited in the middle of an epicontinental sea in North America, the Western Interior Seaway. The upper half of the formation is represented by the Jetmore Chalk and Pfeifer Shale members, and they are together characterized by chalky shale beds interbedded by limestone layers rich in invertebrates. These limestone beds mark the maximum transgression phase of the Greenhorn Cyclothem during the early Turonian. Vertebrate remains are known to occur sporadically in these beds, but there is limited information about their taxonomic diversity.

The University of Nebraska State Museum, Lincoln, houses an assemblage of fossil marine fishes from the upper half of the Greenhorn Limestone in southern Jefferson County, Nebraska, USA. These fossils are the results of surface collecting from the Jetmore-Pfeifer interval. The ichthyofauna consists of at least ten taxa, including six chondrichthyans (*Psychodus anomalus*, *P. occidentalis*, *P. cf. P. whipplei*, *Cardabiodon venator*, *Cretosyrhina montelli*, and *Squirolcaras cf. S. falcatus*) and four osteichthyans (*Xiphactinus audax*, *Pliothedus* indet., *Enchodus gladiolus*, and *E. shumardi*). The fish assemblage is small with a likely collecting bias towards larger taxa, but the fauna is important because it provides a glimpse into the paleobiology of the Western Interior Seaway during its peak transgression. In particular, it is noteworthy that the taxa are remarkably diverse ecologically, comprising durophagous (*Psychodus*), large predaceous (*Cardabiodon* and *Cretosyrhina*), and medium-sized opportunistic (*Squalicorax*) sharks as well as small (*Enchodus*), medium-sized (*Phleocephus*), and large (*Xiphactinus*) bony fishes.

The deposition of the upper Greenhorn Limestone represents an important time frame in the history of the Western Interior Seaway, notably marking the rise and radiation of the geologically earliest mosasaurs in North America. The present study of the Jetmore-Pfeifer interval demonstrates that the Greenhorn fish fauna suggests that the evolution of mosasaurian aps appears to have taken place in a stable fish community in the seaway. This is because practically all the fish taxa recognized also occur stratigraphically below (e.g., basal Lincoln Limestone) and above (e.g., Fairport Chalk) the Greenhorn.

Recent estimates of mean-annual temperature (MAT) in the early Eocene tropics based on the TEX86 temperature proxy indicate temperatures of 31.5 ± 2.3 °C, approaching the MAT maxima of modern tropical forests and mammalian communities (about 35°C). Tropical temperatures during early Eocene hyperthermal events were likely much higher, suggesting the possibility of coincident widespread equatorial heat-death. Terrestrial Paleogene mammals from the northern tropics of South America have been largely unknown, limiting our ability to directly test this hypothesis. A notable exception is the primitive xenungulate *Eotylopus bacatanensis* from the Bogotá Formation, Colombia. While previous studies of preserved pollen had indicated a middle-late Paleocene age, possibly contemporary (or slightly older) than a *Piacenzian* aged “Carinodonta Zone,” recently published U/Pb detrital zircon dates indicate an early Eocene (~53.6 ± 1.1 Ma) age for the mammal-bearing level of the Bogotá Formation. Ongoing fieldwork in the type locality of *E. bacatanensis* has already resulted in recovery of many additional vertebrate fossils including fish, amphibians, reptiles, and mammals. New mammals include an enigmatic small-bodied ungulate and multiple metatherians including several bunodont taxa referable to the Protodidelphidae. Although best known from late Paleocene-early Eocene of Brasil (Itaborai), protodontidels have also been recovered from the late early Eocene of central and western Patagonia, Argentina, and it has been suggested that their widespread occurrence corresponds to the presence of extensive tropical environments throughout South America. Presence of medium-sized herbivorous ungulates, a diversity of frugivorous/mimosivorous marsupials, arboreal rodents and iguanian lizards, and fossil leaves just before the Early Eocene Climatic Optimum and close to the Eocene Thermal Maximum 2 (~53.7 Ma) in tropical South America indicates that diverse tropical ecosystems survived at temperatures approaching their MAT maxima in the past.

**EARLY EOCENE MAMMALS FROM THE HOT TROPICS OF NORTHERN SOUTH AMERICA**

BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; RINCON, Aldo F., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; HEAD, Jason J., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; HERRERA, Fabiany, Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Balboa, Panama

**A MULTI-PERIODIC REAPPRAISAL OF DIET AND MICROHABITAT IN CHADRIANAN AND ORELLAN UNGULATES FROM NEBRASKA BASED ON STABLE ISOTOPES, MEWSOWEAR AND HYPSODONTY INDEX**

BOARDMAN, Grant S., University of Nebraska, Lincoln, NE, United States; SECORD, Ross, University of Nebraska, Lincoln, NE, United States

We infer diet and microhabitat for 12 ungulate taxa from Chadrianan (latest Eocene) and Orellan (earliest Oligocene) age deposits of the White River Group in Nebraska. This period of time is especially interesting because it samples an interval of climate change associated with the onset of the Cretaceous-Paleogene (KP) boundary event. We use carbon and oxygen isotope values of tooth enamel (δ13C and δ18O) to infer ancient habitats based on δ13C values in modern vegetation, corrected for changes in atmospheric composition and physiological enrichment from diet to enamel. Oxygen isotopes in enamel (δ18O) can be used to recognize semi-aquatic species. Mesowear data and hypsodonty index (HI) are used to interpret diet. Mesowear measures total dietary abrasion in ungulate dentition by assessing cusp shape and relief. We categorize “lifetime” diet by comparing the mesowear of fossil taxa to those of modern taxa of known diet via principle component and cluster analyses. Lastly we compare HI, which is strongly correlated with diet, with mesowear results to test consistency between proxies.

We studied 11 ungulate taxa from the Chadrianan, and 7 from the Orellan, with a total of 6 range-through taxa: Subhyracodon (rhinoerodont), Hyracodon (hyracodontid), Merycoidodon (equid), Archaeotherium (entelodont), Agrochoerua (agrochoerid), and Merycoidodon (merycoidodontid). Hypsodonty index indicates that all taxa were brachydont, and thus probably browsers, but mesowear suggests that Subhyracodon, Trigonias (also a rhinocerotid), Eotylopus (an orneromeryc), Leptocercus (an archaceothere), and Orellana Merycoidodon were probably mixed-feeders. High mean carbon values (~−8‰) and mesowear suggest that Merycoidodes and Agrochoerua were browsers in open microhabitats.
and intestines contents revealed that the animal didn’t die of starvation: the guts were full, the specimen was at least 4 years old, and possibly older (4.5 years). The cause of bison showed that this was a young, relatively small-sized animal. Judging by the condition of the mummy, Pearl Creek partial mummy, and Blue Babe mummy from Alaska, were found. Until now, only isolated body parts or partial bodies of adult Bison priscus has been found so far. The analyses thus not only provide new insights into the direct correlation between genetic expression and the morphology of presacral vertebrae in extinct and extant archosaurs. First, the Hox code for the formation of the presacral vertebra column in recent archosaurs was established. The available genetic information was expanded via whole-mount in situ hybridization experiments on embryos of nile crocodile. Next, the direct linkage between changes in Hox gene expression and the morphology of presacral vertebrae was tested in clinic. The osteoderm is alteration is seen in the osteoderm. We hypothesize that this is the result of diagenetic alteration. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. We thin-sectioned the right femoral midshaft and mandible, frontal, and several post-cranial elements, appears juvenile based on its small size and absence of closed neurocentral sutures. The taphonomy of vertebrate skeletal remains in the marine realm is poorly understood, with a majority of previous studies having focused on single skeletons, lagerstatten, or bonedebiogenesis. Few studies have attempted to document environmental gradients in preservation, and at such it has been difficult to establish a concrete taphonomic model for vertebrates in the shallow marine realm. The Neogene Purisima Formation of central California, a richly fossiliferous unit representing depositional settings from nearshore to offshore, offers a unique opportunity to examine preservational trends across these settings. Habitat preference and diet in range-through taxa remained stable, suggesting little habitat change through this interval of global climate change.
we sampled one wild caught and one captive individual. Thirty semi-landmarks around to explore morphological variation using geometric morphometrics. Within each species other hard materials the animal would not naturally interact with. Cervids were analyzed in between the animal and the substrate it traverses, may be morphologically variable within an Because of this, there is a chance that the third phalanx (PH3), which is in direct contact likely bear weight differently and have different biomechanical interactions with the ground. variance due to habitat type and substrate use. Forelimbs and hindlimbs in quadrupeds phalanx within different biotic levels, including within an individual, within a species, and determine the relationship between morphology, habitat, and substrate. We explore factors contributing to morphological variation in the shape of the plantar surface of the third determining the morphological trajectory of a straight PH3 to an angled PH3. After rank ordering the factors, the amount of explained variance is highest for substrate (2.91%). PC2 explained 20% of the total variance and represents the trajectory of a thin, tapered PH3 to blocky, robust PH3 morphology. Rank ordering the factors by explained variance of PC2 shows that habitat explains the most variance (22.12%). Although the amount of explained variance calculated with ANOVA for each factor explained little of the total variance (<3%) each in this exploratory study, the small sample size causes the analysis to have little power to detect differences within and between factors. With a larger sample size, greater variation in the sample among factors will be detectable. Early results show no variation exists between forelimb and hindlimb PH3 in an individual and cervid PH3 morphology is best explained by substrate and habitat interaction with phylogeny following closely behind. In addition, studies interested in PH3 ecomorphology may use captive animals within their sample.

Virtual brain endocasts shed new light on the early evolution of modern birds (Neornithes)
Bourdon, Estelle, The Natural History Museum, London, United Kingdom; Milner, Angela C., The Natural History Museum, London, United Kingdom; WalSH, Stig A., National Museums Scotland, Edinburgh, United Kingdom
Recent studies of the brain anatomy of Palaeogene birds using high resolution X-ray computed tomography (CT) have provided an important source of phylogenetic information for avian systematics. Although the basal most divergences of modern birds (Neornithes) are well supported by both molecular and morphological studies, the phylogenetic placement of many Cenozoic avian groups remains controversial. We used CT slice data to obtain virtual brain endocasts for a broad selection of extinct and extant avian species. The sample consists of 50 living species encompassing all major neornithine clades, plus several key Cenozoic taxa including Lithornis (Lithornithidae), Davesornis (Pelagornithidae), Proopterygion (Phaethontidae), Seiornis (Hydrochoeridae), and Patagornis (Phorusrhacidae). Outgroup comparison is made with non-avian theropod dinosaurs and non-neornithine birds such as Archaeopteryx and Enantiornithes. Anatomical characters used for phylogenetic analysis include: (1) position/shape of different brain regions; (2) form/shape of cranial nerves, blood vessels and sinuses; (3) size of various brain regions relative to overall brain size. We aim to (1) provide a clearer picture of the evolution of various brain regions from the origin of birds to the present, and (2) shed new light on the early diversification of modern birds. This will enable testing of the hypothesis that telencephalic expansion conferred modern birds with an advantage over more basal avian clades at the end of the Cretaceous.

Dorsal or Rostral Nostrials? Testing Fleshy Nostil Position and Airflow in Sauropods Using Computational Fluid Dynamics
Bourke, Jason M., Ohio University, Athens, OH, United States; Porter, William R., Ohio University, Athens, OH, United States; Wittmer, Lawrence M., Ohio University, Athens, OH, United States
The enlarged and caudally retracted bony nasal opening in sauropods has led to conflicting ideas regarding nostril placement. As a soft-tissue structure with few direct bony associations, the fleshy nostril has proven problematic for sauropod life restorations and, more importantly, for understanding sauropod nasal physiology. Early work based on presumed aquatic lifestyles placed the nostrils high on the head. More recent interpretations—based on the anatomy of sauropods and extant outgroups—have argued for a nostril position farther down the snout. We test these varying nostril positions using computer simulations of fluid dynamics. Conservative hypotheses of nasal capsule morphology in the macronarian Camarasaurus and the diplodocoid Diplodocus were generated based on osteological correlates for soft-tissue boundaries using the software Avizos, Maya, and Madbox. Fleshy nostril and choanal placement were manipulated iteratively to test the range of hypotheses proposed. These models were subjected to a computational fluid dynamic analysis using Fluent, simulating a single breath during resting respiration. Fleshy nostril position greatly affected air movement throughout the nasal capsule. Modeling dorsally placed nostrils in Camarasaurus resulted in a direct route to the throat, leaving unreconstructly stagnant airfields in both the rostral end of the nasal capsule and the caudodorsally placed olfactory chamber. Replacement of the fleshy nostril, however, resulted in an airflow pattern more consistent with that seen in our studies of extant sauropods, including a separation of the airfield into two streams, a relatively fast-moving air stream directed to the oropharynx, along with a slower moving olfactory stream. Further manipulation of the airflow was performed to better reflect airflow patterns seen in extant archosaurs. This anatomical arrangement would have enhanced airflow into the olfactory chamber, which is consistent with olfactory bulb size in Camarasaurus. The more caudally placed bony airflow of Diplodocus was more informative of general nasal capsule shape. The caudally retracted bony nasal opening, coupled with the rostrally shifted choana, produced a sinuous airway even when the fleshy nostril was modeled in its traditional dorsal position, but, again, leaving the rostral portion of the nasal capsule as an unrealistic cul-de-sac. A more rostrally positioned fleshy nostril resulted not only in an airway more consistent with our extant findings, but also a very long S-shaped airway. Both taxa exhibit intimate associations of nasal vasculature with the nasal capsule, particularly in the rostral region that was so sensitive to modeled nostril position, suggesting considerable potential for heat-exchange in these sauropods.
Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

ASSessing SPECIES DIVERSITY AND INTRASPECIFIC VARIABILITY IN SHIELD-TAILED TURTLES (Testudinidae, Hesperotestudo) SPANNING THE EARLY CLAREDONIAN THROUGH LATE RANCHOLABREA OF FLORIDA
BOURQUE, Jason R., Florida Museum of Natural History, Gainesville, FL, United States; HULBERT Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States; WOOD, Aarón R., Florida Museum of Natural History, Gainesville, FL, United States

An extinct clade of small (adult carapace length 15–26 cm) land tortoises persisted in Florida from at least the middle–late Miocene to the end of the Pleistocene, a duration of 11–12 million years. Three species have been formally named from the southeastern United States: Hesperotestudo allenii (late Miocene); Hesperotestudo mylnarskii (middle Pleistocene); and Hesperotestudo incisa (late Pleistocene). Members of this clade possess a round to ovate tail shield (supracaudal buckler) comprised of osteoderms that articulate with the caudal vertebrae, a unique feature among testudinids. An extensive sample of both previously and recently collected Hesperotestudo fossils from the middle to late Miocene, early Pleistocene, and early through late Pleistocene of Florida fill in major temporal gaps in the fossil record. These fossils have increased the available material needed to attempt quantitatively and qualitatively analyzing evolutionary patterns within this clade. Specimens largely comprise isolated shell bones, but include two partial shells from the late Hemphillian Swift Mine, and one complete and two partial shells (as well as six whole and partial tail bucklers) from the Blancan Inglis 1C locality. Three-dimensional (3D) geometric morphometric analyses of isolated nuchals, pygals, epiplastra, and xiphiplastra were conducted using a surface laser-scanner to locate semi-landmarks in a xz-grid system encompassing the full 3D surface of each element. Principal components analyses were then used to find clusters in morphospace. The combined results from the analyses were used to delimit and better define species. Preliminary results suggest that two morphologically distinct lineages within this morphospace. The combined results from the analyses were used to delimit and better define species. The recovered strict consensus topology is the most highly resolved phylogenetic hypothesis of basal Ornithischian relationships yet proposed and agrees with other recent hypotheses in recovering heterodontosaurids near the base of Ornithischia. Most taxa previously referred to as ‘hypsilophodontids’ are recovered as non-cerapodan basal neornithischians, and a new clade is recovered as the sister taxon to Cerapoda that contains many ‘hypsilophodontid’ taxa. This dataset was also analyzed using Bayesian methods to determine, via comparison of Bayes factors, whether there is support for partitioning the dataset by anatomical subregions (e.g., cranial versus postcranial) or if a single partition model is preferred. The results of this latter analysis provide an quantitative means of assessing the traditional assumption that cranial characters are more important for resolving ornithischian relationships than postcranial characters.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE JAW ONTOGENY OF Dunkleosteus terrelli (PLACODERM, ARTHRODIRA) SUGGESTS AN ACTIVE PREDATORY HABIT THROUGHOUT GROWTH
BOYLE, James T., State University of New York at Buffalo, Buffalo, NY, United States; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; SNIVELY, Eric, Ohio University, Athens, OH, United States; HILAVIN, William J., Bass Energy, Inc., Fairlawn, OH, United States; BOYD, Clint A., South Dakota School of Mines and Technology, Rapid City, SD, United States

The illusion of systematic stability within Ornithischia has slowly eroded over the past decade, first by the dissolution of Cerapoda and latter by the removal of heterodontosaurids from within Ornithopoda to near the base of Ornithischia. Most recently, some phylogenetic analyses of basal ornithischian relationships recovered some former ‘hypsilophodontids’ as non-cerapodan basal neornithischians, further restricting the taxonomic contents of Ornithopoda. Additionally, the interrelationships of many other ‘hypsilophodontid’ taxa were incompletely resolved in these analyses and in many cases their placement within Cerapoda was uncertain. Thus, the unresolved systematic relationships of ‘hypsilophodontid’ taxa remain one of the largest impediments to clarifying basal ornithischian relationships and understanding the evolution of major ornithischian subclades. Prior analyses of this clade were hampered by the fact that the hypodigm material of many ‘hypsilophodontid’ taxa is highly fragmentary, obscuring crucial character data. The recent discovery of several new ‘hypsilophodontid’ taxa and the referral of more complete specimens to known taxa provide important new data pertinent to addressing this issue. This study supplements these recent advances with additional data regarding the anatomy of ‘hypsilophodontid’ taxa from the latest Cretaceous of North America gleaned from a thorough restudy of published specimens and examination of several recently discovered specimens referable to both previously described and newly recognized ‘hypsilophodontid’ taxa. These new data were compiled into a dataset designed to assess basal ornithischian relationships that included 39 ornithischian terminal taxa (all species exemplars), including 27 ‘hypsilophodontid’ taxa. The recovered strict consensus topology is the most highly resolved phylogenetic hypothesis of basal ornithischian relationships yet proposed and agrees with other recent hypotheses in recovering heterodontosaurids near the base of Ornithischia. Most taxa previously referred to as ‘hypsilophodontids’ are recovered as non-cerapodan basal neornithischians, and a new clade is recovered as the sister taxon to Cerapoda that contains many ‘hypsilophodontid’ taxa. This dataset was also analyzed using Bayesian methods to determine, via comparison of Bayes factors, whether there is support for partitioning the dataset by anatomical subregions (e.g., cranial versus postcranial) or if a single partition model is preferred. The results of this latter analysis provide a quantitative means of assessing the traditional assumption that cranial characters are more important for resolving ornithischian relationships than postcranial characters.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

Adding ADDRESSING THE ‘HYPsiLOPHODONTID’ PROBLEM IN ANALYSES OF BASAL ORNITHISCIAN RELATIONSHIPS: NEW TAXA, NEW DATA, NEW HYPOThESIS
BOYD, Alec A., UC Davis, Davis, CA, United States

Terrestrial vertebrates have reeceived the aquatic realm numerous times since they first colonized land in the Devonian period. Each reeision has followed a unique evolutionary pathway making the classification of an extinct taxon as being aquatic or terrestrial based purely on skeletal morphology is confounded by the fragmentation and usually incomplete nature of fossil vertebrate remains. Observation and comparison of vertebrae of extant aquatic and terrestrial vertebrates suggest that aquatic creatures have a more “simple” vertebral shape. This correlation of form and environment is most likely due to the lesserened effects of gravity in the aquatic realm. I believe this difference will be magnified in the cervical vertebrae as they serve to support the weight of the head. To test this hypothesis a suite of linear character measurements were recorded for the cervical vertebrae of numerous reptiles and mammals representing aquatic, terrestrial and amphibious lifestyles. Principle component analyses showed that aquatic mammals separated clearly from amphibious and terrestrial mammals on the second principle component axis, but amphibious specimens showed no clear separation from terrestrial organisms. Similar results were obtained from the analysis of the reptilian taxa; however, the separation was not nearly as clear as it was for the mammalian taxa. The results of a discriminant analysis of the mammalian and reptilian data further supports the trends observed in the principle component analyses. The discriminant analysis also shows that the characters and structures that best separate these environmental groups are associated primarily with ligaments that aid in structural support of the axial skeleton and serve to bear the weight of the head. The classification scheme based on these measurements will provide a useful tool for the classification and understanding of extinct organisms based on limited skeletal remains.

Technical Session SATV(X Wednesday, October 20, 8:45 am)

ADDRESSING THE ‘HYPsiLOPHODONTID’ PROBLEM IN ANALYSES OF BASAL ORNITHISCIAN RELATIONSHIPS: NEW TAXA, NEW DATA, NEW HYPOThESIS
BOYD, Clint A., South Dakota School of Mines and Technology, Rapid City, SD, United States

The illusion of systematic stability within Ornithischia has slowly eroded over the past decade, first by the dissolution of Cerapoda and latter by the removal of heterodontosaurids from within Ornithopoda to near the base of Ornithischia. Most recently, some phylogenetic analyses of basal ornithischian relationships recovered some former ‘hypsilophodontids’ as non-cerapodan basal neornithischians, further restricting the taxonomic contents of Ornithopoda. Additionally, the interrelationships of many other ‘hypsilophodontid’ taxa were incompletely resolved in these analyses and in many cases their placement within Cerapoda was uncertain. Thus, the unresolved systematic relationships of ‘hypsilophodontid’ taxa remain one of the largest impediments to clarifying basal ornithischian relationships and understanding the evolution of major ornithischian subclades. Prior analyses of this clade were hampered by the fact that the hypodigm material of many ‘hypsilophodontid’ taxa is highly fragmentary, obscuring crucial character data. The recent discovery of several new ‘hypsilophodontid’ taxa and the referral of more complete specimens to known taxa provide important new data pertinent to addressing this issue. This study supplements these recent advances with additional data regarding the anatomy of ‘hypsilophodontid’ taxa from the latest Cretaceous of North America gleaned from a thorough restudy of published specimens and examination of several recently discovered specimens referable to both previously described and newly recognized ‘hypsilophodontid’ taxa. These new data were compiled into a dataset designed to assess basal ornithischian relationships that included 39 ornithischian terminal taxa (all species exemplars), including 27 ‘hypsilophodontid’ taxa. The recovered strict consensus topology is the most highly resolved phylogenetic hypothesis of basal ornithischian relationships yet proposed and agrees with other recent hypotheses in recovering heterodontosaurids near the base of Ornithischia. Most taxa previously referred to as ‘hypsilophodontids’ are recovered as non-cerapodan basal neornithischians, and a new clade is recovered as the sister taxon to Cerapoda that contains many ‘hypsilophodontid’ taxa. This dataset was also analyzed using Bayesian methods to determine, via comparison of Bayes factors, whether there is support for partitioning the dataset by anatomical subregions (e.g., cranial versus postcranial) or if a single partition model is preferred. The results of this latter analysis provide a quantitative means of assessing the traditional assumption that cranial characters are more important for resolving ornithischian relationships than postcranial characters.

Comparative COMPARATIVE TAPHONOMY OF CERATOPSID BONEBEDS: IMPLICATIONS OF NEW DATA FROM SOUTHERN LARAMIDIA
BRANDAU, Deanna L., Natural History Museum of Utah and Dept. Geology and Geophysics, University of Utah, Salt Lake City, UT, United States; ERMSI, Randall B., Natural History Museum of Utah and Dept. Geology and Geophysics, University of Utah, Salt Lake City, UT, United States

Ceratopsid (horned dinosaur) fossils are well-known for preservation in multi-individual assemblages, but this is an oversimplification. Chaamasaurine ceratopsid bonebeds are rare; most specimens are found as isolated individuals. The few known chaamasaurine bonebeds are predominantly juvenile remains and number 2–3 individuals, except for Agujaceratops (up to 10 individuals). These bonebeds typically comprise disarticulated elements preserved in low energy, finer-grained floodplain/overbank deposits with low levels of taphonomic

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modification. In contrast, centrosaurine bonebeds are predominantly attributed to mass mortality events (flooding) encompassing dozens to hundreds of individuals from all size classes. These monodominant disarticulated bonebeds are more often associated with high energy, thick paleochannel deposits and are thought to be hydraulically reworked from overbank deposits, displaying higher amounts taphonomic modification. However, most of these data are from northern Laramidia (e.g., Montana and Alberta).

Our sedimentologic and taphonomic study of two new chasmosaurine bonebeds from the middle Campanian Kaiparowits Formation in southern Utah provides insight into ceratopsid taphonomic patterns and paleoenvironmental associations. These Kaiparowits Formation sites are similar to other chasmosaurine bonebeds in being rare compared to isolated chasmosaurine specimens, comprising 2–3 individuals, exhibit low taphonomic modification, and little hydraulic reworking. One Kaiparowits bonebed was deposited as disarticulated skeletal remains in a channel, whereas the other includes articulated skeletons in a crevasse splay setting.

Because all ceratopsid bonebeds exhibit broadly similar depositional, paleoecologic, tectonic, and basin settings, an alternate explanation is necessary for the rarity of chasmosaurine bonebeds. Although the Kaiparowits Formation has sedimentation rates (0.4–12 cm/ka), chasmosaurine bonebeds are still rare in northern Laramidian formations where sedimentation rates are much lower (4–12.5 cm/ka), which suggests this does not solely explain the difference in preservation. Because chasmosaurine bonebeds are typically found in overbank deposits, and the Kaiparowits Formation has a higher ratio of overbank-hosted deposits to paleochannels, one would expect chasmosaurine bonebeds to be more common in the Kaiparowits Formation, but this is not the case. Therefore, differences between chasmosaurine and centrosaurine bonebeds appear to be better attributed to behavior or ecology, where chasmosaurines were solitary or lived in small groups, but centrosaurines congregated in larger social groups at least occasionally.

Preparers’ Session (Thursday, October 18, 11:45 am)
STATE-OF-THE-ART DIGITAL DATA COLLECTION OF PALEONTOLOGICAL RESOURCES: COMPARING METHODS OF CAPTURE AND QUANTIFYING RESULTS OF 3D POINT CLOUD DATA
BREITHAUPT, Brent H., DOI-Bureau of Land Management, Cheyenne, WY, United States; MATTHEWS, Neffra A., DOI-Bureau of Land Management, Denver, CO, United States; NOBLE, Tommy A., DOI-Bureau of Land Management, Denver, CO, United States
During the last decade there has been a marked increase in the use of 3D data capture for the purpose of documentation, evaluation, and preservation of paleontological resources. Subjects can vary from an isolated tooth to an entire bonebed or from a single fossil footprint to an entire tracksite. The most notable methods for capturing 3D data of paleontological subjects are LIDAR and photogrammetry. Photogrammetric point cloud data (PPCD) contain both the external physical dimensionality of a subject and a high-quality image texture registered precisely for each data point (x,y,z,r,g,b file). Excellent results can be achieved from photogrammetry when the software solves for a robust camera calibration and when overlapping photographs are taken with proper geometry. Resulting PPCD can easily achieve submillimeter precision and be used to produce accurate rapid prototypes. Because of the computational power of the new generation of photogrammetric software, hundreds of photographs can be processed in a reasonable time and stitching the overlapping areas of subjects “in the round.” Advances to software and cameras allow this technique to be used on paleontological specimens of all shapes and sizes in the field, lab, and collections. Relatively low-cost and even free online services allow curators, collections managers and preparators to document material in their collections for research, management, and preparation purposes. Three-dimensional image datasets provide a permanent digital record of paleontological resources and is a non-destructive method to obtain 3D data assessment and can support the creation of comprehensive 3D digital models that can lead to better science–based management decisions, which require that state-of-the-art methodologies be used in the documentation of paleontological resources in accordance with current paleontological legislation (PPRA). In addition, open source software is available for manipulating, scaling, and comparing point cloud data. This not only makes it affordable to use and compare 3D data obtained from various sources, but also makes it possible to conduct scientific evaluation of paleontological subjects. Several studies have been conducted comparing LIDAR and photogrammetry methods. Recent comparisons demonstrate that photogrammetry can be generated at a level that meets (or exceeds) the instrument specifications for the LIDAR unit used in the comparison. Once a PPCD is generated, analytical tools support direct 3D comparison of anatomic features, such as individual skull bones or tracks within a trackway. Virtually every paleontologist has the basic equipment (i.e., scale bar and camera) necessary to successfully create paleontologically useful PPCD.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
DENTAL HISTOLOGY AND TOOTH IMPLANTATION IN EARLY PERMIAN NON-MAMMALIAN SYNAPSIDS
BRINK, Kirstin S., University of Toronto Mississauga, Mississauga, ON, Canada; LEBLANC, Aaron R., University of Toronto Mississauga, Mississauga, ON, Canada; SANDER, P. Martin, University of Bonn, Bonn, Germany; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada
The tooth implantation of non-mammalian synapsids has been previously described as protodont or submultidentate, based on the macroscopic observation that the tooth root is implanted in a shallow socket and separated from neighboring teeth by bone or other connective tissues. However, the mode of tooth implantation in non-mammalian synapsids is poorly known, because the teeth and tooth attachment tissues of these lineages have never been described histologically in any detail. Here, we describe for the first time the tooth attachment of marginal and palatal teeth of sphenacodontids and the marginal dentition of a pygmy tritylodont using histological methods. Dental and marginal teeth of Sphenacodon, Dimetrodon natans, Dimetrodon grandis, and an undescribed varanodont from Oklahoma as well as the teeth of the pterygoid flange and the palatal surface of the pterygoid of Dimetrodon limbatus were examined in longitudinal and transverse sections. We observed that the labial walls of the tooth bearing elements are higher than the lingual walls in all four taxa, creating a superficially pterodont implantation, but all marginal teeth are implanted in true sockets lined with vascularized alveolar bone. The teeth are ankylosed to the alveolar bone but not to each other through a layer of acellular cementum. The pterygoid teeth of Dimetrodon are also connected to alveolar bone by a layer of acellular cementum. Interestingly, these non-mammalian synapsids exhibit plicidentine (infolding of the dentine at the tooth root), a first for Synapsida. The dentine infoldings in Sphenacodon and Dimetrodon have a four-lobed shape below the level of the jaw line, which becomes convoluted closer to the base of the tooth. By comparison, plicidentine in the varanodont is not present, but the four lobes persist in sphenacodontids and are noted to be highest in the root of the tooth. We hypothesize that plicidentine in these non-mammalian synapsids played a role in increasing the surface area of attachment for cementum and alveolar bone at the base of the tooth root. The results of this analysis suggest that development of palatal and marginal dentitions in non-mammalian synapsids is regulated by similar mechanisms regardless of the tooth position in the skull. The occurrence of plicidentine, cementum, and alveolar bone in Early Permian synapsids suggests that the presence of these tissues is plesiomorphic for Synapsida.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:00 am)
SOUTHERN NORTHERN CROCODILES: BOREALOSUCHUS FROM THE CAMPAIGN OF ALABAMA AND THE EARLY BIOGEOGRAPHIC HISTORY OF CROCODYLIA N IN NORTH AMERICA
BROCHU, Christopher A., University of Iowa, Iowa City, IA, United States; DENTON, Robert K., GeoConcepts Engineering, Inc., Ashburn, VA, United States; GRANDSTAFF, B. wilsoni, the new form retains a robust splenial

B. threeensis, the new form retains a robust splenial

the tooth position in the skull. The occurrence of plicidentine, cementum, and alveolar bone in Early Permian synapsids suggests that the presence of these tissues is plesiomorphic for Synapsida.

As mentioned, the Late Cretaceous Borealosuchus are more closely related to species from the Late Paleocene and Eocene than they are to Mammalochirine-Palaeocene western members of the clade, suggesting a substantial unsampled history for the group. Most other eastern crocodyliforms belong to groups found in western North America, and the only other group that has a presence in the Middle to Late Eocene is the African crocodyliforms is limited to coastal groups (e.g. thracosuchids, dyrosaurids). Whether this pattern reflects dispersal or vicariance driven by the rising and falling Western Interior Seaway, and the number and timing of such events, is unclear. The absence of an external mandibular fenestra in the new species, as well as in early putative gavialoids and several

Borealosuchus

Middle Eocene of North America. Unlike either B. wilsoni or B. threeensis, the new form retains a robust splenial synp...
outgroups to Crocodylia, raises questions about the homology of the structure in extant crocodylians; and liability of Boreolaelaps relative to other basal crocodylian clades in our results reveals sensitivity of crocodylian phylogenetic analyses to outgroup sampling.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

**SKULL SHAPE VARIATION IN LEPIDOSAURS: THE INFLUENCE OF ECOLOGY AND PHYLOGENY**

BROCKLEHURST, Neil, Museum für Naturkunde, Leibniz-Institut für Evolutions und Biodiversitätsforschung, Berlin, Germany

Studies on various vertebrate groups have unsurprisingly shown a link between cranial morphology and diet. Studies focused on lizards, however, have produced conflicting results, with some showing little correlation between diet and skull and tooth morphology, and others finding variation in snout shape between carnivorous and herbivorous groups. This investigation focused not only on lizards but also on Rhynchocephalia, both extant and extinct. Measurements were made on the cranium in ventral view, with landmarks positioned around the tooth row and adductor chamber to represent their shape. These landmarks were analysed using the geometric morphometric software Morphologika to examine how skull shape differs between species. Three significant principal components were identified by Morphologika. As Principal Component 1 (PC1) increases in value, the distance between the tooth rows increases, and the distance between the tooth rows and the adductor chambers decreases. As the value of PC2 increases, the tooth row shortens, and the adductor chamber increases in size. PC3 relates to the position of the quadrates relative to each other. As the value increases, the quadrates move closer together. Results show that species within the same clades tend to have similar cranial shapes, but within each clade morphology varies according to dietary specialisation. Predators such as Varanus and Teiidae usually have longer, narrower tooth rows and widely spaced quadrates whereas herbivores like the Iguanidae and the rhynchocephalians Prisosphenodon have relatively larger adductor chambers, positioned closer to the tooth row. Long, narrow tooth rows (reflecting elongate rostra) are also a feature of aquatic lizards. Accredent iguanians and Rhynchocephalia show a similar tooth-row outline, suggesting they occupied similar niches, a factor that may have contributed to the decline of the Rhynchocephalia towards the end of the Mesozoic.

Technical Session IV (Wednesday, October 17, 4:00 pm)

**EVIDENCE FOR TAPHONOMIC SIZE BIAS IN A MODEL MESOZOIC TERRESTRIAL ALLUVIAL-PARALIC SYSTEM**

BROWN, Caleb M., University of Toronto, Toronto, ON, Canada; EVANS, David C., University of Toronto/Royal Ontario Museum, Toronto, ON, Canada; CAMPIONE, Nicolás E., University of Toronto, Toronto, ON, Canada; O'BRIEN, Lorna J.; University of Toronto, Toronto, ON, Canada; EBERTH, David A., Royal Tyrrell Museum , Drumheller, AB, Canada

The body-size distribution of dinosaurs reveals a prominent negative skew (towards large body size), a pattern opposite to modern terrestrial faunas. Here, we test if this pattern is a biological feature of dinosaur faunas or the result of taphonomic processes. We use the Dinosaur Park Formation (DPF: Campanian, Alberta) as a model to examine the relationship of body-size (estimated body mass) with taphonomic/sampling proxies, such as taxon completeness, taphonomic mode, and year of discovery/description, to test the hypothesis that the distribution of body-size in dinosaurs is biased by preservation potential. We find a direct correlation between taxon size and known skeletal completeness (r=0.90, p<0.001). In particular, there is a clear dichotomy in which taxa <60 kg are significantly less complete (mean completeness = ~8%) than those ≥60 kg (~78%). There is also a strong association of body-size and taphonomic mode, with small taxa known largely from isolated and occasionally associated remains, and large taxa known mainly from articulated skeletons. All correlations are consistent both within and between taxonomic groups (e.g., Dinosauria, Ornithischia, Theropoda, Ornithopoda, etc.). A significant correlation is also noted between body mass and both its date of discovery and description, with taxa <60 kg taking an average of ~60 and ~75 years to discover and describe, respectively, compared to ~30 and ~36 years for taxa ≥60 kg. The rates of both accumulative discovery and description for large taxa are best described by a logarithmic curve near an asymptote, while small taxa show either a linear or power law increase through time. This suggests our current knowledge of the large-bodied dinosaur assemblages is representative of the true biological fauna with few discoveries likely to be made in the future, while the diversity and abundance of small taxa are greatly underestimated, with more discoveries to be made. Our results indicate that the interpretation of the paleoecology of the DPF requires recognition of this taphonomic bias, which greatly reduces its compositional fidelity for small-bodied forms. Given that (1) the sedimentary deposits and fossil assemblages of the DPF represent one of the best studied examples of a Mesozoic alluvial-parallic (terrestrial) ‘paleoecosystem,’ and (2) similar patterns have been suggested (but not documented) for other Mesozoic terrestrial ecosystems in the Western Interior of North America, we suggest this pattern of taphonomic size bias may typify vertebrate fossil assemblages in Mesozoic systems. If so, such biases must be considered before patterns of diversity in dinosaur communities through time can be accurately reconstructed, or used to compare and interpret Mesozoic paleoecosystems.

Preparers’ Session (Thursday, October 18, 10:45 am)

**TECHNIQUES AND MATERIALS FOR MICROFOSSIL PREPARATION: MAXIMIZING SUCCESS AND MINIMIZING STRESS**

BROWN, Gregory W., University of Nebraska State Museum, Lincoln, NE, United States

Microfossil preparation is probably the most difficult and stressful job a preparator can undertake. Although successful microfossil preparation requires considerable skill, dexterity and patience, no level of these attributes can overcome the powerful influences of using poor equipment, techniques and materials. On this scale, even minor errors in judgment or execution can result in disastrous loss of data. By optimizing our tools, techniques and materials we can maximize successful outcomes. Proper tools include a stereo microscope with zoom capability and quality optics, a variety of light sources, a stable work-holding stage or jig (a ball-mount), precision preparation tools that provide maximum control (carbide) and minimum damage (polished points of various shapes, insect needles, porcupine quills), hand/arm support that provides optimum positioning and support, and ergonomic seating. Useful materials include various reaction and solution adhesives, specimen supports (polyethylene glycol, cyclododecane) and temporary positioning aids (waxes, plastilime). Techniques include using light of various wavelengths or color temperatures to help differentiate between matrix and bone, enhancing visual perception by preparing through and within water-droplets and using capillary action to apply adhesives, among others. Technique is the most difficult category to describe precisely because, as is true in all other aspects of preparation, each situation encountered will demand a new or significantly modified technique. The best strategy is ‘workstation setup’ (i.e., a workstation specific to your intended use for the microscope and work stage, a method of minimizing the possibility of fragment-loss, arrangement of tools and maintaining work area cleanliness all contribute to the quality of microfossil preparation and may be the difference between a job well-done and a specimen essentially lost to science.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:15 am)

**ON THE UTILITY OF LIKELIHOOD MODELS FOR PHYLOGENETIC RECONSTRUCTION FROM DISCRETE MORPHOLOGICAL CHARACTERS**

BROWN, Joseph W., University of Idaho, Moscow, ID, United States; SLATER, Graham J., UCLA, Los Angeles, CA, United States

After a relatively slow reception a decade ago, morphological likelihood (Mk) models are emerging as a popular alternative to parsimony for phylogenetic reconstruction from discrete morphological characters. The reason for this recent uptake in use is that Mk offers several promising features, chief among which are: 1) the ability to apply likelihood methods to paleontological data (including branch length estimation), and 2) the ability to incorporate molecular and morphological data into a single joint model-based phylogenetic analysis. Despite these promising features, Mk is based on two very strict assumptions: 1) that all character state transitions occur at the same rate, and 2) that the equilibrium frequencies of all character states are equal. These assumptions are clearly wrong, but it is not clear whether these are ‘importantly wrong’ (i.e., оказывает большую, незначительную ошибку). Here we use simulation methods to investigate how model assumption violations impact phylogenetic reconstruction accuracy. Failing to accommodate differences in character state frequencies misleads phylogenetic reconstruction, frequently returning incorrect but highly-supported trees. Violation of the equal transition rate assumption likewise misleads phylogenetic reconstruction, the degree of which depends on the extent of model violation. Results are presented exploring a range of simulation conditions, as well as for an empirical study of archosaurs.

Preparers’ Session (Thursday, October 18, 12:00 pm)

**VERTEBRATE PALEONTOLOGICAL PREPARATION CORE COMPETENCIES AND TRAINING CURRICULUM: RESULTS FROM THE 2012 AUSTIN WORKSHOP**

BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States; DAVIDSON, Amy, American Museum of Natural History, New York, NY, United States; FOX, Marilyn, Yale Peabody Museum, New Haven, CT, United States; JABO, Steven J., Smithsonian National Museum of Natural History, Washington, DC, United States; SMITH, Matt, Petrified Forest National Park, Petrified Forest, AZ, United States

A number of organizations responsible for the care of fossils call for preparation by individuals with specialized training (e.g., Society of Vertebrate Paleontology, National Park Service). At present, there is no consensus as to what constitutes a trained or qualified preparator. A writing workshop at The University of Texas at Austin (UT) Vertebrate Paleontology Laboratory was organized to address this gap between policy and practice. The goal of the workshop was originally to produce preparation standards documents and a curriculum for training and evaluating preparators. In practice, such a project exceeded the time constraints imposed by the one week available to the authors, thus the aim was shifted to defining the trained preparator and creating a model syllabus for teaching basic paleontology laboratory practices. Through this workshop, a team of five preparators drafted a competencies document encompassing the fundamental knowledge, skills, and abilities that typify capable fossil preparators. Twenty-one competencies were identified and elaborated upon, covering areas such as: Critical Thinking, Understanding of Conservation Principles and Ethics, Understanding and Aptitude in the Use of Preparation Tools and Techniques, and Understanding and Use of Adhesives. The competencies were subsequently used to create a model syllabus for an introductory course in fossil preparation. The course is designed to provide students with an overview of the methods commonly used in fossil preparation.
encountered in paleontology laboratories, including preparation, conservation, molding, and casting, exposure to a range of tools and techniques, as well as an introduction to the relevant literature. The syllabus can be easily modified and adopted by other institutions and ensures that students are grounded in the basics of good preparation. The syllabus was also designed to be scalable, allowing it to (e.g., modules can be individually expanded to constitute a short workshop or fill an entire semester. This framework can then function as a broader curriculum for formal or informal training in paleontological preparation. Discussions during the workshop highlighted the need for continuing work toward training programs and standards in preparation. These competencies will provide a foundation for this continuing discussion of standards and best practices in vertebrate paleontological preparation. The core competencies and syllabus may eventually be useful as a basis for certification of vertebrate fossil preparators, as well as provide guidance for hiring officials when writing job descriptions or evaluating applicants for preparation positions.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleocology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:15 am) THERIOPOD DINOSAURS FROM THE LATE CRETACEOUS OF EASTERN NORTH AMERICA: ANATOMY, SYSTEMATICS, BIOGEOGRAPHY AND NEW INFORMATION FROM HISTORIC SPECIMENS BRUSATTE, Stephen L., American Museum of Natural History, New York, NY, United States; CHONIERE, Jonah N., American Museum of Natural History, New York, NY, United States; BENSON, Roger B., University College London, London, United Kingdom; CARR, Thomas D., Carthage College, Kenosha, WI, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States During the late Cretaceous (Campanian-Maastrichtian), when North America was bisected by the Western Interior Seaway, a diverse fauna of carnivorous theropod dinosaurs ranged across the western half of the continent (Laramidia). Some of these taxa, such as Tyrannosaurus and Dromeosaurus, are among the most familiar dinosaurian carnivores of the Mesozoic. Considerably less is known about the theropods that lived in eastern North America (Appalachia) at this time. Their sparse fossil record has frustrated scientists since the first discoveries of theropods in New Jersey and surrounding states by Cope, Leidy, and colleagues in the mid-1800s. Over the past decade, new fossil discoveries and reinterpretations of historic specimens, studied in the context of an ever-growing phylogenetic understanding of theropods, have shed new light on Appalachian theropod faunas. Reasonably complete and diagnostic specimens are rare, but the inventory of Appalachian Late Cretaceous theropods in major museum collections includes specimens of at least three diagnostically taxa: two tyrannosaurids (Appalachiosaurus montgomeriensis, Dryosaurus aquilunguis) and an ornithomimosaur (Ornithomimus antiquus), as well as additional material assigned to the ornithomimosaur (Therizinosaurus antiquus). Other taxa are represented by three of these three taxa based on shared derived characters. A. montgomeriensis, from the mid-Cretaceous Dernomorphos Formation of Alabama, and D. aquilunguis, from the Maastrichtian New Egypt Formation of New Jersey, are both known from holotypes that preserve several cranial and postcranial bones. A recent phylogeny of Tyrannosauridae shows that both A. montgomeriensis and D. aquilunguis are "intermediate" tyrannosaurids, nested between basal taxa such as Guallong and Dilong and the derived, large-bodied Tyrannosauridae, the clade consisting of Albertosaurus, Tyrannosaurus, and kin that were apex predators in western North America and Asia during the latest Cretaceous. Therefore, the eastern North American taxa are considerably more basal than their western contemporaries, suggesting that Late Cretaceous Appalachian may have been a refugium for relic species. The long-mysterious "O. antiquus" is represented by two specimens from the Maastrichtian of New Jersey originally described by Leidy. It can be referred to Ornithomimosauridae based on the gracile, auricularia-metatarsalian pes that lacks a deep notch proximally on the metatarsal II, and is diagnosed as a distinct taxon by autapomorphic bulbous medial condyle on the tibia. Phylogenetic analysis suggests that it is a relatively derived ornithomimosaur, closely related to Ornithomimus and Gallimimus. There is no evidence that "O. antiquus" was a primitive taxon ancestral to Laramidian ornithomimosaurs, as has been argued.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm) SOMITE - LATERAL PLATE INTERACTION AS A DEVELOPMENTAL CONTROL ON EVOLUTION OF TETRAPOD AXIAL MORPHOLOGY BUCHHOLTZ, Emily A., Wellesley College, Wellesley, MA, United States Morphology is understood as the product of natural selection acting on variants generated randomly by the developmental process. If the generation of variation is not random, any bias imposed by the early embryonic interaction of somitic (SM) and lateral plate mesoderm (LPM) cells may be influential. A clade specific component of the somite, presumptive at posterior somite levels (hypoglossal, limb, diaphragm, and cloacal locations) delaminates from the dermomyotome, migrate along routes established by chemical signaling, and then invade and muscularize structures of lateral plate origin. Major transitions in vertebral axial patterning occur at these same locations. For example, the axial cervico-dorsal and dorso-caudal transitions occur at axial locations where somitic cells migrate into the lateral plate limbs. Multiple lines of evidence also suggest that both internal differentiation within the cervical region and the thoracolumbar transition of mammals are tied to the migration of cells from the cervical somites to the lateral plate diaphragm. This study asks whether SM-LPM interaction is also associated with limitations in the meristic variation of the column. Using a database of vertebral anatomy in living and fossil tetrapods assembled from museum collections and from the literature, it concludes that greater SM-LPM interaction is associated with both column subdivision and progressive restriction in meristic flexibility, with mammals being the clade with greatest SM-LPM interaction, regionalization of the column, and meristic constraint. The hypothesis of a causal tie is supported by examples of evolutionary loss of SM-LPM interaction that are associated with reductions in meristic flexibility. This is most vividly demonstrated by terrestrial taxa that have undergone limb loss during re-invasion of marine habitats. These results emphasize the important role that developmental mechanisms may play in influencing and limiting macroevolutionary trends.

Technical Session I (Wednesday, October 17, 9:30 am) EVOLUTION OF THE FORELIMB MUSCULATURE IN TYRANNOSAURIDAE (DINOSAURIA: THEROPODA) BURCH, Sara H., Stony Brook University, Stony Brook, NY, United States The highly reduced forelimbs of tyrannosaurid theropods have sparked many hypotheses about their function. Although the musculature and its function in the charismatich taxon Tyrannosaurus has been studied, the mythology of other tyrannosaurids has largely been ignored. This study provides the first look at the forelimb musculature across the entire clade and examines what the major morphological shifts reveal about the evolution of reduced forelimb function. Osteological correlates of muscle attachment were identified on pectoral girdle and forelimb material in 11 tyrannosaurid and several outgroup taxa. Morphological features were coded as characters and optimized onto a recent tyrannosaurid phylogeny to trace character transformations. Most major shifts in the forelimb musculature occur at the base of Tyrannosaurusidae, though a few appear earlier among tyrannosaurids. The scapula and humerus show an enlargement of the available area for attachment of deltoidus musculature in tyrannosaurids, which is primarily responsible for humeral abduction as well as some protraction and retraction. Expansion of the internal tuberosity is retained in most tyrannosaurids except Raptorex, and a greater reduction in the humerus results in less insertion area and shorter lever arms for much of the adductor musculature of the humerus. Supinator became primarily a flexor of the forearm early in the tyrannosaurid lineage as shown by the excision of its origin proximal to the ectepicondyle and a shift of its insertion from the lateral to the anterior surface of the radius. Inability to pronate or supinate may also be indicated by scars for the interosseous membrane on the radius in some tyrannosaurids. The distal migration of the triceps brachial insertion from the tip of the olecranon also characterizes tyrannosaurids, extending the lever arm without requiring expansion of the olecranon process. In the manus, reduction of the medial tubercle on metacarpal I in tyrannosaurids results in a shorter lever arm for extensor carpi radialis brevis, which is responsible in part for abduction of digit I. Accompanying this reduction, however, is development of a medial tubercle on the proximal ventral surface of F-I near the abductor digit I insertion, indicating a shift of major abduction responsibility to the intrinsic manus musculature. These and other morphological characters of tyrannosaurid forelimbs show a mosaic pattern of reduction and enlargement with retention of robust musculature for some functional units (e.g., flexors, extensors) even as others (e.g., adductors) have become diminished. Substantial differences in the morphology of even closely related taxa suggest that a single functional hypothesis does not apply to all reduced forelimbs.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm) USING GIS SLOPE AND ASPECT DATA AS PREDICTORS OF SURFACE FOSSIL ABUNDANCE IN THE UINTA BASIN, UTAH BURK, Daniel A., Intermountain Paleo-Consulting, Draper, UT, United States A variety of factors contribute to slope degree and aspect in a primarily erosional modern environment such as that found in the Uinta Basin (Wagonhound) Member of the Uinta Formation in Uintah Co., Utah, USA. These factors include but are not limited to: the freeze-thaw cycle, vegetation, insolation, presence of water, and regolith development. These factors combine to determine the types of slopes and aspects upon which fossils will be found at the surface. Data regarding fossils found in a sample PLSS section was collected through paleontological reconnaissance surveys. Slope and aspect data were obtained from a 5m resolution DEM. Using a GIS, slope angle and aspect data were combined with fossil data and analyzed. Slopes were classified into two nominal categories: low angle (angles between 0° and 10°) and high angle (angles > 10°). Aspects were classified into two nominal categories: southern (angles between 120° and 330°) and northern (all other aspects). These categories were combined to create four nominal categories for all fossils: North Low, North High, South Low, and South High. Assuming a random, unbiased distribution of fossils in the subsurface, χ² analysis showed that, with 99.5% confidence, fossils are not distributed equally on all surface types. Fossils were 81.3% to 87.1% more likely to be found on surfaces in the South Low category than any other single surface category. Surfaces with southern aspects tend to have less available water allowing them to support less vegetation and contributing to more poorly developed regolith. Regolith is more developed on northern facing surfaces and can obscure or destroy existing fossils. Additionally, surfaces with higher angle slopes have less available surface area with which to expose fossils. Therefore, the combination of low angle slopes and southern aspects allows for fossils to be found on the ground surface more readily. Other factors possibly influencing discovery of fossils not considered in this study include rock type, degree of weathering, time of day or year and local weather conditions during which reconnaissance surveys were conducted, and attitude and skill of surveyors.

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PLESIOSAURS HAD A TASTE FOR BIRDS
BURNHAM, David A., University of Kansas Biodiversity Institute, Lawrence, KS, United States; MARTIN, Larry D., University of Kansas Biodiversity Institute, Lawrence, KS, United States; ROTHCHILD, Bruce M., University of Kansas Biodiversity Institute, Lawrence, KS, United States

Presence of unhealed bite marks or stomach contents suggests the possibility of predation, but could also represent scavenging. Healed bite marks witness failed predation and potentially allow identification of both prey and predator. Avian predator-prey interactions are difficult to document because of the fragility of the avian skeleton. Partially digested hesperornithiform bones have previously been reported in stomach contents of the mosasaur Tylosaurus and enantiosaurine bird bones, in the abdominal cavities of an ichthyosaur and the dromaeosaur, Microaptor. We present evidence that the Late Cretaceous ornithurine, Hesperornis, was a prey item for plesiosaurs, in a manner analogous to the relationship between contemporary penguins and killer whales. Conical depressions were macroscopically and radiologically examined on the left leg of a Hesperornis (YPMU 17208) and compared to the tooth character and spacing of dentition in mosasaurs and plesiosaurs. The tibiotarsus had a series of rounded 4.4 mm depressions at 11.9 mm intervals, with inwardly pressed bone fragments. The size and separation of the depressions matched that of a small polycotylid plesiosaur. Radiologic examination of the distal tibiotarsus revealed an irregular moth-eaten radiolucent area, documenting osteomyelitis complicating the bite trauma.

The Hesperornis appears to have been attacked by a polycotylid plesiosaur that was unable to maintain its grip and the Hesperornis was able to escape. While there is evidence of plesiosaur predation on fish and cephalopods, there is limited evidence that they targeted tetrapods. To examples of plesiosaur predation, a pliosaur and an embryonic ichthyosaur, is now added Hesperornis.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)
QUANTITATIVE ANALYSES OF CRANIAL CHARACTERS IN PANOPLOSAURUS AND EDMONTONIA (ANKYLOSAURIA: NODOSAURIDA) AND THEIR TAXONOMIC IMPLICATIONS FOR THE CLADE
BURNS, Michael E., University of Alberta, Edmonton, AB, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada

The clade Edmontonia-Panoplosaurus is widely accepted as the most highly-derived group of nodosaurid ankylosaurs. Despite representation by adequate cranial, postcranial and osteodermal material, the taxonomic assignment of some specimens remains equivocal. Four new skulls referred to this clade were collected from Dinosaur Provincial Park in 1998 and can be used to quantitatively reassess cranial characters with measurement data and binary morphological characters. PCA and neighbour joining analyses on raw measurement data suggests possible affinities between Panoplosaurus and one of these 1998 specimens. Statistical analyses of some characters suggest division into “Panoplosaurus” and “Edmontonia” specimen groups. Normalized for skull length, the “Edmontonia” group exhibits wider length to width ratios. Panoplosaurus also has arm encroachment over the anterior rim of the lateral temporal fenestra that is not observed in “Edmontonia” specimens. Most bivariate plots show that many characters traditionally used to distinguish Panoplosaurus fall within the range of variation of specimens referred to Edmontonia. This is complicated by the fact the holotype skull of Panoplosaurus is significantly shorter than all other skulls referable to Edmontonia-Panoplosaurus.

The addition of new characters into a character-taxon matrix allows a specimen-specific parsimony evaluation of those characters. An initial heuristic search (10000 replicates, tree bisection reconnection algorithm) of 7 ingroup and 3 outgroup OTUs and 54 characters (16 parsimony-informative) returned 17 most parsimonious trees (length 29 steps, consistency index 0.93, and retention index 0.92). A 50% majority rule consensus returns the holotype of P. mirus as the most deeply nested specimen and the holotype of E. rugosidens as most basal. This means that either the remainder of the specimens examined represent P. mirus, or that Edmontonia may be paraphyletic.

Completion of this project hinges on inclusion of all available skull specimens referable to this clade, including the holotype of E. longiceps, and incorporating all available data (including results of morphometric analyses) into a more global analysis before taxonomic decisions can be made. It is clear, though, that the inclusion of more anatomical data demonstrates that the relationships amongst specimens referred to this clade are more complex than previously intimated. The addition of more material and data may help to clarify possible taxonomic groupings among all relevant specimens.

Technological Session VII (Thursday, October 18, 2:30 pm)
EXPLORING AND EVALUATING THE IMPACT OF ANATOMICAL PARTITIONS ON MORPHOLOGY-BASED PHYLLOGENETIC ANALYSES
BURROUGH, Robert W., The University of Texas at Austin, Austin, TX, United States

Paleontologists must use, of necessity, limited data to reconstruct the relationships of extinct taxa represented by fossils. An implicit assumption that underlies many paleontological systematic studies is that characters from anatomical sub-regions (i.e., the cranium, appendicular, or axial post-cranial skeleton) each provide similar or congruent phylogenetic signal independent of one another. A test of this assumption using an example dataset of extant Emydyl turtles divided into two anatomical partitions (cranial and shell). I conducted a series of tests to evaluate how those partitions affect resulting phylogenetic estimations. Traditional parsimony approaches were used to evaluate congruence between partitions when they are independently analyzed, including the partition-homogeneity test. In addition to parsimony, congruence was evaluated using Bayesian partition analyses, Bayes factor calculations, and topological congruence between reconstruction methods. The results of these tests indicate that the phylogenetic hypotheses generated by each partition independently are not fully congruent regardless of reconstruction method, and that a loss of resolution is generally found when using only cranial characters; shell characters often yield increased resolution by comparison. Compared to other reconstruction methods (e.g., Bayesian or maximum likelihood) parsimony has increased topological resolution, regardless of the partition used. The partition-homogeneity test was inconclusive, with partitions appearing to be no more, or less, congruent than incongruent with one another. Bayes factors indicated that partitioning the data into two anatomical partitions is appropriate and statistically preferred. Bayesian partition analyses showed that top tree topology was improved when each partition is allowed to inform tree topology independently. This indicates that each partition is appropriate within the dataset and that each partition is potentially evolving at a different rate. If the partitions exhibit rate heterogeneity then selection of characters for evaluating older (stem) versus younger (crown) taxa is greatly impacted. The independece of characters within a given partition must also be critically evaluated. These data indicate that exploration of a dataset is critical to understanding how character partitions may be informing tree topology and may produce biased results, and give insight into the selection of characters and character partitions for turtle systematics, providing a methodological framework for addressing complex systematic questions employing modern methods.
CONTINUOUS CHARACTER STATES AND THEIR IMPACT ON THE
PHYLOGENY OF THE PTEROSAURIA

BUTTON, David J., University of Bristol, Bristol, United Kingdom; UNWIN, David M., University of Leicester, Leicester, United Kingdom; PURNELL, Mark A., University of Leicester, Leicester, United Kingdom

The use of continuous characters in phylogenetic analysis is controversial, primarily because there is no consensus method for coding them into discrete states, which can result in conflict owing to inconsistencies in delimitation of states between different analyses. Such problems may be especially marked in vertebrate paleontology as analyses of fossil vertebrates often include a relatively high proportion of continuous characters. The pterosaurs are a notable example of such a group, with recent analyses containing 20-25% continuous characters. Difficulties with state delimitation may hence be contributing to the current lack of consensus in pterosaur phylogeny. To test this possibility two recent contrasting analyses of pterosaurs were reanalysed employing an alternative treatment using TNT. This approach is capable of handling continuous character data directly, avoiding the need to delimit discrete states. Experimentation with inclusion and exclusion of continuous characters showed that whilst they do convey some phylogenetic signal, many such characters, and the majority of character states, are flawed. Critically, however, varying the treatment of continuous characters failed to detect any significant role for them in the conflict between pterosaur phylogenies which, in this case, appears to be related to fundamental differences in general data selection and coding, with certain problematic taxa (such as Germanodactylus) coded differently for identical characters between matrices. Additionally, a basal-most position of the Anurognathidae and, more tentatively, paraphyly of the Cnochosaurosia are supported. Some theoretical and practical issues with continuous characters, especially for groups with small sample sizes as is typical for fossil vertebrates, prevent their use from being generally recommended. However, as they do show some phylogenetic signal, they cannot be omitted outright. Rather than ruling out entire classes of data based on presumed weaknesses it would seem more prudent to critically evaluate all characters on the grounds of the hypotheses of homology they present. In the case of pterosaurs it is clear that movement toward a consensus regarding their phylogenetic relationships will require a transparent and thorough reappraisal of character selection and coding.

Technical Session IV (Wednesday, October 17, 2:45 pm)

CONTINUOUS CHARACTER STATES AND THEIR IMPACT ON THE PHYLOGENY OF THE PTEROSAURIA

BUTTON, David J., University of Bristol, Bristol, United Kingdom; UNWIN, David M., University of Leicester, Leicester, United Kingdom; PURNELL, Mark A., University of Leicester, Leicester, United Kingdom

The use of continuous characters in phylogenetic analysis is controversial, primarily because there is no consensus method for coding them into discrete states, which can result in conflict owing to inconsistencies in delimitation of states between different analyses. Such problems may be especially marked in vertebrate paleontology as analyses of fossil vertebrates often include a relatively high proportion of continuous characters. The pterosaurs are a notable example of such a group, with recent analyses containing 20-25% continuous characters. Difficulties with state delimitation may hence be contributing to the current lack of consensus in pterosaur phylogeny. To test this possibility two recent contrasting analyses of pterosaurs were reanalysed employing an alternative treatment using TNT. This approach is capable of handling continuous character data directly, avoiding the need to delimit discrete states. Experimentation with inclusion and exclusion of continuous characters showed that whilst they do convey some phylogenetic signal, many such characters, and the majority of character states, are flawed. Critically, however, varying the treatment of continuous characters failed to detect any significant role for them in the conflict between pterosaur phylogenies which, in this case, appears to be related to fundamental differences in general data selection and coding, with certain problematic taxa (such as Germanodactylus) coded differently for identical characters between matrices. Additionally, a basal-most position of the Anurognathidae and, more tentatively, paraphyly of the Cnochosaurosia are supported. Some theoretical and practical issues with continuous characters, especially for groups with small sample sizes as is typical for fossil vertebrates, prevent their use from being generally recommended. However, as they do show some phylogenetic signal, they cannot be omitted outright. Rather than ruling out entire classes of data based on presumed weaknesses it would seem more prudent to critically evaluate all characters on the grounds of the hypotheses of homology they present. In the case of pterosaurs it is clear that movement toward a consensus regarding their phylogenetic relationships will require a transparent and thorough reappraisal of character selection and coding.
ON THE CRISTA CIRCUMFENESTRALIS OF SNAKES: COMPARATIVE ANATOMY, SIMILARITY, FUNCTION AND THE FOSSIL SNAKES DINILYSIA AND NAJAISH
Caldwell, Michael W., University of Alberta, Edmonton, AB, Canada; Palci, Alessandro, University of Alberta, Edmonton, AB, Canada

Despite more than two centuries of discussion, the origin and evolution of snakes remains a much debated, and highly controversial problem. The principal barrier to achieving reasoned consensus on snake phylogeny resides in the inaccurate language of squamate comparative anatomy as applied to snakes and in contrast to lizards. Anatomical nomenclature underpins empirical statements that are used as transformed metadata statements as characters and states; these statements are then tested via congruence to hypothesize synapomorphies that support sister group relationships and thus the constitution of clades. A characteristic anatomical feature of snakes, not observed in lizards, is the crista circumfenestralis (CCF), that extend forward to contact the posterior margin of the prootic. According to this homology criterion neither of the otoccipital (crista tuberalis and crista interfenestralis) that extend forward to contact the posterior margin of the prootic. According to this homology criterion neither Dinilysia patagonica nor Najaish rionegrina possess a CCF. Metadata statements and character state assignments asserting the presence of the CCF in Dinilysia and Najaish are rejected with respect to the quality of comparative anatomical observation leading to such metadata and state assignments.

FIRST RECORD OF THE SYNECHODONTIFORM SHARK SPHENODUS (NEOSELACHII, ORTHACODONTIDAE) FROM THE DANIAN OF NORTH AMERICA
Callahan, Wayne R., New Jersey State Museum, Trenton, NJ, United States; Schein, Jason P., New Jersey State Museum, Trenton, NJ, United States; Schroeter, Elena R., Drexel University, Philadelphia, PA, United States; Parris, David C., New Jersey State Museum, Trenton, NJ, United States; Lacrova, Kenneth J., Drexel University, Philadelphia, PA, United States

The synechodontiform shark Sphenodus is here reported from the Hornerstown Formation (Danian) of Gloucester County, New Jersey. A well-preserved, upper-right lateral tooth was recovered in June of 2011, from the Inversan Company glauconite quarry, during a joint field expedition between the New Jersey State Museum, Drexel University, and the Delaware Valley Paleontological Society. The complete tooth (NJSM 23223) displays the following characteristics: (1) a typical, tearing-type crown that is lingually inclined and moderately sigmoidal in lateral view; (2) acute cutting edges, flanked by blade-like enameloid ridges that extend as heels along the upper surfaces of the root and bear numerous vertical folds; (3) a highly vascularized (pseudopolyglycorhizite) root which is sub-oval in basal outline and has a flattened, slightly concave base.

The genus Sphenodus has a temporal range that extends from Early Jurassic into the early Paleogene. The only other confirmed report of the genus in North America is of specimens referred to Sphenodus sp. from the Upper Cretaceous of Hornby Island, British Columbia, Canada. The Paleogene record is limited to a single species, Sphenodus lundgreni, a large shark known from the Danian of Scandinavia, the United Kingdom, Russia, and Kazakhstan. Additional specimens of S. cf. lundgreni have been reported from Greenland and New Zealand. Based on size, tooth morphology and age, we assign NJSM 23223 to Sphenodus lundgreni. This is the first record of this taxon from the Americas and the lowest latitudinal occurrence in the Northern Hemisphere. Since the roots of synechodontiform sharks are seldom preserved, it is possible that isolated tooth crowns of S. lundgreni have been recovered in other North American Danian localities, but mis-identified as lamnid teeth, which they closely resemble. We encourage scrutiny of Danian chondrichthyan tooth collections from Atlantic and Gulf Coastal Plain localities for other possible occurrences of this rare taxon.

NEW DATA ON THE CENOMANIAN VERTEBRATE SITE OF NAZARÉ (WEST CENTRAL PORTUGAL)
Callapez, Pedro, Universidade de Coimbra, Coimbra, Portugal; Barroso-Barcenilla, Fernando, Universidad de Alcalá de Henares, Universidad Complutense de Madrid, Alcalá de Henares, Madrid, Spain; Cambra-Moo, Oscar, Universidad Autónoma de Madrid, Madrid, Spain; Pérez-García, Adán, Universidad Autónoma de Madrid, Madrid, Spain; Torices, Angélica, University of Alberta, Edmonton, Canada

The Cenomanian vertebrate site of Nazaré is located in a coastal cliff of West Central Portugal, and is comprised of large exposures of Upper Cretaceous marginal-marine carbonates and continental siliciclastics. The study of this vertebrate site, internationally known from the presence of the only dyrosaurid from Europe (attributed exclusively based on a mandibular symphysis), has been recently resumed to compile a detailed survey of its faunal assemblage, biostatigraphy, and paleoecology. This new study reveals the presence of several important Lower and Middle Cenomanian fossiliferous levels, in which numerous vertebrate macroremains (shallow aquatic fauna; fishes, turtles and crocodilians) appear well preserved and partially articulated. Fish remains are abundant and mainly composed by scattered scales, teeth and skull fragments, though an almost complete specimen has been also found. Specifically, isolated teeth from Pycnodontiformes have been identified. They are crushing teeth with a smooth surface and subcircular or elongated crowns in occlusal view, very similar to teeth belonging to the genus Coelodus. Other discovered teeth, both isolated and implanted in fragments of a dentary, are elongated and inclined distally, with a mesial flexure. They also have a distal carina with a slightly wavy pattern, and a mesial carina that has a better defined cutting edge. Lingual longitudinal folds are present in the base of the crown. These teeth are remarkably similar to those classified as Enchodus. The specimen that is nearly complete has characteristics that allow us to identify it as a primitive teleost cf. Elopomorph. Turtle remains may correspond to Pan-Cryptodira and, probably, Pan-Placodontia. Both are likely aquatic forms, which may have lived in transitional or marine environments. New crocodylomorph material has also been discovered, but it cannot be assigned to Dyrosauridae. All this material sheds new light on the little known record of European Cenomanian vertebrates. The particular location of Nazaré, close to the transition from Tethys to the Temperate domain, will be useful to explain possible faunal changes and migrations influenced by sea-level changes and regional paleogeography.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

Caldwell, Michael W., University of Alberta, Edmonton, AB, Canada; Palci, Alessandro, University of Alberta, Edmonton, AB, Canada

Despite more than two centuries of discussion, the origin and evolution of snakes remains a much debated, and highly controversial problem. The principal barrier to achieving reasoned consensus on snake phylogeny resides in the inaccurate language of squamate comparative anatomy as applied to snakes and in contrast to lizards. Anatomical nomenclature underpins empirical statements that are used as transformed metadata statements as characters and states; these statements are then tested via congruence to hypothesize synapomorphies that support sister group relationships and thus the constitution of clades. A characteristic anatomical feature of snakes, not observed in lizards, is the crista circumfenestralis (CCF), that extend forward to contact the posterior margin of the prootic. According to this homology criterion neither of the otoccipital (crista tuberalis and crista interfenestralis) that extend forward to contact the posterior margin of the prootic. According to this homology criterion neither Dinilysia patagonica nor Najaish rionegrina possess a CCF. Metadata statements and character state assignments asserting the presence of the CCF in Dinilysia and Najaish are rejected with respect to the quality of comparative anatomical observation leading to such metadata and state assignments.

New data on the Cenomanian vertebrate site of Nazaré (West Central Portugal)
Callapez, Pedro, Universidade de Coimbra, Coimbra, Portugal; Barroso-Barcenilla, Fernando, Universidad de Alcalá de Henares, Universidad Complutense de Madrid, Alcalá de Henares, Madrid, Spain; Cambra-Moo, Oscar, Universidad Autónoma de Madrid, Madrid, Spain; Pérez-García, Adán, Universidad Autónoma de Madrid, Madrid, Spain; Torices, Angélica, University of Alberta, Edmonton, Canada

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NEW RECONSTRUCTION OF THE PARIALMORPHOLOGY OF PACHYRHINOSAURUS CANADENSIS, A CENTROSAURINE CERATOPSID FROM THE CAMPANIAN OF ALBERTA

CAMPBELL, James A., Carleton University, Ottawa, ON, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada; LANGSTON, Wann, University of Texas, Austin, TX, United States

The centroaurine ceratopsid, Pachyrhinosaurus, is known from multiple, disarticulated elements derived primarily from bone bed assemblages. Described species include P. lakustai from the Wapiti Formation, AB (~72-73 MA); P. canadensis from the Scabby Butte and St. Mary River Formation, AB (~71 MA), and P. perforatum from the Prince Creek Formation, Alaska (~69 MA). Adult members of the clade exhibit extreme pachyostosis of the nasal and postorbital ornamentation, which causes the facial portions of the skulls to be typically preserved as massive, fused units. The pachyostotic skull is completely thin and fragile. While none are known from complete specimens, the morphology of the parietal and its associated ornamentation, which is often critical to distinguishing closely related centrosauras, can be reliably inferred for most taxa. However, the parietal ornamentation of P. canadensis is poorly understood, with the only significant material being two partial ramus, CMN 9602 and CMN 10644, and a partial P3 spike, CMN 8863, described from the Scabby Butte bone bed. The initial identification of these elements was tentative due to their fragmentary nature and their dissimilarity to ceratopsian parietal material known at the time. Comparison to multiple P. lakustai parietals from the Grande Prairie bone bed now allows for the first formal description of the parietal of P. canadensis. Although it closely resembles P. lakustai, it is unknown if P. canadensis possessed dorsally-projecting processes on the midline ramus. Based on CMN 9602, P. canadensis: lacks P1 processes; has short, wide-based, postero-medially directed P2 processes on caudal margin; has wide-based, elongate, caudo-laterally projecting P3 processes that curve gently laterally; and low, well-fused, elongate, imbricated epiparietals at loci 4-6 (P7 is broken off). The caudal margin of the midline ramus of CMN 9602 adjacent to the P2 surface has a large, sinus-like, pathologival opening; similar pathologies are common on P. lakustai skulls. CMN 10644 is a partial left lateral parietal ramus that may represent the counterpart to CMN 9602. It preserves at least four, low epiparietals (P4-P7) and the thickened contact surface for the squamosal; an additional epiparietal would have straddled the parietal-squamosal contact. CMN 8863 is a massive, isolated, partial left P3 spike. Its size (basal dimensions ~ 110 x 80 mm) is what would be expected from an adult-sized P. canadensis skull, which are notable for being up to 50% larger than that of other putative adult-sized Pachyrhinosaurus taxa. This suggests that CMN 9602 and CMN 10644 represent much smaller and/or younger specimens despite their adult bone texture and well-fused epiparietals.

Technical Session VIII (Thursday, October 18, 2-45 pm)

NEW LATE MIOCENE NORTH AMERICAN ARTIODACTYL FROM THE AMAZON BASIN: IMPLICATIONS FOR INTERCHANGE DYNAMICS

CAMPBELL, Kenneth E., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; PROTERO, Donald R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; FRAILY, Carl D., Johnson County Community College, Overland Park, KS, United States

A new genus and species of palaeomerycid artiodactyl from the upper Miocene Acre Conglomerate of the Amazon Basin (older than 9.01 Ma, based on Ar/Ar dating) found in the channel of the Acre River between Bolivia and Brazil documents the first known occurrence of an early-middle Miocene dromomerycine artiodactyl in South America. Characters of the nearly complete dentary place the new taxon amongst the earliest dromomerycines, closest to Barbouromyx trigonoconus, which lived in North America during the early to middle Miocene, 20-16 mya. However, it is a new genus and species that is distinguished from all other dromomerycines by its relatively wide lower molars and large labial stylids. Along with the previous documentation of gomphotheres, peccaries, and tapers from the Acre Conglomerate or older beds, the presence of an early-middle Miocene dromomerycine artiodactyl in South America is further evidence that the first pulse of the Great American Faunal Interchange occurred in the early late Miocene, not the Plio-Pleistocene as traditionally portrayed.

Romer Prize Session (Thursday, October 18, 8:30 am)

A UNIVERSAL LIMB SCALING RELATIONSHIP FOR ESTIMATING BODY MASS IN EXTINCT TERRESTRIAL TETRAPODS

CAMPIONE, Nicolas E., University of Toronto, Toronto, ON, Canada

Body size is intimately related to the ecology and physiology of an organism. Accurate body mass estimates are therefore vital for inferring a wide range of paleobiological attributes (including growth rates, metabolism, and energetics) and investigating large-scale evolutionary and ecological patterns in the history of life. Scaling relationships between limb measurements and body mass of extant birds and mammals are commonly used to predict body mass in extinct members of these crown clades, but their suitability for predicting body mass in more distantly related stem taxa (e.g., non-avian dinosaurs and non-mammalian synapsids) is frequently criticized based on the observation that 1) limb scaling patterns in some extinct clades can significantly deviate from each others (e.g., Ungulata vs. Carnivora), 2) scaling patterns may be affected by differences in gaits and/or limb postures, and 3) outliers may have a disproportionately large effect on scaling coefficients, especially at large body size. This study directly tests if these criticisms affect the relationship between body mass and various stylolodomp limb measurements in terrestrial quadrupedal tetrapods. Stylodolamp length and minimum shaft circumference were taken from 200 mammal and 47 non-avian reptile species, all of which were derived from skeletons with individual live weights. Scaling patterns between different clades of mammals, birds, and between dinosaurs and reptiles were examined using bivariate line fitting techniques (Standardized Major Axis) and phylogenetic independent contrasts. The analyses confirm significant differences between select groups in some proportional properties, but, remarkably, the relationship between stylodolamp circumference and body mass, in particular the combined humeral and femoral circumference, is highly conserved in extant terrestrial quadrupedal tetrapods, despite disparate limb postures, gaits, and phylogenetic histories. As a result, this study conclusively rejects many of criticisms of a universal scaling equation for estimating body mass in terrestrial quadrupedal tetrapods. This approach also allows the incorporation of percent prediction errors (PPE) into mass estimates, and demonstrates that combined circumference (PPE<2%) is a more accurate estimator of body mass than all other metrics tested here, including the commonly used femur length (PPE<70%). As a result, this method will also enable testing of other mass estimation methodologies, such as volumetric models. This study provides a much-needed, robust, phylogenetically corrected framework for accurate and consistent estimation of body mass in extinct terrestrial quadrupods, which is important for a wide range of paleobiological studies and meta-analyses of body size evolution.
forest. Small fish bones are often in sorted, partially digested, apparently disgorge masses, about 30mm in diameter, indicating lack of current and modest depth. Large predatory fishes are rare, but isolated bones of 70 cm muscullage (Esox) and 30 cm Pimeknnows (Pyschocheilus) have been found with mammals in fluvial environments, peripheral to the leaf-bearing siltstone.

Technical Session I (Wednesday, October 17, 9:15 am)

ONTOGENY AND PHYLOGENY OF CEPHALIC ORNAMENTATION IN TYRANNOSAUROIDEA (DINOSAURIA, COELUROSAURIA)

CARR, Thomas D., Carthage College, Kenosha, WI, United States

Cephalic ornamentation is seen in all derived tyrannosauroids. A robust sample size and growth series are known for most taxa, providing the opportunity to assess larger scale patterns in this potentially important adaptation for the clade. Cephalic horns in tyrannosauroids have a conserved pattern that includes cornual processes that extend from the lacrimal, jugal, and postorbital. Also, the dorsal surface of the nasals is coarse. Ornamentation is taken to an extreme in Alioramus altai, where a series of stout horns extend from the nasals, and a fourth set from the lateral surface of the jugal.

In this study the ontogenetic development of cephalic ornamentation in each species of derived tyrannosauroid (Bistahieversor + Tyrannosauridae) was compared in a phylogenetic context. Growth series were reconstructed, where possible, by parsimony analysis of discrete characters. There are four principal findings:

(1) The growth pattern of ornamentation is conserved, where the ventral jugal horn grows first, the lacrimal process develops second, and the postorbital horn appears last. In each species, the lacrimal and postorbital horns enlarge with growth. This iterative pattern of development indicates it was an important adaptation that functioned to identify relative maturity among both sexes. As a result, the ontogenetic pattern of development is thought to have inhabited humid forested environments such as flying squirrels, beavers, or certain dormice, most of them recorded only when the sample size is large enough. Of some of them is in de facto present in a few late Vallesian sites, thus supporting our interpretation. Alternatively, these genera may have been associated with very specific habitats that, for unknown reasons, are not sampled during the late Vallesian. Our results cast serious doubts on the very existence of the Vallesian Crisis suggesting that rather than an abrupt event, a series of extinctions occurred during a longer time span. While it has not been evaluated whether the same pattern will be observed in large mammals or faunas in other areas, previous approaches have generally omitted the bias introduced by the quality of the record and, as shown here, they may importantly affect diversity calculations.

Technical Session II (Wednesday, October 17, 12:00 pm)

DIVERSITY, ABUNDANCE AND TURNOVER IN THE ANTARCTIC MARINE FAUNA DURING THE EOCENE IN RESPONSE TO CLIMATE CHANGE

CASE, Judd A., Eastern Washington University, Cheney, WA, United States

The La Meseta Formation crops out on the northern end of Seymour Island, northeastern Antarctic Peninsula and its deposits have been dated by $^{36}$Ar/$^{39}$Ar ratios to range from 54.2 Ma to 34.2 Ma, thus encompassing nearly the entire Eocene. The La Meseta Formation spans nearly an 18 million year time frame and exhibits an 8°C drop in temperature from 11°C to 3°C. The La Meseta Fm is divided in seven stratigraphic units (Telm 1-7); in units Telm 3-5, spanning from 54.2 Ma to 45.2 Ma, the diversity index of neoselachian sharks is very high (H= 1.814), nearly equaling the shark diversity values (H= 1.920) in the modern tropics today, with high levels of abundance as well. Penguin diversity is high (H= 1.619), with low levels of abundance (10% of marine vertebrate fauna), while cetacean diversity (1 species) and abundance are low. In units Telm 6 and 7 (41.0 Ma to 34.2 Ma), a significant portion of the 8°C temperature drop occurs on the isothermal surface in vertebrate diversity are seen. Sharks are now extremely rare in the two upper units, penguin diversity remains high but abundances dramatically increase (90% of marine vertebrate fauna). The cetacean fauna shows only a slight increase in diversity, however cetacean abundance shows a substantial increase. The drop in ocean temperature and the changes in marine vertebrate diversity and abundance seem to coincide with a deep water opening of the Drake Passage around 41 Ma.

Technical Session X (Friday, October 19, 8:15 am)

A NEW TATARIAN DICYONODONT FROM MOZAMBIQUE

CASTANHINHA, Rui, Instituto Gulbenkian de Ciência and Museu da Lourinhã, Lisboa, Portugal; ARAÚJO, Ricardo, Southern Methodist University and Museu da Lourinhã, Dallas, TX, United States; COSTA JÚNIOR, Luis, Museu Nacional de Geologia, Maputo, Mozambique; ANGIELCZYK, Kenneth J., Field Museum of Natural History, Chicago, IL, United States; MARTINS, Rui, Instituto Tecnológico e Nuclear and Museu da Lourinhã, Lisboa, Portugal

A nearly complete three-dimensionally preserved [skull and mandible, with a series of 19 articulated dorsal, sacral and tail vertebrae, ribs, ilia, partial pubis and femur (ML1620) was collected from the Late Permian Karoo sediments, Metangula Graben, northern Mozambique (Niassa Province), Cádiz Formation. The specimen can be distinguished by the following four autapomorphies: radiating pattern of vascular foramina plus grooves and ridges on the external surface of the frontal, a shallow pit on the extent of the preparai, shaw-shaped profile of the articular surface of the quadrate in posterior view and
a waterdrop-shaped interpterygoid vacuity. Micro-CT visualization of the internal cranial bones combined with a phylogenetic analysis demonstrate a set of characters shared with Eumantellidae (namely, the interparietals contribute to the intertemporal skull roof and lateral dentary shelf present and well developed) and Emyploidea (namely, palatal surface of premaxilla with groove-like depressions that have straight sides and a rounded anterior end). However, the absence of both caniniform depression and keel-like extension of the palatal rim posterior to the caniniform process plus symphyseal region of lower jaw with an upturned margin that is raised above the level of the dorsal surface of the jaw rami with a scooped-out depression on its posterior surface is distinct from Emyploidea. Moreover, the possession of 6 maxillary tooth positions and 11 dentary teeth is also distinct from emyploids, none of which possess non-caniniform teeth. On the other hand, the presence of the lateral palatal foramen at the level of the anterior, expanded palatal exposure of the palatines is distinct from Eumantellidae.

This specimen was collect as a result of an annual expedition that started in July 2009. Since then, important fossil sites have been discovered. The sediments are Tatarian in age which is equivalent to the Beaufort Group, possibly correlatable to the Cistecephalus Assemblage Zone from South Africa. Mozambique offers a new window of unstudied sites suggesting that a complete faunal list from the East African Late Permian is still far from being accomplished.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FIRST RECORD OF AN APATEMYID FROM OREGON: SINCLAIRELLA DAKOTENSIS FROM THE TURTLE COVE MEMBER OF THE JOHN DAY FORMATION

Cavin, Jennifer L., John Day Fossil Beds National Monument, Kimberly, OR, United States; Samuel, Joshua X., John Day Fossil Beds National Monument, Kimberly, OR, United States

Sinclairella dakotensis is a rare and unusual species belonging to the family Apatemyidae, a group of archaic insectivorous mammals of uncertain phylogenetic affinities. Here we report a new occurrence of S. dakotensis from the Arktokanaged Turtle Cove Member of the John Day Formation, Oregon. Two isolated teeth, a lower first incisor and an upper second molar, were found at two separate sites. Both were located in Unit C of the Turtle Cove Member in the Blue Basin area of John Day Fossil Beds National Monument. Because of the well-studied stratigraphy with persistent, traceable ash layers found in the Turtle Cove Member of the John Day Formation, these finds can be dated to between 29.75 and 28.8 Ma. The distinctively enlarged lower incisor, and morphology and measurements of the M2 were consistent with published descriptions of S. dakotensis from the Great Plains region. S. dakotensis has previously been found in Chadronian to early Arktokan aged deposits from South Dakota, North Dakota, Colorado, Nebraska, and Saskatchewan. This find represents the first occurrence of the taxon west of the Rocky Mountains and possibly the youngest dated occurrence to date. Due to the hypertrophied, procumbent incisors and elongate digits on the manus, apatemyids are thought to have been ecologically similar to extant “wood-eaters.”

Poster Session II (Saturday, October 20, 4:15 - 6:15 pm)

REVISION OF A MIOCENE CARASSUS-LIKE CYPRINID LUCYPINUS (TELEOSTEI, PISCES) FROM EAST CHINA AND ITS BEARING ON FRESHWATER FAUNAL EXCHANGE BETWEEN EUROPE AND ASIA

Chang, Mee-Mann, IVPP, Beijing, China; Chen, Gengjiao, Natural History Museum, London, United Kingdom; Steinitz, Turtle, Germany

Lucypinus, a waterbuck-shaped cyprinid, is now generally recognized as a representative of the clade Sicydinae belonging to the family Cyprinidae. The genus Lucypinus was first described from the lower part of the Turtle Cove Member of the John Day Formation, Oregon. Two isolated teeth, a lower first incisor and an upper second molar, were found at two separate sites. Both were located in Unit C of the Turtle Cove Member in the Blue Basin area of John Day Fossil Beds National Monument. Because of the well-studied stratigraphy with persistent, traceable ash layers found in the Turtle Cove Member of the John Day Formation, these finds can be dated to between 29.75 and 28.8 Ma. The distinctively enlarged lower incisor, and morphology and measurements of the M2 were consistent with published descriptions of S. dakotensis from the Great Plains region. S. dakotensis has previously been found in Chadronian to early Arktokan aged deposits from South Dakota, North Dakota, Colorado, Nebraska, and Saskatchewan. This find represents the first occurrence of the taxon west of the Rocky Mountains and possibly the youngest dated occurrence to date. Due to the hypertrophied, procumbent incisors and elongate digits on the manus, apatemyids are thought to have been ecologically similar to extant “wood-eaters.”

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE ANATOMY AND PHYLOGENETIC PLACEMENT OF THE CRETACEOUS STEM TURTLE NAOMICHELYS SPECIOSA

Chapman, Sandra D., Natural History Museum, London, United Kingdom; Sterli, Juliana, CONCET-Museo Egidio Feruglio, Trelew, Argentina; Lyson, Tyler R., Yale University, New Haven, CT, United States; Joyce, Walter G., University of Tübingen, Tübingen, Germany

Naomichelys speciosa is a highly unusual turtle from the Cretaceous of North America. The type specimen consists of an isolated entoplastron that was discovered in Aptian-Albian sediments in Montana more than 100 years ago and that was diagnosed as a new species of turtle by its unusual surface sculpturing consisting of raised tubercles. A small number of additional fragments have since extended the temporal range to the Campanian and the spatial range to Alberta, Maryland, Oklahoma, Texas, Utah, and Wyoming, but these specimens add little to help understanding the anatomy or phylogenetic position of this enigmatic taxon. The unique surface sculpture of the shell, how sculptured in life, is poorly known and has been reconstructed recently as being the same as that found in extant turtles of the clade Solemidae and N. speciosa is now generally recognized as a representative of that clade.

Field crews of the Field Museum of Natural History discovered an unusually well-preserved, near complete skeleton of Naomichelys speciosa in the Aptian-Albian Trinity Sands of Texas in the 1950s, but the specimen was never described in any detail, likely because the braincase is only partially preserved. A phylogenetic analysis places N. speciosa as sister to the so longed taxa Helochelydra noppcaii from the Early Cretaceous of England and Solemys verniculata from the Late Cretaceous of Spain based on the complete lack of an ossified processus interfenestralis, formation of a secondary pair of “basicoxial tubercles” by the pterygoids, and based on the presence of V-shaped anterior peripherals, a supernumerary entoplastral scute, and the unique surface ornamentation. Among others, the presence of a secondary intertubercular fossa, extension of the upper temporal roofing posterior to the level of the basicoxial condyle, and primitive cervical vertebrae with a biconvex fourth cervical place N. speciosa within the clade Meloaniformes. Meloaniformes is therefore known to have had a near global distribution in the Cretaceous, a pattern best explained by vicariance. The presence of large nasals, confluent external nares, a single vomer, eleven peripherals, five wide vertebral, large mesoplastra, five pedal claws, and the absence of lacrimals, supratemporals, temporal emarginations, palatal teeth, and supramarginals support placement of N. speciosa just outside of crown Testudines. The presence of limb osteoderm and short digits support the hypothesis that N. speciosa was a terrestrial turtle.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MEASURING THE PENGUIN HUMERUS: THE IMPACT OF INTRASPECIFIC VARIATION ON QUANTITATIVE CHARACTERS

Chavez-Hoffmeister, Martin F., School of Earth Sciences, University of Bristol, Bristol, United Kingdom

Isolated skeletal elements are often used as type specimens in vertebrate paleontology. In the case of fossil penguins, the humerus has been one of the most widely used elements, but its reliability for taxonomic treatment has only been recently studied. It has been suggested that angular measures are useful for discrimination of taxa at different levels; however these results have been based on the use of average values for the studied species. This study aimed to evaluate the impact of intraspecific variability on our ability to use metric characters for taxonomic treatment. Through the expansion of published sets of linear and angular measurements, the distributions of data for four species of extant penguins are analysed through the construction of modified logarithmic differences diagrams. This modification consists of the use of box plots instead of linear graphics to show the distribution of data in each measure analyzed. The results show that: 1) the use of average values for the evaluation of measures is inadequate; 2) the proportions between measures vary for each individual; 3) each measure has different ranges of variation; and 4) the angular measurements have wide ranges of variation. Comparing the three species of the genus Pygoscelis to each other, only four of the 12 measures evaluated are reliable for all three species and none of the measures allows their discrimination. This exemplifies the difficulties of using isolated elements for taxonomic purposes and the importance of considering intraspecific variability of each character to identify which of them can be useful for taxonomy.
Here we report a new spadefoot toad (Anura: Pelobatidae) from Tsagan Khushuu, Mongolia, NORELL, Mark A., American Museum of Natural History, New York, NY, United States; CHENG, Jianye, American Museum of Natural History, New York, NY, United States; ITS IMPLICATION FOR THE PHYLOGENY AND BIOGEOGRAPHY OF THE PELOBATIDAE

The most basal member of the Pelobatidae. Interestingly, it also suggests that, within the Pelobatoidea (17 taxa/37 characters). The results show that the new taxon represents the combination of many independent single-death events, but it has also been shown that consistent seasonal patterns in the stable isotope composition of tusk dentin. Multi-year comparisons will be used to determine if animals that died in the same season actually died simultaneously, in the same year.

Mastodon mandibular tusks are numerous at the site and convenient for censusing, but their annual growth increments are often obscure. However, X-ray computed tomographic (CT) scans of mandibular tusks reveal cyclic features in dentin density that appear to correspond to annual growth increments. Previously reported oxygen isotope (δ18O) data from one tusk support this interpretation of the CT data. Additional serial isotope analyses combined with increment thickness profiles now further reinforce this interpretation. The δ18O and nitrogen isotope (δ15N) series from the Snowmass tusks consistently show elevated values during periods of slowed and growth work to correct for potential winter. Periodic peaks in δ15N probably result from winter nutritional stress. However, the simultaneous highs in δ18O are contrary to expectations for mid-latitude temperate regions, where meteoric water δ18O tends to display higher values in summer and lower values in winter. Explaining this ‘inverted’ δ18O signal in Snowmass mastodon tusks requires invoking either a seasonal pattern of water source variation shared by individuals at the site or a mechanism for enrichment of δ18O in the local water source during the winter months. Enrichment in δ18O of snow pack due to sublimeation during the cold, dry, high-altitude winters may explain the anomalous oxygen values. Isotopic patterns from Snowmass mastodon tusks are consistent among individuals, present a first look at seasonal variation in a high-altitude population of mastodonts, and support the interpretation of annual increments in CT data.

Recent studies of fossil mammal skeletons from the Jehol Group of western Liaoning, China, which is known for its well-preserved Mesozoic vertebrate fossils, have revealed a much greater diversity of locomotor adaptations of Mesozoic mammals than previously known. These Mesozoic taxa provide a unique opportunity to study their paleoecology. Instead of the traditional perception that Mesozoic mammals were generalized terrestrial animals excluded by the dinosaurs from many specialized ecological niches, these discoveries indicate that mammals of the Jehol Group likely occupied a breadth of ecological niches, possibly approaching the ecological diversity of extant mammals.

To develop a method to quantify the range of locomotor morphotypes among Mesozoic mammals, I conducted a morphometric analysis of the entire postcranial skeleton of 51 small-bodied extant mammals of 13 orders, including Afrosoricida, Carnivora, Cingulata, Didelphimorphia, Dasyuromorphia, Diprotodontia, Erinaceomorpha, Monotremata, Peramelemorphia, Primates, Rodentia, Scandentia, and Soricomorpha. Eight locomotor categories were used: arboreal, gliding, scansorial, terrestrial, fossorial, semi-fossorial, semi-aquatic, and saltatorial. Twenty-four osteological indices were derived from 54 linear measurements of the entire postcranial skeleton in contrast to the indices of individual elements applied in previous studies. Linear Discriminant Analysis of those indices shows statistically significant differences among the diverse locomotor categories. In the plots of Linear Discriminant Analysis, fossorial and saltatorial mammals have particularly distinctive postcranial skeletons, whereas arboreal, scansorial, and terrestrial mammals show some overlap suggesting that similar morphological features may respond to different locomotor adaptations. Two fossil representatives, Sinocricetodon and Fruitadens, are shown by Principle Component Analysis to plot among generalized terrestrial and specialized fossorial mammals, respectively. This preliminary study suggests that this quantitative morphometric analysis of the entire postcranial skeleton supports the conclusions drawn from previous qualitative studies of individual features of limb skeletons. Moreover, this method helps identify the critical indices derived from the entire postcranial skeleton for distinguishing locomotor categories and with just several simple measurements estimates the locomotor adaptation of fossil mammals more accurately and effectively than previous qualitative methods.

A TAXONOMIC REVISION OF THE SAPOERNITHIDAE (AVES: PYGOSTYLLIA) FROM LIAONING PROVINCE, CHINA

CHIAPPETTA, Louis M., Dinosaur Institute-Natural History Museum of Los Angeles County, Los Angeles, CA, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; CLEMENS, William A., University of California Museum of Paleontology, Berkeley, CA, United States

The origin of primates has long been thought to relate in part to arboreality, yet direct fossil evidence of positional behaviors of the earliest primates has been lacking as these taxa are only represented by fragmentary dentitions. Though plesiadapiforms (stem primates) are generally considered to have been arboreal based on partial skeletons from the late Paleocene and early Eocene, it is unclear whether this substrate preference evolved independently or was characteristic of the first primates in the early Paleocene. The Garbani Channel fauna localities in Garfield County, northeastern Montana, are thought to represent the late Pueracen (Pu3; ~65MYA) and have yielded hundreds of dental specimens of Puratorius, the oldest and most primitive plesiadapiform known. Several isolated astragali and calcanea were recovered from four Garbani Channel localities and are referred to Puratorius based on size, abundance, and diagnostic similarities to dentally associated tarsals of euarchontans in general, and plesiadapiforms specifically. In the astragalus, these similarities include a dorsoventrally deep fibular facet relative to the medial tibial facet, a medial edge of the trochlea that extends onto the neck, and a helical sustentacular facet clearly confluent with the navicular facet. Within plesiadapiforms, these astragali are most similar to those of micromysids in having a body with a relatively high medial height and a large flexor fibularis groove. Several similarly sized calcanae are also diagnostically similar to those of other plesiadapiforms in having an extant facet fairly aligned with the long axis of the calcaneum, a prominent sustentaculum with a helical sustentacular facet that extends distally onto the body, a large peroneal tuberosity, a round and concave cuboid facet, a distinct plantar pit, and lacking a fibular facet. These characteristics indicate a mobile ankle that would allow pedal inversion in order to adjust to an uneven substrate, typical of euarchontan mammals. While results from recent phylogenetic analyses failed to support primate or placental affinities of Puratorius, this new tarsal evidence strongly suggests that Puratorius is a plesiadapiform that lies near the ancestry of all primates within Euarchonta. These specimens are the first to demonstrate that the oldest known plesiadapiforms possessed postcranial modifications for arboreality compared to other mammals in the earliest Paleocene, and these specializations likely played a key role in the evolutionary success of the earliest primate radiation.

Technical Session XIII (Friday, October 19, 2:15 pm)

TARSAL MORPHOLOGY OF THE OLDEST PLESIADAPIFORM PURATORIUS INDICATES ARBOREALITY IN THE EarLIEST PRIMATES

CHESTER, Stephen G., Yale University, New Haven, CT, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; CLEMENS, William A., University of California Museum of Paleontology, Berkeley, CA, United States

The Garbani Channel fauna localities in Garfield County, northeastern Montana, are thought to represent the late Pueracen (Pu3; ~65MYA) and have yielded hundreds of dental specimens of Puratorius, the oldest and most primitive plesiadapiform known. Several isolated astragali and calcanea were recovered from four Garbani Channel localities and are referred to Puratorius based on size, abundance, and diagnostic similarities to dentally associated tarsals of euarchontans in general, and plesiadapiforms specifically. In the astragalus, these similarities include a dorsoventrally deep fibular facet relative to the medial tibial facet, a medial edge of the trochlea that extends onto the neck, and a helical sustentacular facet clearly confluent with the navicular facet. Within plesiadapiforms, these astragali are most similar to those of micromysids in having a body with a relatively high medial height and a large flexor fibularis groove. Several similarly sized calcanae are also diagnostically similar to those of other plesiadapiforms in having an extant facet fairly aligned with the long axis of the calcaneum, a prominent sustentaculum with a helical sustentacular facet that extends distally onto the body, a large peroneal tuberosity, a round and concave cuboid facet, a distinct plantar pit, and lacking a fibular facet. These characteristics indicate a mobile ankle that would allow pedal inversion in order to adjust to an uneven substrate, typical of euarchontan mammals. While results from recent phylogenetic analyses failed to support primate or placental affinities of Puratorius, this new tarsal evidence strongly suggests that Puratorius is a plesiadapiform that lies near the ancestry of all primates within Euarchonta. These specimens are the first to demonstrate that the earliest known plesiadapiforms possessed postcranial modifications for arboreality compared to other mammals in the earliest Paleocene, and these specializations likely played a key role in the evolutionary success of the earliest primate radiation.
angustis, Didactylorhynchus jii, and Shenshinornis primita—whose validity has yet to be critically assessed. We present the results of a qualitative and quantitative analysis of twelve specimens, including the aforementioned holotypes and examined the characters used to diagnose the four previously named species. The regression models reveal that the compared limb elements show a strong correlation, with all specimens, including the holotypes, fitting the regression lines. Our examination of the four species diagnoses reveals that these contain characters influenced by taphonomic biases and/or differences in ontogeny. In some instances, our observations were also unable to confirm the characters specified in these diagnoses. Our results indicate that the perceived morphological differences among previously named sauropterygians are better interpreted as taphonomic artifacts, ontogenetic differences, or mistaken observations. The regression models indicate that the observed differences in size are better interpreted as ontogenetic variation within a single growth series. Based on these observations, we argue that Sapeornis angustis, Didactylorhynchus jii, and Shenshinornis primita are junior synonyms of Sapeornis chaoyangensis.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MORPHOMETRICS OF RATITE FEMORA AND IMPLICATIONS FOR SEXUAL DIMORPHISM IN DINOSAURS

CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan; BRINK, Kirstin S., University of Toronto Mississauga, Mississauga, ON, Canada; KOBAAYASHI, Yoshihtugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; SUZUKI, Daisuke, Sapporo Medical University, Sapporo, Hokkaido, Japan

Sexual dimorphism in non-avian dinosaurs has traditionally been studied based on cranial material, especially in taxa with ornamental display structures (e.g., ceratopsians and hadrosaurids). However, with the exception of a rigorous morphometric study of Kentrosaurus, few studies have focused on assessing sexual dimorphism using postcranial skeletons. This may be due to the fact that sexual dimorphism based on size and morphology in the skeletons of extinct analogs, such as Alligator mississippiensis, is poorly known. Here, we test for sexual dimorphism in the femur of the ratites (Struthio camelus and Dromaius novaehollandiae), which are basal members of modern birds. As these ratites show a sexual size dimorphism, they are ideal to test whether morphological sexual dimorphism independent of size can be detected in the skeleton. We performed a principal components analysis (PCA) on geometric morphometric data of the femur of males and females at a variety of growth stages. The bones were analyzed from photographs in proximal, distal, anterior, and posterior view, using landmarks and semilandmarks. In the ostriches, three distinct groups are detected: juveniles, adult females, and adult males. The adult groups are separated from the juvenile group by the morphology of the proximal end of the femur and the proportions of the posterior condyle. Adults of both sexes differ from juveniles by having a thicker neck of the head of the femur and a longer medial edge of the lateral condyle in posterior view. Adult females differ from males by having an anterolaterally-rotated head of the femur and an expanded proximalateral margin of the trochanter. Interestingly, the morphological differences of the trochanter are also dimorphic in Kentrosaurus. On the other hand, there are no significant morphological differences between sexes in the emu, but the adults are distinguished from juveniles by the robustness of the neck of the head of the femur, as seen in the ostriches. This suggests that the dimorphism in emus is only size-related and not morphological. Our study demonstrates that the presence of morphological sexual dimorphism is variable, even in closely related taxa. When morphological sexual dimorphism is present, it may be detected in the femora using geometric morphometrics. An understanding of the sexual dimorphism in ratites has implications for the interpretation of sexual morphological dimorphism in dinosaurs, as dinosaurs may exhibit both sexual size dimorphism and morphological sexual dimorphism.

NEW INFORMATION ON NQWEBASAURUS THWAZI, A COELOUSORIAN THEROPOD FROM THE EARLY CRETACEOUS (HAUTERIVIEN?) KIRKWOOD FORMATION IN SOUTH AFRICA

CHONIERE, Jonathan N., Bernard Price Institute, University of the Witwatersrand, Johannesburg, South Africa; FORSTER, Catherine A., George Washington University, Washington, DC, United States; DE KLIERK, William J., Albany Museum, Rhodes University, Grahamstown, South Africa

We performed additional preparation on the holotype skeleton of Nqwebasaurus thwazi and discovered new material from the holotype. We describe this material, which includes a maxilla with small, conical, unserrated teeth and bones of the braincase, as well as parts of the holotype postcranial anatomy that were previously poorly documented. We incorporate this new anatomical information into a broadly sampled matrix designed to test theropod relationships. Our phylogenetic results hypothesize that Nqwebasaurus is the basalmost ornithomimosaur, and we recover numerous characters supporting this relationship, including features of the maxilla, frontal, dentition, axial skeleton, forelimb and hindlimb. Nqwebasaurus is the first African ornithomimosaur and the first Gondwanan member of this group known from articulated skeletal material, supporting the hypothesis that coelurosaurian groups were cosmopolitan during their early evolutionary history. The presence of reduced dentition and a gastric mill in Nqwebasaurus strongly suggest that this taxon was herbivorous. Additionally, some features of the anatomy suggest alvarezsaur affinities, strengthening the possibility that alvarezsaurians and ornithomimosaurans are more closely related than currently thought.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

BODY SIZE RECONSTRUCTION FOR FOSSIL NORTH PACIFIC PINNIPEDA (MAMMALIA: CARNIVORA): PROBLEMS AND IMPLICATIONS

CHURCHILL, Morgan, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States; KOHNO, Naoki, National Museum of Nature and Science, Tokyo, Japan

Animal body size is strongly correlated with a variety of ecological variables, including trophic position, diversity of prey, and species range size. However, body size can be difficult to quantify for fossil taxa due to incomplete skeletal material. To produce estimates of body size for fossil pinnipeds (seals, sea lions, and walruses), we regressed the log of 14 cranial measurements against log body weight and total length. Cranial measurements were selected based on their frequency of preservation within fossil taxa, ease of measurement, and presence of the measured feature across different pinniped families. Over 700 adult specimens of both genders, representing all 33 extant species, were examined. Two different sets of equations were created: 1) a set based on measurements from specimens of known body size and 2) a separate set of equations based on average body size and the average measurement of a given variable. Standard error, standard error of estimation, percent prediction error, and R² value were used to test the accuracy of the different regressions. PCA analysis of log measurements was used to determine if a separate equation of body size was needed for Phocidae and Otariidae, and which equation was most appropriate for extinct pinniped groups. Of individual cranial characters, mandible and condylobasal lengths were found to provide the best estimates of body size. Overall, estimates performed using known body sizes were more reliable than those using mean values. Estimates of total length were more accurate than estimates of body weight. Body weight is more variable than body length, due to seasonal changes in body condition reflecting fasting, and animals collected as stranded specimens may be underweight due to illness. PCA analysis of measurement data was able to recognize two major groups: 1) a group comprised of Phocidae and the "enaliarctine" Pacificotaria, and 2) a separate group comprising Otariidae, Odobenidae, Desmatophocidae, and all other "enaliarctines". Body size estimates were created for a range of North Pacific taxa, spanning the late Oligocene through Pliocene. Based on these estimates, body length was limited to less than 2.5 m until the middle Miocene. Three main groups filled this large pinniped size category (total length > 2.5 m): odoladines (middle Miocene); odobenids (late Miocene to early Pleistocene); and phocids (Mirounga) and otariids (Zametopias) (late Pleistocene to Present). Future work will evaluate the use of multivariate regressions of body size, as well as examine ecological factors which may explain changes in pinniped body size through the Neogene.

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caudal propulsion, to parallel adaptations for less caudal forms of locomotion and additional changes coinciding with modifications in lifestyle. Previously demonstrated for skates, this is now noted in electric rays, stingrays, and ‘guitarfishes’ independently. These changes involve the development of a free vertebral centrum, composed of areolar cartilage, is found more posterior along the trajectories among disparate batoid groups. For example, in any lineage of batoid, similar Jurassic forms than other groups of batoids. We find evidence of repeated similar phenotypic

The consistency with which findings report a paraphyletic “Rhinobatiformes” and the “Rhinobatiformes” is paraphyletic to the exclusion of other derived batoid lineages. As such, we sought to determine the extent to which patterns and rates of evolution. As such, we sought to determine the extent to which patterns and rates of evolution.

GUITARFISH PARAPHYLHY AND THE ORIGIN OF SKATES AND RAYS: ESTIMATING ACCUMULATION RATES OF VERTEBRAL FUSION AMONG BATOID FISHES

The exposure is capped by an approximately four-inch thick layer of arenitic sandstone that contains quartz gravel, phosphatic pebbles, and copious elasmobranch and bony fish remains. The exposure is capped by an approximately four-inch thick layer of arenitic sandstone that contains quartz gravel, phosphatic pebbles, and copious elasmobranch and bony fish remains.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:45 am)

BAVARIAN APPROACHES TO THE INVESTIGATION OF MORPHOLOGICAL RATE HETEROGENEITY IN DISTINCT ANATOMICAL SUBREGIONS

The chondrichthyan fauna includes, but is not limited to: Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri. Bony fish include Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri. Bony fish include Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri.

The chondrichthyan fauna includes, but is not limited to: Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri. Bony fish include Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri. Bony fish include Chiloscyllium minutum, Pachyrhizodus, Enchodus petrosus, Scapanorhynchus texanus, Borodinopristis schwimmeri.
CHEMICAL AND MOLECULAR CHARACTERIZATION OF ENDOGENOUS PROTEINS FROM THE BLOOD VESSELS OF BRACHYLOPHOSaurus CANADENSIS AND TYRANNOSaurus REX CORRECT BONE
CLELAND, Timothy P., North Carolina State University, Raleigh, NC, United States.
Lymph vessels (referred to herein as vessels for brevity and clarity) have been observed after demineralization of extant and fossil bone from the Recent to the Cretaceous; however two competing hypotheses have been suggested as the source of these structures: they are endogenous, representing original blood vessels; or they are the result of recent invasion and colonization of biofilm-producing bacteria. We hypothesized that if original structures would exhibit proteins in common with comparable vertebrate material that are not expressed by bacteria. Vessels from a specimen of Brachylophosaurus canadensis (MOR 2598) and Tyrannosaurus rex (MOR 1125) were collected after cortical bone fragments were demineralized with ethylenediaminetetraacetic acid (EDTA) using aspectic techniques in a laboratory dedicated solely to fossil analyses to avoid contamination.

Antibodies against several vascular proteins differentially bind these dinosaur soft tissues in multiple assays, supporting the hypothesis of endogeneity. The same antibodies do not bind to bacterial biofilm. High-resolution mass spectrometry also supports an endogenous source, as peptides from myosin, tubulin, actin, and tropomyosin have been detected from the B. canadensis specimen and peptides from myosin and actin have been detected from the T. rex specimen. Myosin and tropomyosin are only found in metazoan taxa, and tubulin is only found in eukaryotic taxa; these proteins are not common lab contaminants. Purgatoriid specimens lack any records of purgatoriid. Similarly they are unknown in any Lancia local fauna. Here we report discovery of a purgatoriid in the Puercan 1 local fauna found in the Garbani Channel, approximately 18 percent of over 7,800 currently cataloged mammalian specimens are referable to Kaswanga Point, Rusinga Island. The new material includes parts of at least a dozen skulls, multiple specimens are referable to 'pigotti' Brachylophosaurus canadensis, and a small head preserved in external compression from a specimen of Basilosaurus zvgozhikhi. These teeth and postcranial elements confirm this species is also different than the relatively shorter-faced and more aquatic *Osteoleamus* from the same formation. Further work is needed to elucidate the ontogeny of this species, and the larger question of the extent of biotic diversity in the Miocene of East Africa.

The process of fossilization is complex and is influenced by a variety of factors, including the type of organism, the environment in which it lived, and the specific conditions under which it died and was preserved. The presence of proteinaceous material in the blood vessels of *Brachylophosaurus canadensis* and *Tyrannosaurus rex* suggests that these structures may be endogenous to the fossil material. The use of mass spectrometry and immunohistochemical techniques has allowed researchers to identify proteins characteristic of endogenous vascular tissue, further supporting the hypothesis of endogeneity.

**Technical Session IX (Friday, October 19, 11:00 am)**

**NEW SPECIMENS OF 'CROCODYLUS' PIGOTTI (CROCODYLIDAE) FROM RUSINGA ISLAND, KENYA, AND A REFINED UNDERSTANDING OF THE SPECIES**

CONRAD, Jack L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; JENKINS, Kirsten, University of Minnesota, Minneapolis, MN, United States; DUNSWORTH, Holly M., University of Rhode Island, Kingston, RI, United States; HARCOURT-SMITH, William E., Lehman College, Bronx, NY, United States; MCNULTY, Kieran P., University of Minnesota, Minneapolis, MN, United States

During June and July of 2011, we recovered parts of more than a dozen 'Crocodylus' pigotti (Boswell's Crocodile) a poorly known and relatively small (approximately 2.5 m long), early Miocene crocodylid from Rusinga Island, Lake Victoria, Kenya. We report on previously unknown parts of the anatomy and provide an updated phylogenetic analysis. Known only from one relatively complete skull and limited, fragmented, referred material, 'Crocodylus' pigotti lacks a detailed description. We describe numerous new remains of 'Crocodylus' pigotti recovered from a locality within the Fossil Bed Member of the Hiwegi Formation at Kaswanga Point, Rusinga Island. The new material includes parts of at least a dozen skulls, cervical, dorsal, and caudal vertebrae, scapulocoracoids, humeri, ulnae, parts of the manus, an ilium, an ischium, femora, and tibiae. The postcranial skeleton reveals a robust crocodilian with a "generalist" skull. 'Crocodylus' pigotti was originally compared to the Crocodylus niloticus morphotype and allied with it phylogenetically. However, recent phylogenetic analyses have shown *Crocodylus* pigotti to be an osteoarcan crocodylid, a result further supported by our own analyses. Even so, the gestalt of the relatively long face, "generalist" skull, "Crocodylus" pigotti is more that of a subadult *Crocodylus niloticus* than the relatively shorter-faced *Osteoarcanus*. This lends credence to the early suggestion that 'Crocodylus' pigotti might have been ecologically similar to small or subadult generalist predator *Crocodylus niloticus*. An unnamed Miocene fossil from Lothagam Kenya probably represents another new Miocene osteoarcan similar to *Crocodylus* pigotti. Over its history, osteoarcan diversity has mirrored that of crocodylids—a fact not immediately apparent based on the two extant relictual species. Ranging from two to five-plus meters...
and with a variety of snout and tooth types, Osteoelaemina includes generalist dwarfs, presumably piscivorous giants, and a variety of forms between. Osteoelaemines were a significant part of the Miocene freshwater fauna in Kenya.

Institute of Vertebrate Paleontology and Paleoanthropology and the Carnegie Museum of Natural History have explored fossiliferous karstic fissure-fillings (Fissures A-E) near Shanghuang in southern Jiangsu Province, eastern-central China. These sites have yielded rich middle Eocene vertebrate faunas, including remarkable primate assemblages currently considered among the best-known Asian records of early primates. Three adapiform taxa, including two sivaladapids (Hoanghonius sp. nov. and Rencunius war, both of which belong to the subfamily Hoanghonini) and the adapoid Adapoides troglodytes have been identified from the Shanghuang fissure-fillings. All previously described adapiform fossils from Shanghuang, including specimens that were previously interpreted as pertaining to a taxon resembling Eurolemur, can now be attributed to Adapoides. Newly collected specimens of Adapoides significantly improve our knowledge of its anatomy and relationships. A phylogenetic analysis incorporating the Shanghuang adapiforms has been conducted to explore the relationships of these taxa. Shanghuang sivaladapids are the oldest undisputed members of Hoanghonini and extend the geographic range of this subfamily to Jiangsu Province. These fossils provide crucial information for understanding the origin and subsequent radiation of sivaladapids in Asia, revealing previously unsuspected taxonomic and paleoecological diversity during the early history of the group. Adapoides troglodytes shows affinities with European Adapinae, supporting the hypothesis of adapoid dispersal from Asia to Europe during the middle Eocene. The phylogenetic and biogeographic affinities of the Shanghuang fauna reflect the complex role played by Asia during the early evolution of adapiform primates.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:00 am)

BRIDGING THE GAP: NORTH CAROLINA'S ROLE IN LATE CRETACEOUS (CAMPANIAN) RESEARCH AND ITS IMPLICATIONS FOR REGIONAL PALEOBIOGEOGRAPHY AND FAUNAL CORRELATIONS
CRANE, Cynthia D., Department of Geological Sciences, East Carolina University, Greenville, NC, United States

New research from a vertebrate fossil site discovered near Elizabethtown, Bladen County, North Carolina, has contributed to an updated Late Cretaceous (Campanian) age faunal list. The new data support previous paleobiogeographic interpretations and indicate latitudinal extensions of species previously restricted to other localities of the Atlantic and Gulf Coast region. They also permit a faunal comparison and correlation with known localities to the north (Ellisdale, New Jersey) and to the south (Hannahatchee Creek). During the Campanian, a fluvially-dominated estuarine system preserved vertebrate elements from a multitude of organisms in a ca. 10 cm thick bonebed at the top of the Bladen Formation of the Black Creek Group. The bonebed, overlain by Cenozoic terrace deposits, is exposed at the new site, approximately 6 km from Phoebus Landing. The Elizabethtown site has yielded a greater abundance and diversity of vertebrate material than Phoebus Landing, thus permitting a more detailed understanding of the regional paleoecology. Bulk samples from the bonebed have yielded a diverse assemblage of fresh water, brackish water, and terrestrial organisms representing at least 44 taxa, including 22 species of selachians, seven species of osteichthyes, as well as crocodylians, mosasaurs, freshwater and saltwater turtles, pliosaurs, four dolphin taxa, one genus of Mammalia, and one genus of Amphibia. Of particular note are the occurrence of Cimolomys sp., Albanepteron sp., Deinosuchus rugosus, Ornithomimomus sp., Dromaeosauridae gen. and sp. indet., Tyrannosauridae gen. and sp. indet., Hadrosauridae gen. and sp. indet., and Bordoidiprion sp.

DELOTPHYCIUS: CRANIAL CHARACTERS AND RETHINKING EARLY HOLOCEPHALAN PHYLOGENY
CRISWELL, Katharine E., University of Chicago, Chicago, IL, United States; FINARELLI, John A., University College Dublin, Dublin, Ireland; FRIEDMAN, Matt, Oxford University, Oxford, UK, United Kingdom; GARWOOD, Russell, Manchester University, Manchester, United Kingdom; COATES, Michael J., University of Chicago, Chicago, IL, United States

During the early 1980s the noted fossil collector S. P. Wood discovered a pair of exceptionally intact specimens of Deltophyctius, a Lower Carboniferous holoccephalan, while excavating the fossil fish site at Bearsdens, Scotland (Serpukhovian: ~326-318 Ma). We obtained a CT-scan of the most complete Deltophyctius species and have identified and digitally isolated parts of the skull, mandible, and pectoral girdle. Deltophyctius traditionally was diagnosed by features including a head shield made up of dermal plates and scales, supraorbital sensory line grooves on the surface of the dermal bones, presence of mandibular spines, but lack of frontal spines in contrast to the array present on the rostrom of its closest relative, Menaspis. This species of Deltophyctius reveals numerous characters that were not previously known, including details of the braincase concealed by the deromatocranium. The orbits are separated by endocranial space: there is no interorbital septum. The quadrate are positioned anterior to the orbit and there is some evidence for a large crano-quadrate passage perforating the broad suborbital shelf. For the first time we can begin to see the internal structure of the otic capsules: these are small, as in living chimaeroids. Posteriorly, the occipital is a single plate showing no synarcual plate, consistent with absence of a dorsal fin and associated spine. It is also apparent that mineralized chondrocranial are absent. These new data fill in previously-missing character state information for this taxon, and serve to falsify previous hypotheses of the evolution several functional character complexes, in particular the evolution of the paired sensory organs. Holoccephalans represent an important component of the post-Devonian evolutionary radiation of modern vertebrate clades. This is a topic of
increasing interest as we begin to explore the refilling of vertebrate ecomorphospace in the recovery period following the Hangenberg extinction.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:45 am)

ASYNTHESIS OF CENOZOIC NEOTROPICAL MAMMAL EVOLUTION IN SOUTH AMERICA: BIOGEOGRAPHY AND INFLUENCES FROM HIGHER LATITUDES
CROFT, Darin A., Case Western Reserve University, Cleveland, OH, United States

Fossil assemblages from the Southern Cone have long been the basis for understanding patterns of Cenozoic mammal evolution in South America. More recent studies of assemblages from other parts of the continent have added a geographic dimension to this mainly temporal framework, revealing additional complexities. The present study synthesizes the past two decades of research on terrestrial Cenozoic mammals of tropical South America (the Neotropics). Within this region, spatial gaps in sampling and shared characteristics among faunas of each region permit the recognition of two subregions: low latitude (LL) faunas north of about 15° S and mid-latitude (ML) faunas south of 15° S.

The pre-Oligocene record of terrestrial mammals in tropical South America includes only two well characterized ML localities, Tiupampa, Bolivia and Itaborai, Brazil. The lack of unambiguously correlative and well-sampled extratropical localities during the Paleocene and early Eocene hampers biogeographic conclusions based on these sites, but circulate xenarthrans and microbiotherian marsupials may have originated in the tropics during this interval. New middle Eocene mammals from Contamana, Peru (LL) mostly remain undescribed but are noteworthy in including the oldest rodents in South America, suggesting a LL tropical origin for caviomorphs. Pyrotheres may also have originated in the LL tropics by the late Eocene.

The earliest interval for which detailed time-correlated comparisons of tropical and extratropical localities are possible is the late Oligocene. Such studies reveal few clear examples of suprageneric endemism in the Neotropics, but argyrolagid and caenolestid marsupials and tylotyean armadillos may have originated in the ML tropics by this time. By the early Miocene, distributions of some suprageneric clades, such as mesotheriid notoungulates and chinchillid rodents, clearly differ among LL and ML Neotropical localities and between tropical and extratropical regions. This pattern persists into the middle Miocene with these and other groups. Primates become restricted to tropical latitudes during the middle Miocene and groups such as pangolins may have originated in LL areas by this time. Range contractions of older lineages into the tropics and extratropical expansions of newly originating clades continues into the late Miocene and Pliocene. Mammals such as astrapotheres are last recorded in LL latitudes during this interval. Neotropical evidence of the earliest stages of the Great American Biotic Interchange is surprisingly scarce, but a proboscidean and artiodactyls from the LL Madre de Dios Formation have been proposed to represent its first phase in South America.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

MODELING FUNCTIONAL TRADE-OFFS OF TEETH FROM EXTINCT AND EXTANT HARD PREY CRUSHING TAXA
CROfts, Stephanie B., University of Washington, Seattle, Seattle, WA, United States
The dense mineral composition of teeth, especially enamel and enamelled layers, means that they are commonly found in the fossil record. Because of the tight connection between tooth morphology and function, tooth shape is often used to infer the diet of organisms; and tooth morphologies are generally placed in one of three categories: cutting, piercing, and crushing. Experiments measuring the mechanics of cutting blades and puncturing devices, as well as experimental measurements of tooth performance in these two categories have found that notched blades reduce the energy needed to cut through animal flesh, and that the need to prevent tooth failure leads to a trade-off in the ability of canine teeth to puncture flesh. In this study we set out to test the relative ability of different tooth morphologies to crush prey items. I constructed four series of archetypal tooth models that graded from one morphological extreme to another, covering the range of morphologies used for durophagy. Using a tooth with a flat occlusal surface as ‘tooth zero’, I varied the degree of convexity and concavity of the occlusal surface to generate two series of models. To generate the other two series, I added a conical stress concentrator to the center of the occlusal surface and changed its morphology. To vary the shape I changed two parameters: the height, or how far a force concentrator would extend above the occlusal surface of ‘tooth zero’, and the radius, which determined how far the base of the force concentrator spread over the occlusal surface ‘tooth zero’. By mounting these models in a materials testing system, I was able to measure the force needed by these shapes to crush morphologically and compositionally identical prey items. I compared these results to finite element models of these same tooth shapes to determine whether prey-breaking or prevention of tooth breakage plays a more important role in the evolution of crushing tooth shape. Based on these two data sets, it appears that there is a trade-off, similar to that seen in puncturing teeth, between tooth shape durability and tooth function.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)
OGMOPHIS, CALAMAGRAS AND THE 32 MILLION YEAR OLD AGGREGATION OF SNAKES FROM THE WHITE RIVER FORMATION: ARE THEY ERYCINES?
CROghan, Jasmine A., University of Alberta, Edmonton, AB, Canada; CalDWELL, Michael W., University of Alberta, Edmonton, AB, Canada
Fossil taxa attributed to the Erycines, like many other fossil snakes, are defined almost entirely by vertebral forms. The ‘erycine’ serpentine aggregation from the Oligocene White River Formation consists of four largely complete and articulated individuals, including skulls. The observed vertebral variation, rostral to caudal, provides a unique opportunity to identify potential overlap of existing vertebral form taxa with the columnar variation present in these four individuals. More importantly, these complete skeletons, rich in critical anatomical details, provide key data for synonymizing numerous vertebral form taxa and for systematizing these animals using complete skeletal data. For example, the caudal vertebrae visible on the specimens do not display the additional complex processes definitive of Oligocene erycines with the exceptions of Oligocnemus and Eryx. The mid trunk vertebrae of the Oligocene aggregation possess low neural spines and flattened neural arches (similar to modern Erycines), yet vary throughout the vertebral columns of all four individuals. Vertebral descriptions at the subfamilial, generic, and importantly, the species level, are loosely defined in extant erycines. Therefore, the previous assignment of these snakes to Ogmophis sp. and Calamagras sp., or to any other genus of erycine, extant or extinct, is presently unsupported. External examination of the available skeletons revealed the presence of morphometric markers attributable to Erycines: a larcinal foramen not entirely surrounded by the prefrontal bone. Preliminary analysis of the individuals in this White River opidian aggregation demonstrates the presence of three out of the six diagnostic features of the subfamily Erycines, and strongly suggests that these specimens require recognition as new taxa, not as Ogmophis or Calamagras.

FUNCTIONAL MECHANICS OF ORNITHOMIMOSAUR CRANIA COMPARED TO OTHER THERIOPODS
CURF, Andrew R., University of Bristol, Bristol, United Kingdom; RAYFIELD, Emily J., University of Bristol, Bristol, United Kingdom

Ornithomimosauras have long been referred to as ostrich mimicking dinosaurs due to their apparent cranial convergence with many of the extant paleognathes. Both groups possess lightweight skulls with large orbits and derived ornithomimosaurus become edentulous and possess a keratinous rhamphotheca. Whether this convergence is superficial or functional is of importance to understanding the evolution of this group and theropods in general. The skulls of three ornithomimosaurus (Garudimimus and the ornithomimids Struthiomimus and Ornithomimus) were digitally reconstructed using CT scan data. Virtual muscles were created using osteological correlates, from which bite forces were calculated. Hypothetical beaks that cover the rostrum were created based on known fossils and modern birds to study their effects. Finite element models were run using the muscle loads. Geometric morphometric methods allowed us to compare the deformation undergone by the skull in addition to analysing strain patterns. These were then compared to an ostrich model that was validated by the author, and previous finite element studies of other theropods (Allosaurus and Coelophysis).

Results show that sutures play a role in reducing overall strain in skulls. As with the ostrich skull, using a homogeneous material property with a Youngs modulus less than that of cortical bone makes a good compromise when sutures are not easily segmented from CT scans. Beaks reduce strain in the skulls, with more extensive morphologies capable of much higher feeding loads. The derived ornithomimosaurus had smaller muscle loads but strain similarly to the more primitive Garudimimus. When scaled to the same sizes and loaded equivalently the derived species deform differently suggesting that they might be exploiting different diets. Based on the results we suggest that derived ornithomimosaurus experience more similar strain patterns to those of ostriches, but ostrich skulls experience higher strain magnitudes under equivalent loads. When compared to typically carnivorous theropods (Allosaurus and Coelophysis) ornithomimosauras have very different strain patterns due to their edentate nature which are exaggerated by the presence of a beak. This has implications for feeding method and may be linked to the hypothetical herbivorous diets of the ornithomimosaurus and the repeated evolution of beaks in theropod dinosaurs.

Technical Session I (Wednesday, October 17, 10:15 am)
MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF AN ORNITHOMIMID (DINOSAURIA) BEARDED BY THE HOSE SHOE CANYON FORMATION, ALBERTA
CULLEN, Thomas M., Carleton University, Ottawa, ON, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; EVANS, David C., Royal Ontario Museum, Toronto, ON, Canada; CURRIE, Philip J., University of Alberta, Edmonton, AB, Canada; KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Sapporo, Japan

Data from bone beds and osteological tracestructures provide information from which hypotheses regarding ontogeny, metabolism, ecology, and behaviors of ancient vertebrates can be established. Multiple hind limb elements (femora, fibulae, tibiae, metatarsals, and pedal phalanges) from three individuals from the first North American bone bed of Late Cretaceous ornithomimoids were examined histologically. Each specimen showed
fibrolamellar tissue, near-equal spacing of lines of arrested growth (LAGs), and osteon development at outer bone margins, indicating that they were experiencing rapid growth at the time of death. However, this rate was decreasing in the largest individual, possibly indicating the onset of maturation. The two smaller individuals were determined to be two and three years of age at death, while the adult male was determined to be four years old at the time of death. Of note is that LAGs and other histological signals remain consistent across the different hind limb elements examined within individuals. This indicates that for at least some small theropods, age at death can reliably be determined from various postcrania long bones. This has the potential to significantly increase the database available for determining growth patterns within various taxa as long as body size at the time of death can be determined.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

TEEN SCIENCE SCHOLARS AT THE DENVER MUSEUM OF NATURE AND SCIENCE: NURTURING THE NEXT GENERATION OF SCIENTIFIC LEADERS

The Teen Science Scholar program (TSS) at the Denver Museum of Nature & Science involves high school youth (ages 15 to 18) in authentic scientific research in order to encourage their selection of an academic and career path in science. The program began in 2007 with a focus in vertebrate paleontology and is now in its sixth year. Scholars are selected based upon academic performance, a personal objective to pursue an interest or career in science, recommendations on leadership and science interests, and the potential to be future community leaders. Special emphasis is placed on students who are underrepresented in the sciences, women and minority students, and who will be the first in their family to attend college. The program began in vertebrate paleontology and now includes additional tracks in zoology since 2009, health sciences since 2010 and archeology since 2011. Scholars in paleontology, zoology, and archaeology spend time doing field research collecting data and specimens. This is followed by six weeks of specimen preparation, identifications, and analysis in the Museum laboratories. Students in health sciences are involved in laboratory experiments and analysis. Students are paid for their work during the summer. The objective of each year’s program is to provide an authentic research experience that results in the development of new scientific knowledge and helps students understand the complete process of science. Scholars have finalized their research work through abstract publication, peer-reviewed papers including the description of new taxa, video presentations, publications and posters. Many of the students continue as Museum volunteers after the summer program. Students who have participated in the program are tracked to follow their educational development, careers, and interests in science. Among those that have graduated from high school over half are majoring in a science or engineering field. Of those who have graduated from college, all three are in postgraduate programs in science, one in paleontology. We anticipate that graduates in TSS will eventually become science mentors and role models for students in their communities.

BONE HISTOLOGY OF A DWARF SAUROPOD DINOSAUR FROM THE LATEST CRETACEOUS OF JORDAN AND A POSSIBLE BIOMECHANICAL EXPLANATION FOR “TITANOSAUR-TYPE” BONE HISTOLOGY
D’EMIC, Michael D., Georgia Southern University, Statesboro, GA, United States; WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States

Titanosaurus is a globally distributed, diverse, morphologically disparate sauropod clade that exhibits a dramatic range of adult body sizes. A new titanosaur from very small body size from the Maastrichtian of Jordan has completely fused sutures among the neural arches, centra, and ribs of a posterior dorsal vertebra, sacrum, and posterior caudal vertebrae. A thin section of the midshaft of the femur reveals a cortex completely remodeled by multiple generations of overlapping secondary osteons. This has the potential to significantly increase the database available for determining growth patterns within various taxa as long as body size at the time of death can be determined.

TRANSFORMATION OF THE PECTORAL GIRDLE DURING THE FIN-TO-LIMB TRANSITION
DAESCHLER, Edward, Academy of Natural Sciences, Philadelphia, PA, United States; SHUBIN, Neil, The University of Chicago, Chicago, IL, United States; JENNINGS, Jr., Farish A., Harvard University, Cambridge, MA, United States

Investigations of the fin-to-limb transition within the stem tetrapod lineage have tended to focus more on the appendages and less on the girdles that buttress and orient the appendages. We examined the pectoral girdles in a series of Late Devonian tetrapodomorph sarcopterygians including Eusthenopteron, Tiktaalik, and Acanthostega in order to track the dramatic transformation of this integral functional component during the transition. The reduction of the ventral portion of the cleithrum and the concomitant expansion of the endochondral scapulocoracoid are recognized as key changes in this segment of the tree. A complex of other changes reflect shifting function of the pectoral appendage and decoupling of the head and pectoral girdle. Specific character changes include the loss of the dorsal portions of the supracleithral series (post-temporal and supracleithrum), increase in the relative size of interclavicle, and flattening of the ventral body wall. The glenoid fossa assumes a more ventral position and posteroventralrotal orientation. Additionally, the shape of the glenoid fossa changes from rounded to elongate, and the re-oriented appendage necessitates changes in the action of the muscles that drive the appendage, specifically reflected in the loss of the subscapular fossa in the scapulocoracoid plate of early tetrapods. In summary, the transformation of the pectoral girdle within the stem tetrapod lineage involved a reduction and loss of continuity with the skull, redirection of the appendage to more ventrolateral orientations, and reorganization of the associated musculature to provide mechanisms of support.
A NEW LARGE-BODIED THEROPOD DINOSAUR FROM THE UPPER MORRISON FORMATION (LATE JURASSIC, TITHONIAN) OF COLORADO

DALMAN, Sebastian, Department of Geosciences, Fort Hays State University, Hays, KS, United States; PAULINA CARABAJAL, Ariana, CONICET-Museo Carmen Funes, Plaza Hincul, Argentina; CURRIE, Philip J., University of Alberta, Edmonton, Canada

In 1953, J. T. Gregory and D. Techter of the Yale Peabody Museum of Natural History discovered a partially preserved theropod skeleton in the Morrison Formation (late Tithonian) of Meeker County in Montezuma County, Colorado, U.S.A. The specimen consists of several well-preserved cranial, axial, and appendicular elements, some of which are still unprepared and embedded in hard sediment, explaining why this material lay largely unnoticed in the collections of the Museum until now. All the cranial elements, including the braincase, left premaxilla, maxilla, quadratojugal, and dentary were CT scanned so that digital 3D reconstructions could be done, allowing morphological description and comparisons. The Meckel's premaxilla represents a large-bodied theropod, distinct from Allosaurus and Saurophagognus from the same formation. The specimen is characterized by a short and deep premaxilla (with 4 teeth), deep maxilla, and a robust quadratojugal. These cranial elements are more massive than the equivalent elements in known specimens of Allosaurus. Preliminary phylogenetic analysis, based on previous phylogenies of this clade, positions this new form within Allosauroidea, more closely related to Allosaurus, Fukuiraptor and Neovenator.

MOLAR WEAR GRADIENT ANALYSIS IN EXTANT AND FOSSIL KANGAROOS (MARSUPIALIA, MACROPODODA)

DAMUTH, John, University of California, Santa Barbara, CA, United States; JANIS, Christine M., Brown University, Providence, RI, United States; TRAUVOLLON, Kenny J., University of Queensland, Brisbane, Australia; ARCHER, Michael, University of New South Wales, Sydney, Australia; HAND, Suzanne J., University of New South Wales, Sydney, Australia

We have developed techniques for the analysis of both relative and absolute rates of abrasive molar wear among species of kangaroos and wallabies (Macroopodidae). The molars of fossil and extant macropodoids are lophodont, with relatively simple crowns dominated by large transverse ridges. These ridges wear down through a recognizable wear morphology sequence that is similar in all species. The overall rate of wear, however, appears to differ consistently among species. We assess relative wear rates for a species based on a comparison of the degree of wear among the lower molars of each individual. Since the four molars erupt in sequence from front to back, anterior molars will experience wear earlier in the animal’s lifetime than will posterior molars. Thus, for most of the adult lifetime there is a wear gradient along the molar row. The steepness of the gradient should indicate the average rate of abrasive wear, irrespective of the animal’s age.

We tested this in a sample of 1,660 museum specimens (representing 73 species) of extant macropodoids. For each specimen, we visually scored the lower molar cusps according to a set of eight wear classes. The results confirm that steeper gradients (measured by linear least-squares slopes of wear class versus tooth position) are associated with species that are usually considered to experience higher rates of dental abrasion. For example, browsing, forest-dwelling macropodoids (Dorcopsis spp., Thylogale stigmatica) and tree kangaroos (Dendrolagus) show slopes that are approximately one-third of those of the mixed feeding, open country Macropus robustus and the grazing M. giganteus. As expected, molar gradient slopes change little with known or apparent age (when including only those teeth still functional and in occlusion). That these gradient slopes reflect mostly differences in wear rates, rather than differences in developmental timing, is supported by measures of absolute wear rates based on molar height from known-age individuals of extant species. Browsing Dendrolagus lunolotis shows absolute wear rates of 0.25mm/yr or less, approximately one third that of the mixed-feeding Macropus robustus (0.65 mm/yr) — roughly the same difference as seen in the gradient slopes.

The gradient wear technique is straightforward to apply to fossil species. Gradient slopes of Pleistocene Macropus giganteus from Victoria Fossil Cave, South Australia are as steep as those of the extant grazing species of Macropus, whereas the short-faced kangaroo Stenurus gilli, found in the same cave deposit, has a gradient that is shallower by a factor of four or five. Thus it is likely that these two sympatric species differed in their wear rates to at least the same degree as do extant grazing and browsing macropodoids.

TESTING THE ACCURACY OF ECOLOGICAL NICHE MODELS USING THE LAST GLACIAL MAXIMUM FOSSIL RECORD OF MAMMALS

DAVIS, Edward B., University of Oregon Museum of Natural and Cultural History and Department of Geological Sciences, Eugene, OR, United States; MCCIGUE, Jenny L., University of Washington School of Environmental and Forest Sciences, Seattle, WA, United States; KOO, Michelle S., University of California Museum of Vertebrate Zoology, Berkeley, CA, United States

The geographic distributions of many species are expected to change dramatically over the next century to accommodate global climate change. Conservation biologists model these expected changes using a suite of techniques called Ecological Niche Models (ENMs). ENMs sample physical environmental parameters (temperature, precipitation, seasonality) and vegetation parameters from known modern distributions of species, creating a multidimensional model of the current realized niche of the species. This niche model can then be mapped on hypothesized future climate surfaces, producing hypotheses of future species distributions. These hypotheses have been used to plan conservation efforts, and some researchers have suggested programs of assisted migration to transition species to new optimal environments. We test the accuracy of the most commonly used ENMs by projecting models of 50 mammal species onto Last Glacial Maximum (LGM, ~18–21 Ka) paleoclimate surfaces and comparing their hindcast distributions to the LGM fossil record. Our fossil data are drawn from the FAUNMAP II database, and include sites with dates from 30–10 Ka that clearly cross the LGM, ~20Ka. We tallied the number of sites both within and outside each ENM that contain and do not contain each species, allowing us to quantify the mismatch between hindcast and fossil distributions. The ENMs for many species predict distributions south of the southernmost fossil occurrences, but there is no apparent consistency in the model-data mismatch. At one extreme are species like Marmota flaviventris, which has a close match between its LGM fossil distribution and ENM. On the other end of the spectrum, Procyon lotor, Vulpes vulpes, and Ursus americanus have ENMs that reconstruct LGM distributions entirely south of all of their known LGM fossil distributions. Most surprisingly, some species, like the raccoon, appear to be unaffected by changes in their ENMs, suggesting the LGM conditions contained little to no analog to their current realized niches. We seek the phylogenetic and ecological controls on the mismatch between models and data, which will be valuable information to consider for future-climate ENMs. We hypothesize that observed mismatches could be caused by one or a combination of three factors: 1) niche evolution between LGM and today, 2) modern realized niche undersampling fundamental niches, or 3) problems with the LGM climate model properly parameterizing glacial edge effects.
This probably indicates a markedly older age for Hainin than the only well-known continental deposits of Europe that are Cernay-Berru and Walbeck. Few species clearly show close phylogenetic affinities with North American or Asian taxa, even at family-level, enhancing the endemic character of the European region during roughly the first half of the Palaeocene.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW FRESH-WATER HYBONDITID SHARK FROM LIMA CAMPOS BASIN (EARLY CRETACEOUS), BRAZIL, AND ITS PALEOGEOGRAPHIC CONTEXT

DE FIGUEIREDO, Ana Emilia Q., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; PINHEIRO, Felipe L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; DENTZIES, Paula C., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; FORTIER, Daniel C., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; SCHULTZ, Cesar L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Hybodontiforms are recorded from the Devonian to Cretaceous, with widespread geographic distribution. In Brazilian sedimentary basins, they were recognized in Permian and Triassic deposits of the Paraná Basin, along with some Jurassic-Cretaceous units from the northeast part of the country. In the latter deposits, they are diverse, representing four genera after the recent discovery of a yet unrecorded genus Planohyodus. The fossil specimens were from Early Cretaceous of Malhada Vermelha Formation, Lima Campos Basin (Ceará State, Brazil) and represent a new species, characterized by stronger ornamentation composed by simple non-branching folds that almost reach the apex of the main cusp and distinctly divergent lateral cusplets. The genus Planohyodus was recorded in the Early Jurassic of Luxemburg, and in the Middle Jurassic (Batonian) of France, Scotland and England. Late Jurassic remains occur in Northeastern Spain, France and England. Thus, in the Jurassic, they were restricted to Europe, in a number of different palaeoenvironments, associated with marine facies. This scenario radically shifted during the Cretaceous. The European fossils are still present on the Barriassain/Hauterivian of Spain, and Barremian of Denmark. Additionally, a dispersion event is identified through the South American records of Malhada Vermelha facies. This probably indicates a markedly older age for Hainin than the only well-known deposits of the South American records of Malhada Vermelha facies. This scenario radically shifted during the Cretaceous. The European fossils are still present on the Barriassain/Hauterivian of Spain, and Barremian of Denmark. Additionally, a dispersion event is identified through the South American records of Malhada Vermelha Formation of Lima Campos Basin and Missão Velha Formation (Araripe Basin). The latest fossils were found in the Santonian of New Mexico (USA). Differing from the European predominance during the Jurassic, the Brazilian record is strictly related to continental environments. The Malhada Vermelha and the Missão Velha formations are associated to fluviolacustrine facies, even though the latter one has some marine influence. The discovery of Planohyodus in continental facies of northeast Brazil corroborates recent discoveries of this taxon in fluviolacustrine deposits of Spain. Curiously, the dispersion of Planohyodus to South America, probably from European forms, occurred when the separation of Gondwana and Laurasia was completed with the opening of the Atlantic Ocean.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE BACTERIAL FLORA OF REPOSITORY FOSSILS: SOURCES, SURVIVAL AND REMOVAL

DE LA GARZA, Randolph G., Sam Houston State University, Huntsville, TX, United States; LEWIS, Patrick J., Sam Houston State University, Huntsville, TX, United States; PRIMM, Todd P. Sam Houston State University, Huntsville, TX, United States

Microbes are well known for their ability to degrade a wide range of substances, including rock and bone. Fossils are a repository of similar microbial community as the rock matrix that they are found in, suggesting that microbes known to weather rocks may also affect fossils. Although there is considerable attention and effort applied to the preservation and conservation of fossils for long term storage, research concerning the detection and prevention of microbial growth is lacking in the scientific literature. Given the premise that microbes could damage fossils, our research question focuses on the presence of bacteria on fossils that are stored in repositories. Roughly twenty fossil bones, varying from early Triassic to late Pleistocene in age, were tested for presence of culturable bacteria. Some of these fossils were unprepared while others had been cleaned and curated. Fossils were swabbed with sterile cotton tip swabs which were streaked onto R2A and nutrient agar plates. Colonies that grew over time were identified using staining and biochemical tests. Additional experimental protocols were also used to determine the state of bacteria found on the fossils. Bacteria that were present on the fossils were extracted into microcentrifuge tubes and were heated to near boiling point to kill vegetative cells, selecting those that produce spores to survive. Initial results from both experiments indicate that microbial counts on stored fossils are relatively low and that the bacteria that are present are predominantly gram-positive, chained bacteria, with evidence that the microbes are in an active, vegetative state on fossils. The persistence of human-derived microbes was also investigated by the addition of concentrated solutions of the ubiquitous human skin bacterium Staphylococcus epidermidis onto decontaminated fossils. Human-derived microbes were determined to survive on fossils for relatively short durations, with 98% of S. epidermidis dying off within 24 hours. The most effective decontamination method was placing fossil specimens in an incubator at 95°C for 15-20 hours, although this is impractical for most specimens. Ethanol and acetone were also tested as potential antimicrobial agents, but were found to be ineffective in thoroughly reducing microbial populations, with acetone being the lowest in effectiveness. We are currently identifying bacteria isolated from the fossils in an effort to determine if they are primarily human-derived or soil-derived. This work paves the way for examination of potential bacterial degradation/modification of fossils.

This probably indicates a markedly older age for Hainin than the only well-known continental deposits of Europe that are Cernay-Berru and Walbeck. Few species clearly show close phylogenetic affinities with North American or Asian taxa, even at family-level, enhancing the endemic character of the European region during roughly the first half of the Palaeocene.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

SIGNIFICANT MESOZOIC VERTEBRATE FOSSIL LOCALITIES DISCOVERED DURING CONTINUING PALEONTOLOGICAL RESOURCE INVENTORY AND MONITORING AT ARCHES NATIONAL PARK

DEBIEUX, Donald D., Utah Geology Survey, Salt Lake City, UT, United States; MADSEN, Scott K., Utah Geology Survey, Salt Lake City, UT, United States; KIRKLAND, James I., Utah Geology Survey, Salt Lake City, UT, United States; INKENBRANDT, Paul, Utah Geology Survey, Salt Lake City, UT, United States; SANTUCCI, Vincent L., National Park Service, Washington, DC, United States

Through a systematic program of paleontological resource inventory and monitoring, the National Park Service (NPS) has been at the forefront of paleontological resource management on public lands. After more than a decade of work, initial inventories have been completed in many parks and the NPS has moved on to a second phase which involves monitoring of known sites and targeted inventory of specific formations identified as having high potential for significant discoveries during preliminary surveys. A baseline paleontological resource inventory of Arches National Park focusing on the documentation of previously known sites and survey of the highly fossiliferous Upper Jurassic Morrison and Lower Cretaceous Cedar Mountain formations was completed in 2000 by NPS personnel in cooperation with the Utah Geological Survey (UGS). Recently, the UGS produced Potential Fossil Yield Classification (PFYC) maps of the park using newly updated geologic maps. In the fall of 2011, the UGS and NPS conducted additional field inventory in the park, targeting rocks of the Chinle, Wingate, Kayenta, and Navajo formations. These formations were chosen because of their potential for discovery of significant vertebrate fossils based on sites known from areas adjacent to the park. Also, these formations are located along the flanks of the Salt Valley, where uplift, collapse, and erosion of these rocks due to salt tectonics has made typically chliff-forming strata more accessible for ground survey. Our survey resulted in the identification of over 50 new localities. Numerous vertebrate localities were documented in the Chinle Formation. The first dinosaur body fossils from the Kanab Formation in Utah were found in the park. Vertebrate tracksites were found in the Chinle, Wingate, Kayenta, and Navajo formations. In addition to providing ground truth for PFYC maps, we field checked the new geologic maps and refined several contacts including the recognition of more extensive exposures of the Moenkopi Formation that were confirmed by the discovery of Chirotherium track localities. In our effort to establish baseline data for the monitoring of discovery and erosion, we developed detailed photometry of an important vertebrate track and feeding trace locality discovered in the Cedar Mountain Formations during the previous survey.

Edwin H. and Margaret M. Collins Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

PLESIOSAUR FLIPPER HYDRODYNAMICS AND ITS IMPLICATIONS ON PLESIOSAUROMORPH AND PLIOSAUROMORPH ECOMORPHOLOGY

DEBLOS, Mark C., Marshall University, Huntington, WV, United States

Plesiosaurs are a group of extinct, secondarily marine tetrapods unique for evolving two pairs of hydrofoil-shaped flippers that propelled the animal by producing lift. They are divided into two distinct morphotypes: plesiosauriomorphs, characterized by long necks and short heads, and pliosauriomorphs, characterized by short necks and large heads. Plesiosauriomorphs are thought to be cruising predators whereas pliosauriomorphs are thought to be active pursuit predators. If true, then plesiosauriomorphs ought to have flippers optimized for efficiency while pliosauriomorphs ought to have flippers optimized for maneuverability. The present study is the first to quantify the hydrodynamic properties of flippers from various taxa within Plesiosauria. These hydrodynamic data were then used to test the hypothesized predatory styles of the plesiosauriomorph and pliosauriomorph body types. Flippers hydrodynamics were approximated via static comparison of shapes across cross-sections at the propodial, epipodial, metapodial, and phalangeal regions from plesiosauriomorph and pliosauriomorph taxa including Elasmosauridae, Polycotylidae, and Pliosauridae. The thickness, chord length (the line connecting the leading and trailing edges of the flipper), and maximum camber (the mean curvature of the top and bottom surfaces of the flipper) were measured at these cross-sections and used to determine the resulting lift and drag using FossiSimUJIL, an aerodynamics program developed by NASA based on wind tunnel data. The ratio of lift to drag was used as an index of flipper efficiency. The degree of camber was used as a measure of maneuverability since increasing the camber reduces the speed at which a given angle of attack no longer produces lift (the stall speed). Flippers from plesiosauriomorph taxa had high lift-to-drag ratios and low camber whereas those from pliosauriomorph taxa had lower lift-to-drag ratios and higher camber. This study is the first to examine plesiosaur hydrofoils quantitatively and will have broad application for our understanding of plesiosaur biology, for the biology of other aquatic tetrapods, and for the behavior of biological hydrofoils in general.

Romer Prize Session (Thursday, October 18, 9:15 am)

PATTERNS AND PROCESSES AT ORIGIN OF BIRDS: MACROEVOLUTIONARY TEMPO AND MODE

DECECCHI, Thomas A., McGill University, Montreal, QB, Canada

The origin of powered flight in birds marks one of the major transitions in vertebrate evolution. Birds represent one of only three known occurrences of flight in tetrapods, and the only one with a well-resolved fossil record preceding its origins. Here I use a compilation of quantitative and qualitative data of this transition to generate high resolutions of the
patterns and processes that shaped this macroevolutionary event. Underlying trends in theropod evolution were isolated so that particular phenotypic changes could be identified and their potential drivers investigated. This presentation looks at two proposed trends that have functional consequences for the origin of flight: forelimb discrete character change and appendicular length evolution. The findings demonstrate that character change in the theropod forelimb skeleton is not uniform, the node Aves is not associated with high levels of concentrated character change, and the forelimb phenotype does not evolve similar to other modules, such as the skull, axial column, or the hind limb. Although allometry does not explain the tempo and mode of forelimb quantitative changes, the general trend of body size reduction within Coelurosauria does drive the observed pattern of forelimb elongation prior to the node Aves. At Aves however, a significant decoupling of fore- and hind limb scaling from body size occurred such that early avians have distinctively different allometries in these regions compared to their non-avian antecedents. Early birds have distinctly shorter hind limbs and longer forelimbs than expected based on non-avian regressions, indicating a novel selective regime compared to similar sized feathered maniraptorans. The three main ecological scenarios proposed to explain the transformation of a theropod forelimb into a wing (tree’s down, ground up, and wing assisted incline running (WAIR)) were tested. Using an extensive dataset of extinct and extant mammalian, reptilian and avian climbers scored for 17 climbing related characters as well as individual indices correlated to scannorial ability, non-avian theropods are shown to not possess the morphological adaptations required by extant arboreal taxa. The WAIR model is also challenged based on allometry and ontogenetic factors, gross morphological differences in the pectoral region between non-avian theropods and extant birds and biomechanical limitations in the theropod body plan; all of which limit its escalation, at least two. These findings lay out the pattern and ecology of a major evolutionary transition in a level of detail that has not previously been achieved and create a framework to examine other major transitions.

Technical Session XII (Friday, October 19, 3:30 pm)

A NEARLY COMPLETE FOSSIL IGNUAN FROM THE UPPER CREATURE (CAMPANIAN) TWO MEDICINE FORMATION OF WESTERN MONTANA

DELMAR, Jr. David, Washington University, St. Louis, MO, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; HEAD, Jason J., University of Nebraska-Lincoln, Lincoln, NE, United States; MOORE, Jason R., Dartmouth College, Hanover, NH, United States; WILSON, Gregory P., University of Washington, Seattle, WA, United States

The Late Cretaceous was an important interval for the early diversification of many extant lizard clades, but much of what is known of Late Cretaceous lizards from North America is restricted to disarticulated and isolated remains from vertebrate microfossil localities. This bias in the fossil record makes it difficult to fully grasp their diversity, richness, and evolutionary history. Here we report on a nearly complete and mostly articulated lizard from the Egg Mountain locality of the Upper Cretaceous (Campanian) Two Medicine Formation of western Montana. The specimen was preserved in heavily bioturbated, reworked terrigenous and volcaniclastic sediments with a potential palaeoecological overprint. The specimen was recovered as part of a vertebrate assemblage including isolated dinosaur teeth and eggshell, at least two partial and one complete lizard skeletons, and several other well-preserved lizard and mammal skeletons. We performed a phylogenetic analysis of 232 taxa that were scored for 363 morphological characters. Our analysis recovered an Adams consensus topology that places the taxon among pleurodontian iguanians forming a polytomy with Corytophanidae (e.g., basilisks) and Polychrotidae (e.g., anoles). Three unambiguous synapomorphies support the node: presence of postorbitofrontal rugae on the jugal, relatively narrow pyritiform recess, and clavicle with a proximal expansion. This new specimen represents the oldest record of the North and Central American clade including corytophanids and polychrotids and provides important new constraints on divergence timing and biogeographic histories of these groups.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Palaeoecology and Taxonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 12:00 pm)

EXPLORING THE “LOST CONTINENT” OF APPALACHIA - THE ELLISDALE LAND FAUNA AND ITS IMPLICATIONS FOR LATE CRETACEOUS BIOGEOGRAPHY

DENTON, Robert K., GeoConcepts Engineering Inc., Ashburn, VA, United States; O’NEILL, Robert C., New Jersey State Museum, Trenton, NJ, United States

Since its discovery in 1980, the Ellsisdale Site (Campanian Stage, Late Cretaceous) of the Marshalltown Formation of Monmouth County, New Jersey has produced the largest and most diverse fauna of terrestrial and freshwater vertebrates yet known from the Late Cretaceous of eastern North America. These data suggest that Appalachia may have served as a refugium for some Cenomanian/Turonian taxa of Laramidian origin; nevertheless, many of the Ellisdalian taxa are unique, with no known Laramidian or Eurasian equivalents. The boreoecidian lizard Proteosia and batrachosauroid salamander Parrisia are the least derived members of their respective families, and may have had an Appalachian origin.

Additional fossil discoveries from sites located throughout the eastern part of North America now suggest that the endemism seen initially at Ellisdale may be characteristic of the continent of Appalachia as a whole. This supports Dr. Baird’s original contention that the “Ellisdalean” assemblage would eventually be recognized as an important reference fauna, and critical to unlocking the secrets of the “Lost Continent” of Appalachia.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST RECORD OF TRACKS IN THE PERMAN (LOPINGIAN) OF THE PARANÁ BASIN, SOUTHERN BRAZIL

DENTZIEN-DIAS, Paula C., Universidade Federal do Rio Grande - FURG, Rio Grande, Brazil; PAES, Voltaire, Universidade Federal do Rio do Sul - UFRGS, Porto Alegre, Brazil; SCHULTZ, Cesar L., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil

Footprints are the most common vertebrate ichnoskeletons in the geologic record. These traces were unknown in the Lopingian of Southern Brazil until a new outcrop containing four distinct trackways and a partial track was found in the colian facies of the Pirãmbia Formation, in the southwestern region of the Rio Grande do Sul State. This outcrop is located at the eastern end of the municipality of Santana do Livramento (30° 42'44'' S, 55°02'34'' W). The partial and two complete trackways occur at the same level, but none of these trackways allow distinguishing morphological details. These trackways have different sizes, the largest trackway has 2.8 cm width and 2 cm in length, with a gauge of 5 cm and a stride of 8 cm, and the largest track is 14 cm in width, 12 cm in length, stride of 62 cm and gauge of 42 cm. There is no apparent morphological difference between the footprints of the same track making it impossible to differentiate manus or pes prints. Two other trackways occur in an upper level, and are better preserved. These trackways comprise different sizes and shapes of footprints, representing fore and hind feet. The smaller tracks, representing the manus prints, are oval in shape, 8 cm in width and 7 cm in length. The larger tracks are triangular in shape and display 5 short digits, with a width of 8.8 cm (digits) and 4.5 cm (heel), the footprint length is 10.2 cm. The gauge of this trackway is 24 cm and the stride is 28 cm. The hind feet display five digits, but in the forelimb it is not possible to distinguish the digits. The second track, which occurs at the same level, has very similar features, such as the same size and the same direction (moving north). All prints were preserved in a dune forested wind, and exhibit structures of microavalanche triggered by the weight of the animal. The probable trackmaker of the best preserved trackways is believed to be to about 60 cm in length due to the morphology of their paws, it is likely a therapsid. The complete lack of body fossils in the Pirãmbia Formation and the rarity of vertebrate trace fossils means that currently the footprint record provides the only evidence of the fauna that lived during the Lopingian in the southern part of the Paraná Basin. Thus, these tracks represent a highly significant addition to the paleontological studies of the Paraná Basin and to the footprint records of South America and of the global Permian.

Technical Session XVI (Saturday, October 20, 8:45 am)

TIMES NOT SO TOUGH AT LA BREA: DENTAL MICROWAVE TEXTURE ANALYSIS CLARIFIES THE FEEDING BEHAVIOR OF THE SABER-TOOTHED CAT SMILODON FATALIS AND AMERICAN LION PANTHERA ATROX

DECHANT, Lisa R., Vanderbilt University, Nashville, TN, United States; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States; SCOTT, Jessica R., University of Arkansas at Little Rock, Little Rock, AR, United States; UNGAR, Peter S., University of Arkansas, Fayetteville, AR, United States

The saber-toothed cat Smilodon fatalis and American lion Panthera atrox were among the largest terrestrial carnivores that lived during the Pleistocene, going extinct along with other mega fauna ~12,000 years ago. Previous work suggested that times were tough at La Brea (California) during the late Pleistocene, as nearly all carnivores have greater incidences of tooth breakage (used to infer greater carcass utilization) compared to today. High-magnification microweave of S. fatalis, in contrast, has suggested they avoided bone, even more than do extant cheetahs. As Dental Microwave Texture Analysis (DMTA) can differentiate between different levels of bone consumption in extant carnivores (specifically, the avoidance of bone in the cebeth Acroynx jubatus, durophylogy in the spotted hyena Crocuta crocuta, and more generalized behavior in the African lion Panthera leo), we use DMTA to clarify the dietary niches of extinct carnivora from La Brea. Specifically, we tested the hypothesis that times were tough at La Brea with carnivorous taxa utilizing more of the carcasses (as suggested by tooth breakage data). We predicted that S. fatalis avoided bone more than P. atrox, as P. atrox has reduced canines and the highest percentage of tooth breakage of all Pleistocene carnivores. Our results instead show no evidence of bone crushing by P. atrox, with lower complexity (Axf) and texture fill volume (Tfy) than extant P. leo and C. crocuta (p<0.001). Panthera atrox is indistinguishable from A. jubatus in both Axf and Tfy (p>0.05). In contrast, S. fatalis has DMTA characters most similar to P. leo,
with Asf values intermediate between A. jubatus and P. leo. (statistically separable from all extinct and extant taxa). Smilodon fatalis has significantly lower eLPstar than A. jubatus (p<0.01) and significantly higher Tfy than both A. jubatus and P. atrox (p<0.05), suggesting that S. fatalis did not avoid bone to the extent previously suggested by SEM microwear data. Lower mean Asf and Tfy values in P. atrox and S. fatalis compared with P. leo and C. crocuta suggest that carcass utilization by the extinct carnivorans was not necessarily more complete during the Pleistocene at La Brea; thus, times were not any “tougher” than today. Perhaps instead, increased tooth breakage may have resulted from consumption of larger prey that generated higher forces during capture. Additionally, minor to no significant variation was found when comparing specimens from older (pts 77 and 91, ~30–35 Ka) to younger (pts 67, ~11.5 Ka) deposits, suggesting that declining prey resources were not a primary cause of their extinction.

**NEW INFORMATION ON THE HYPOBRANCHIAL SKELETON OF THE EARLY PERMIAN LEPPOSOLIDY LYSORPHPH AMBILAPHIBIAN BRACHIDECTYES**

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The Late Paleozoic Lysorophidae is a small Permo-Pennsylvanian lepospondyl amphibian family comprised of only two genera, Brachidectyes and Pleuroptyx. The group is moderately well known given the frequently excellent preservation afforded by their location in abrasion burrows. The group is best known for their elongate bodies, reduced limbs, and highly fenestrate skulls and highly ossified hypobranchial skeleton.

Heretofore undescribed specimens collected by Everett C. Olson, and deposited in the UCLA Vertebrate Paleontology collections, provide additional information on the details of the hypobranchial skeleton in the North American genus Brachidectyes. UCLA VP 29496, from the Lower Permian (Leonardian) Fairmont Shale, Hennessey Group near Norman, Oklahoma includes a small partial skull, articulated anterior presacral vertebrae, and exceptionally preserved hypobranchial apparatus. Preservation of the hypobranchial apparatus in Lysorophidae is not uncommon because of the highly ossified nature of the individual elements, but they are frequently disarticulated and somewhat scattered. UCLA VP 29496 preserves a robust and well-articulated hypobranchial skeleton demonstrating previously undocumented patterns of articulation of the medial-most elements.

In previous studies a midline basibranchial element was unable to be identified. The specimen described here does not show clearly any of the hyoid arch elements; however, a very small midline element is present ventral to the margin of the mandible that could be a basibranchial. The hypobranchials of the first posthyoid arch appear to be very tightly articulated with one another in the ventral midline. Further, they are also very tightly articulated with the more lateral ceratobranchials. This hyp-to-ceratobranchial articulation is in fact so tight as to be potentially fused. Subsequent segments do not show a hypobranchial element, but ceratobranchials 2-4 are very well developed. Ceratobranchials of the second posthyoid arch articulate very closely with one another in the ventral midline. The ceratobranchials are strongly waisted, and their expanded distal ends give them an almost hourglass shaped outline. The hypobranchial skeleton in Brachidectyes shares certain features characteristic of juvenile amphibians on the one hand, and fully metamorphosed adults on the other hand. This mosaic of features is ascribed to the aquatic, neotenic features of an otherwise adult individual. A new reconstruction of the hypobranchial skeleton and its position relative to the ventral surface of the skull is offered.

**EVIDENCE FOR PERIODS OF INCREASED ARIDITY DURING THE LATEST CRETAUCEOUS OF NORTH AMERICA: A DESCRIPTION OF SEVERAL MASS DEATH ASSEMBLAGES OF TURTLES**

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Several localities (N=6) within the latest Cretaceous Hell Creek Formation of southwestern North Dakota and eastern Montana contain remarkable assemblages of numerous fossilized skeletal remains of riverine and ponded water turtles. Baenid turtles dominate the faunal assemblages. While trionychid soft-shelled turtles occur at each of these localities and a macrobaenid is found at one locality, all other North American Late Cretaceous turtles (adocids, chelydrids, kinosternids, and nelsonianchelydids) are absent. These localities not only provide important insights into the vertebrate fauna and paleoecology of this region at the period just prior to the momentous K/T extinction, but are also interpreted to be the result of climate-induced mass mortality events. At each locality, differing degrees of articulation indicative of various stages of post-mortem decay among individuals suggest the turtles died over an extended period of time prior to burial. Furthermore, mudcracks are found in the layer immediately below the fossil-bearing bed in at least one of the localities. We review the occurrence of mass mortality events in modern riverine and ponded water turtle populations and interpret the fossil localities to be after-death assemblages. While mass death assemblages of terrestrial dinosaurs are common in the Campanian of Alberta (attributed to monsoon rains and flooding), evidence for mass mortality events of aquatic animals is absent. We suggest the Western Interior of North America experienced more significant periods of drought during the Maastrichtian compared to the Campanian, and were responsible for the aquatic turtle death assemblages described.
FIRST STABLE ISOTOPE ANALYSES ON CROCODILES AND DINOSAURS FROM THE LATE CRETACEOUS “LO HUECO” FOSSIL SITE (CUENCA, SPAIN)

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The “Lo Hueco” fossil site (Cuenca, Spain) was fortuitously discovered in 2007 while constructing the high-speed railway Madrid-Levante. More than 8,500 macrofossils were recovered and the vertebrate assemblage suggested an age of Late Campanian-Early Maastrichtian.

Preliminary stable isotope analyses were performed on crocodiles and dinosaurs from two different levels: G1 and G2, with the former being older. Diagenetic alteration has been discounted based on two lines of evidence: 1) differences in dentine and enamel δ13C values were detected, with the former showing consistently higher values, and 2) crocodiles have lower δ18O values than dinosaurs (mean δ18Ocroc = 19±4‰ vs mean δ18Odin = 20±8‰). This result is in good agreement with the observed low latitude relationship between ectotherms and endotherms not only at present, but also in the Late Cretaceous. Calculated total mean δ18Ocroc and temperature values are comparable for crocodiles (δ18Ocroc = -3±0.7‰; temp. = 22±4.11.5°C) and dinosaurs (δ18Ocin = -3±0.9‰; temp. = 22±1.19°C). δ18Ocroc values correspond to precipitation waters in tropical and subtropical locations, whereas temperature values are in good agreement with estimated temperatures during the Late Campanian-Early Maastrichtian for the paleolatitude of “Lo Hueco” (≈31°N). A slight increase has been observed in δ18Ocroc, δ18Ocin, and temperature values from G1 to G2. G1 corresponds to a proximal muddy floodplain (close to distributary channels), whereas G2 represents a distal muddy floodplain (far from distributary channels) and thus, in this last scenario, isotopic values may be influenced by slightly drier conditions. Another possibility is that there was a shift towards warmer conditions between G1 and G2. Finally, δ15C values determined for dinosaurs are in the range of C3 feeders, with theropods showing a mean δ15C value of -10.7±0.8‰ and sauropods having a mean δ15C value of -11.1±0.2‰, with similar isotopic values in G1 and G2.

These preliminary isotopic results on the recently discovered “Lo Hueco” fossil site allow a first approximation to the paleoclimatic and paleoenvironmental conditions in Iberia during the Late Cretaceous.

NEW INSIGHTS ON MAMMALIAN FAUNAL DYNAMICS FROM THE MIOCENE OF SPAIN

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The mammalian fossil record of Spain offers one of the best opportunities in the Eurasian Miocene to investigate patterns of faunal turnover through time due to its completeness, high taxonomical resolution and comprehensive coverage of the Miocene Epoch. We evaluated diversification in relation to environmental history for large mammals identified to the species level. Large mammal species included in the analysis belong to Artiodactyla, Perissodactyla, Hyracoidea, Proboscidea, Primates and Carnivora. We focused on the interval from 12.0 to 5.5 Ma, which contains 72 localities from 13 basins supported by paleomagnetic dating. The occurrence of localities in different basins makes it difficult to establish age correlations among them directly. We established a comprehensive chronological sequence through maximum likelihood appearance-event ordination. Changes in mammalian diversity of Spain have been traditionally analyzed using the Mammalian Neogene (MN) biochronological framework, which has long time bins of unequal duration. Applying an ordination method permitted us to analyze diversity changes at a finer time resolution. We parsed the localities into 0.5-Myr time bins. Since observed first and last appearances underestimate the real temporal range of taxa, we calculated 80% confidence intervals on the observed duration of each lineage. We evaluated rates of origination, extinction, diversification and turnover as well as changes in faunal composition and trophic structure. Three significant turnover periods were identified. The first one, between 12.0 and 11.5 Ma, was mainly driven by originations with a substantial number of immigrations. High turnover between 9.0 and 8.0 Ma arose from a combination of appearances and disappearances. Disappearance of some browsers and appearance of mixed feeders and grazers suggests that this period of faunal turnover was related to environmental change toward more open habitats. Finally, significant faunal change occurred between 6.5 and 5.5 Ma. The extinction rate for this interval was the highest for all the intervals evaluated. At this time, the Messinian Salinity Crisis extended throughout the Mediterranean Region and the mammalian fauna experienced a major reorganization. Finer temporal resolution and standardized diversity metrics have provided more detailed insight into the timing and pattern of faunal events over time and also will facilitate comparison with other Miocene records.

TRADITIONAL CLASSROOM VISITS ARE NECESSARY WHEN EVOLUTION IS TAUGHT AS A CONTROVERSY: BROADENING THE IMPACT OF INDIVIDUAL CLASSROOM VISITS

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Recently, the state of Tennessee passed a law that permits teachers to teach scientific topics like evolution and global warming as controversial. While much debate has ensued about this legislation, Tennessee teachers can now choose to teach sound science as they always have, or introduce alternative ideas or explanations. While citizens are working on changing the current state of affairs, in the meantime, scientists and paleontologists aim to ensure sound science is taught in the classroom – one classroom at a time. Although classroom visits can be time consuming, they are a primary way of engaging with local students and teachers. Further, visits to one or two classrooms allow for replication of similar presentations and activities in future classroom visits, cutting down on preparation time. Here, we propose and discuss guidelines we have implemented to improve the quality and quantity of classroom visits by paleontologists. First, we carefully select schools and classrooms where we will have the greatest impact. This includes visiting students that will benefit from the types of experiences paleontology can provide. For example, we annually visit the Tennessee School for the Blind and teach lessons that require students to make inferences about fossils by their sense of touch. Unable to use visual teaching tools, students and faculty are challenged to communicate paleontological science through creative mediums. Second, we involve both graduate and undergraduate students in classroom visits to walk them through the teaching process by providing examples of appropriate classroom activities, and allowing them to build confidence in a new environment. Through graduate and undergraduate visits, each student will quickly gain the confidence to independently visit other classrooms throughout a given year. Third, we aim to tap into existing programs. Although independent classroom visits are beneficial to the individual classrooms visited, if we can infuse paleontological lessons into existing outreach programs that can be implemented by volunteers already engaged in classroom outreach, our efforts will stretch much further. As teachers are required to teach the standards, focusing on under taught standards such as evolution and climate change is an excellent way of ensuring these concepts are adequately discussed in public schools. Our guidelines help broaden the benefits of classroom visits while simultaneously giving students and teachers access to knowledgeable paleontologists who accept evolution. Classroom visits, while traditional and time consuming, are an important tool for improving communication outside of the ivory tower, and training undergraduate and graduate students in broader impact activities.

RICHARDOESTESIA sp. in the formation. Interestingly, previous reports on theropods in the Upper Cretaceous Prince Creek Formation of northern Alaska preserves the single most informative record of dinosaur diversity from high paleolatitudes (82 degrees North) in North America. As such, it figures prominently in ongoing debates regarding dinosaur provinciality, migration, and overwintering strategies. Essential to hypothesis-based testing of these broader questions is a more comprehensive understanding of faunal composition of polar taxa from the Prince Creek Formation. However, current knowledge of the diversity and relative abundance of the Prince Creek Formation dinosaurs remains limited and available data is potentially biased given that most material has been collected from a small number of highly productive bone bed deposits. In order to more fully characterize its faunal composition, we analyzed teeth from microvertebrate assemblages, including Pedionomys Point, from the Prince Creek Formation. Our results reveal considerably greater diversity among both ornithischians and theropods than has been previously recognized. As many as six ornithischians have earlier been documented in the formation; in addition to a known theséalosaurine, we note the presence of cheek teeth from a smaller, morphologically distinct basal ornithopod most similar to either Orodromeus or possibly Zephyrosaurus. Prior work recognizes five theropod taxa, most of which have been referred to largely non-contemporaneous taxa from lower latitudes. Our analysis is the first to document the occurrence of Ricardoestesia sp. in the formation. Interestingly, previous reports of chondrichthysans from the formation are likely attributable to teeth of a small avian dinosaur, or possibly a crocodilian. In contrast to earlier studies that suggest Troodon sp. is the most abundant theropod in the unit, its remains are relatively rare in our microvertebrate analyses. These new data significantly enhance the known diversity of dinosaurs from the Prince Creek Formation and provide critical new data for cross-latitudinal comparisons with temporally equivalent beds, such as the Horseshoe Canyon Formation of Alberta.
Posterior Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ASSESSING PREDATOR-PREY INTERACTIONS THROUGH THE IDENTIFICATION OF BITE MARKS ON AN AETOSAUR (PSEUDOSUCHIA) OSTEODERM FROM THE UPPER TRIASSIC (NORIAN) CHINLE FORMATION IN PETRIFIED FOREST NATIONAL PARK (ARIZONA, USA)

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Paleoecological interactions of extinct tetrapods are typically difficult to infer. Although scarce, trace fossils can offer a glimpse into predator-prey interactions in ancient communities. Here we provide evidence for a Late Triassic predator-prey interaction based on an aetosaur osteoderm (PEFO 34869) with feeding traces. The partial paramedian osteoderm of the aetosaur *Toxochasaurus* exhibits multiple tooth marks, presumably produced by a predator/scavenger feeding on the aetosaur carcas. The feeding traces include a series of four punctures forming an approximately 125-degree arc on the ventral surface of the osteoderm (interpretation: single bite), with additional pits and scores with striations marking the dorsal surface. The punctures on the ventral surface have an average spacing of ~1.0 cm and range in width by 2.1-4.1 mm and in length by 4.6-9.1 mm. Carnivorous taxa from the same locality as well as other nearby sites from the Upper Triassic Chinle Formation, Petrified Forest National Park, include large-bodied (>3 meters) phytosaurs (*Pseudalopatias*), a rauisuchid, and numerous small-bodied (<3 meters) forms such as the *dinosaur* *Chinesaurus* and the non-archosaurian archosauromorph *Vancleaveae*. To identify the trace-maker, we compared the morphology of the bite marks to the tooth orientation and morphologies of these taxa. *Chinesaurus* and *Vancleaveae* were ruled out based on their smaller size and more compact tooth-spacing (<0.5 mm) compared to the spacing of the punctures in PEFO 34869. This leaves the rauisuchid, *pseudalopatias*, phytosaur, or an as yet undiscovered large carnivorous reptile as the possible trace-maker. Despite the high degree of heterodomy in *pseudalopatias*, the observed pattern (spacing, arc curvature, and puncture pattern) of the four punctures is inconsistent with any portion of their dentition. The almond-shape of the punctures and striation density (~3 per mm) of the bite marks are most consistent with the teeth of a rauisuchian-grade animal (such as the *Postosuchus*). Furthermore, the spacing and arc curvature of the punctures on the ventral surface closely matches the premaxillary teeth of *Postosuchus kirkpatricki* (~3.0 cm spacing and 130-degree arc). Aetosaurs were protected by a dorsal and ventral carapace of osteoderms that was covered by skin or keratin in life, creating an obstacle to predators/scavengers trying to gain access to the flesh underneath. PEFO 34869 provides important insight into paleoecological interactions between terrestrial herbivores and carnivores in the Late Triassic of the American Southwest and may shed light on specialized feeding techniques used on heavily armored aetosaur carcasses.

Technical Session XIX (Saturday, October 20, 3:00 pm)

THE EFFECTS OF CRANIODENTAL SAMPLING ON ECOLOGICAL VARIABLES IN MODERN AND FOSSIL MAMMAL LANDSCAPE ASSEMBLAGES

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Accurate paleoecological reconstructions depend on obtaining a representative sample of the animals living on past landscapes. However, due to limited resources, surface collection and recording of mammal fossils in open-air sites is often limited to a subset of taxonomically informative specimens (e.g., teeth, horn cores). It is currently unknown how this selective sampling methodology could bias paleoecological reconstructions. Here we examine the effects of craniodental collection on three ecological variables: body size distribution, species richness, and relative abundance. Seventeen systematic transects in which all surface fossil specimens are documented were conducted in the Ileret Tuff Complex (~1.53—1.51 Ma) of the Okote Member (Koobi Fora Formation, East Turkana, Kenya), resulting in a total mammalian sample of 430 identified specimens (NISP) with a craniodental subset of 130 NISP. Fifty-five systematic transects of modern skeletal remains in the Shompole Conservancy, Kenya, resulted in a total mammalian sample of 7,378 NISP and a craniodental subset of 576 NISP. To address our question of potential bias resulting from craniodental collection, various statistical analyses were conducted comparing the entire faunal sample to the craniodental subsets for both modern and fossil datasets. Results show that sampling only craniodental remains does bias body size distributions but not species richness or relative abundances. Thus, we expect that diversity measures should be minimally affected by craniodental sampling, but caution is required when analyzing body size distributions derived from only mammalian craniodental remains.

Posterior Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ONTOGENETIC CHANGE IN THE CRANIAL ENDOSCA AND ENDOSEOUS Labyrinth of AMERICAN ALLIGATOR (ALLIGATOR MISSISSIPPIENSIS): IMPLICATIONS FOR THE INTERPRETATION OF EXTINCT ARCHOSAURS

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Extant crocodilian skulls undergo dramatic transformation during ontogeny. For example, rapid growth of the face and suspensorium relative to the braincase reorients neurosensorv structures such as the eyes and tympanum. How this growth pattern impacts endocranial anatomy has never been evaluated. Moreover, although anecdotal reports suggest that “young” crocodilians resemble their modern relatives in having the basic midline proportions of the endocranial cavity, the relationship of ontogeny to any measure of how well the endocast serves as a proxy for brain structure has never been documented, which has implications for the study of extinct archosaur brain/endocast evolution. We present the results of an extensive ontogenetic analysis of *Alligator mississippiensis* comprising 15 specimens ranging from embryos to old adults and encompassing an 18-fold difference in skull length. Specimens were CT-scanned, and 3D representations of the inner ear and dural envelope were generated in Amira. Some specimens were soaked in an iodine/potassium-iodide solution to stain the neural tissues, allowing direct comparisons of the brain and endocast. Ontogenetic trends include: (1) the olfactory tracts become increasingly elongate and are less acutely angled from the cerebrum parasagittally; (2) the optic lobes become increasingly less prominent and lose contact with the meninges as the venous sinuses enlarge; (3) the general proportions of the brain change whereby the forebrain dominates in perinates, becoming about equal to the midbrain and hindbrain by a year of age, whereas in adults the midbrain and hindbrain together occupy most of the endocranial space; (4) the common crus of the inner ear elongates, resulting in a 20% increase in the angle of elevation of the rostral and caudal semicircular canals from the horizontal plane, increasing their effective length; and (5) this increase in the arc of the canals tracks an increase in the volume of the cerebellum situated medial to the labyrinth. Ontogenetic changes in endocranial anatomy may reflect ecological shifts from active pursuit of small prey to ambush predation of larger prey. Change in elevation of the olfactory lobes likely reflects the progressive enlargement of the feeding apparatus, whereas changes to the inner ear and cerebellum may reflect increasing reliance on the rapid head movements of ambush predation. More broadly, the ontogenetic trend of the endocast becoming a progressively poorer proxy of the underlying brain may pertain to extinct archosaurs, shedding light on anatomical interpretation of fossil endocasts, but also perhaps even allowing tests of similar ontogenetic shifts in functional and ecological roles, as has been suggested to occur in tyrannosaurs.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

BUILDING A BETTER DATABASE: PROTEIN IDENTIFICATION AND LONGEVITY IN CROCODYLIAN BONE AND TEETH

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Despite increasing evidence that informative biomolecules may persist across geological time, the phylogenetic utility of recovered molecules is hampered by, among other things, the need for an appropriate molecular database for non-mammalian taxa against which to compare recovered sequences. Without such a database, the entire proteome may exist, but be unrecognized by current search algorithms. Therefore, because members of Crocodylia are, along with birds, extant sister taxa to Dinosauria, we present the first representative bone and tooth proteome for extant members of this crown clade. Though few crocodylian proteins have yet been sequenced, we have conducted mass spectrometry on extant samples, and identified bone and tooth proteins using the databases of birds and other vertebrates. These data provide a baseline for sequences recovered from extinct representatives of this clade as we begin the first ever time-point sampling across a single clade to test the hypothesis of a limited temporal preservation. Although bone and tooth DNA from a single organism are identical, the bone proteome as the expression of the “directions” of DNA, is different than the tooth proteome. Here we also compare bone and tooth proteomes because these tissue types are most likely to preserve in the rock record. This comparison will allow us to objectively state which tissues are the best targets for molecular recovery from fossils.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

COMPARATIVE NEUROANATOMY OF FOSSIL AND LIVING WATERBIRDS

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Waterbirds are a diverse avian clade that includes species adapted to many unique ecological niches such as wing-propelled diving, foot-propelled diving, and plunge-diving. Several shifts in neuroanatomy have been proposed to accommodate these ecologies, and thus may offer insight into the prey-capture strategies of extinct species. We examined an array of fossil and living waterbird skulls through computed tomography imaging. Using the program Avizo, we rendered virtual endocasts of the brain and semicircular canals and estimated the volume of neural structures such as the floccular lobe and sagittal eminence. Additional fossil species that had been studied using the same technique were included from the literature. Previous workers have proposed that thickening of the subarachnoid space is characteristic of deep diving birds. Cerebellar folds were not visible in the endocasts of any deep diving bird. Postosuchus kirkpatricki is characterized by a highly asymmetric endocast, which contains a more developed right hemibrain, suggesting that this animal may have had similar aetisaur features. Further study is needed to confirm the presence of a superotemporal fossa in Pachycentrodon. Additional studies are necessary to address the role of the superotemporal fossa in the extant relatives, suggesting that these groups had attained modern ecologies by at least the
Oligocene Epoch. In contrast, stem members of Phaeontidae show marked differences from their extant relatives and may have differed from their modern equivalents in their ecologies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ISOTOPIC INDICATORS OF SEASONALITY AT A LATE MIOCENE PRIMATE LOCALITY IN HUNGARY

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The Vallesian Crisis (9.7 Ma), a Late Miocene mammalian turnover event recorded throughout Europe, marks the extinction of many closed forest adapted faunal forms, including the hominoids. In western and eastern Europe, this turnover event is associated with increasing seasonality and aridity, as well as a shift in the vegetation from closed canopy subtropical evergreen to more open canopy deciduous forest and woodland. Floral and faunal data for Late Miocene central Europe indicate the persistence of humid and relatively aseasonal conditions throughout this period. The rich Late Miocene primate locality of Rudabanya in north-central Hungary provides a unique opportunity to examine the paleoecology of central Europe during this time. The degree of seasonal variation in temperature and/or precipitation was examined in four genera of medium to large bodied herbivores at Rudabanya by serially sampling stable oxygen isotope values found within tooth enamel. Sampled taxa include Hipparthotherium intrus, Tetrapodomodon longirostris, Aceratherium incisivum, and Propotamochoerus palaeochoerus. Serial samples were collected using a dental drill on the external tooth surface, as well as from thin sections using a computerized MicroMill. Oxygen isotope results for all sampled taxa reveal a pattern of seasonal enamel growth. Serial samples demonstrate an intra-tooth range of oxygen isotope of variation between 2.3‰ and 2.9‰, with a mean range of 2.7‰. The gonphothere, T. longirostris showed the greatest range of oxygen isotope variation (3.1‰), while the equid, H. intrus showed the least (2.2‰). These results suggest that the Rudabanya fauna experienced a moderate degree of seasonal variation in temperature and/or precipitation. The examination of intra-tooth isotopic variation provides insight into the paleoecology of Rudabanya during a highly dynamic period in the evolution of terrestrial mammals in Europe.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

THE FOSSIL RECORD OF THE DIAMONDBACK TERRAPIN, MALACLEMYS TERRAPIN (TESTUDINES: EMMYIDAE)

EHRET, Dana J., Monmouth University, West Long Branch, NJ, United States; ATKINSON, Benjamin K., University of Florida, Gainesville, FL, United States

New fossil materials of the diamondback terrapin (Malaclemys terrapin) are described from Late Pleistocene coastal deposits of South Carolina, Georgia, and Florida. The only previous records for the genus included two late Pleistocene carapace fragments recovered from South Carolina, a faunal list inclusion from the Page-Ladson locality in Florida (late Pleistocene), and a Holocene shell and postcranial elements from Bermuda. This paucity of fossil materials made it one of the least well-known fossil genera within the extant emydid turtles. Here we describe new fossil material of the diamondback terrapin from Edisto Beach, South Carolina, the South Brunswick River, Georgia, and specimens from Florida’s Ausilla and Suwannee Rivers and the U.S. Gulf coast. These newly described materials expand the fossil range for the genus Malaclemys into southeastern Georgia and peninsular Florida. Specimens represent carapacial bones from numerous individuals at each locality. Fossils are identified as Malaclemys based on the features of scute sulci and the presence of annuli scars on most specimens. Today, diamondback terrapins occur along the Atlantic and Gulf coasts of the United States from Cape Cod, Massachusetts to south Texas, with a disjunct population of unknown origin existing in the Bahamas. The general lack of fossil material for Malaclemys is likely the result of misidentification or non-identification, inadequate collecting in areas where specimens may be found, and the fragile nature of the material. Furthermore, ecological restriction of Malaclemys to coastal salt marshes, mangroves, and tidal creeks limits the potential for fossilization. Fossil localities for Malaclemys appear to reflect historical shorelines during Pleistocene glacial-interglacial cycles. Based on current geographic and fossil distributions, it appears that Malaclemys terrapin evolved and dispersed along the southeastern Atlantic and Gulf coasts prior to the Late Pleistocene.

Technical Session V (Wednesday, October 17, 3:45 pm)

PHYSIOLOGICAL AND EVOLUTIONARY IMPLICATIONS OF THE COCHLEAR MORPHOLOGY OF MIOCENE MYSTICETE (CETACEA)

EKDALE, Eric G., San Diego State University, San Diego, CA, United States

Mysticetes (baleen whales) are sensitive to low frequency (LF) vibrations, and the morphology of the cochlea that houses the organ of hearing reflects that sensitivity. Sensory thresholds are correlated with development of a secondary lamina for the basilar membrane along the outer wall of the cochlea, the number of turns completed by the spiral, and the tightness of apical coiling. Mammals with lower LF thresholds, such as extant Odontoceti (echolocating toothed whales), tend to have cochlear apices with reduced laminae, a greater number of turns, and more tightly coiled apical whorls when compared to mammals with higher LF thresholds, such as extant Odontoceti (echolocating toothed whales). In an investigation of the evolution of auditory morphology and physiology of baleen whales, the internal and gross anatomy of fossil cochlea of mysticetes allied with two major extant clades, Balaenidae (right whales) and Balaenopteridae (rorquals), were reconstructed utilizing high resolution CT data. Most phylogenetic hypotheses suggest that these two groups diverged early in mysticete evolution, most likely during the late Oligocene to early Miocene. The extinct taxa studied include new information from fossils of the Temblor Formation (middle Miocene), namely Peripolocetus vesilifer (stem balaenid) and Parietobalaena securis (stem balaenopterid), and published data of Herpetocetus sp. (stem balaenopterid; Yorktown Formation, Lower Pliocene). Anatomical features associated with LF sensitivity are present in the Miocene and Pliocene taxa, but variations reflecting phylogeny and functional differences also were observed. For example, extinct Peripolocetus and extant Balaenoptera share a reduced secondary laby that is restricted to the first half of the basal turn of the cochlea, whereas the lamina extends into the final third of the basal turn in the extinct and extant members of the balaenopterid lineage. The reduction of the secondary lamina unites the balaenid lineage, but it also suggests that the clade has evolved a lower LF threshold than the balaenopterids and allied taxa. Additionally, cochlea of the extant whales (Balaena and Balaenoptera) coil more loosely and to a lesser degree (<2.5 turns versus >2.7 turns in the fossils) than the extinct whales, suggesting independent evolution of the low degree of coiling in extant balaenopterids and balaenids, and an increase in LF thresholds through geologic time. Using this information, the most recent common ancestor of crown Mysticeti is hypothesized to have possessed a cochlea with over 2.5 turns, a tightly coiled apical whorl, and low LF thresholds relative to extant taxa. Reconstruction of the cochlea of Oligocene and Eocene outgroups is planned in order to polarize the anatomy and test this hypothesis.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

NEW SCIENCE OUTREACH MODEL FROM STUDENT-RUN PILOT PROGRAM, PARADIGM SHIFT

ELSHAFIE, Sara J., University of Nebraska-Lincoln, Lincoln, NE, United States; THOMPSON, Kari, University of Chicago, Chicago, IL, United States; CALAND PUYMARTIN, Guy K., University of Chicago, Chicago, IL, United States

Among the scientific disciplines, paleontology is particularly well suited for the hands-on, creative learning processes that students respond to best. The Paradigm Shift model, a new student-run science outreach program, "Paradigm Shift," brings current science to classrooms through engaging, relevant activities and personalized, prolonged mentorship. In 2012, the authors successfully launched a pilot program that involved over twenty student participants at the University of Chicago and served over fifty minority students in a local middle school. In the Paradigm Shift program, mentors work consistently with middle school students in weekly one-hour sessions over a nine-week period. A low mentor: student ratio, between 1:2 and 1:4, ensures direct interaction and personal attention, and the prolonged duration of the program allows mentoring relationships to develop. Each mentor designs a 45-minute activity on a science topic of his or her choice. All activities include a hands-on component and emphasize critical thinking, use of the scientific method, and real-world application. Mentors share their expertise and enthusiasm while gaining teaching experience. Mentors also incorporate their own studies into the curriculum, giving middle school students insight into scientific fields and education and career opportunities.

In the second part of the program, students work with their mentors to create learning tools that communicate their topics of investigation to a general audience. Students then use these tools to educate the public at a culminating showcase event. This exercise reinforces creative concepts and gives students presentation and communication skills. Learning tools and activities developed through the Paradigm Shift program are available on an open-source web domain. Paradigm Shift also incorporates tracking mechanisms for immediate and long-term impact assessment.

The emphasis of the Paradigm Shift program on collaboration, hands-on activity, and scientific and creative thinking makes it a viable model for education in paleontology and other natural sciences. Topics covered in the 2012 pilot program included Comparative Anatomy, Earth History, Plate Tectonics, and Natural Selection, in lessons designed using current research and resources rather than textbooks and conventional material. Paradigm Shift also offers an opportunity for students at multiple levels to connect and learn from each other. The program’s emphasis on personalized and perpetual learning, as well as its versatile applicability, makes this model a valuable tool for any institution.

Technical Session XV (Saturday, October 20, 9:30 am)

COMPLEX DENTAL STRUCTURE AND WEAR BIOMECHANICS IN HADROSAURID DINOSAURS

ERICKSON, Gregory M., Florida State University, Tallahassee, FL, United States; KRICK, Brandon, University of Florida, Gainesville, FL, United States; NORELL, Mark A., American Museum of Natural History, New York, NY, United States; SAWYER, W. G., University of Florida, Gainesville, FL, United States
The grinding teeth of mammals (e.g. horses) are biomechanical marvels. Their complex four-tissue composition strategically wears, creating course surfaces to comminute tough and abrasive plants (e.g. grasses), liberating nutrients inaccessible to other herbivores. Grinding dentitions evolved repeatedly and almost exclusively in mammals. A rare occurrence outside this group is in the fossil record of the Triassic archosaur Bauria, a theropod archosaur recovered from the wearing of teeth from Late Triassic deposits. The mantle consists of 2) the functional significance of each tissue, and 3) how dietary changes were achieved in different taxa through histological modifications. Our results show that hadrosaurids evolved not only the most histologically and biomechanically sophisticated dentitions known among reptiles. They rivaled, and in some ways exceeded those of advanced herbivorous mammals in complexity.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ELONGATE BONE ORIENTATION IN RIVERS: BONE AZIMUTHS AND POLARITIES DO NOT CORRELATE WITH FLOW DIRECTION
EVANS, Thomas, Montana State University, Bozeman, MT, United States
Fluvial transport or reorientation in the taphonomic history of fossil skeletal material is typically inferred by measuring the long axis orientations of elongate bones, plotting the orientations on a rose diagram, and inferring a paleocurrent direction (or lack thereof) based on any preferred orientations observed. This method assumes there is a concrete and identifiable correlation between bone orientations and current direction. To test this assumption, ~1800 modern bones were seamed in two rivers (Big Beef Creek, WA; and East Fork Sevier River, UT), 3800 bone casts were seamed in three rivers (Big Beef Creek, WA; East Fork Sevier River, UT; and Levelock Creek, AK), and 13 rivers were searched for bones naturally occurring in them. The bones seamed were from many mammalian taxa and from all portions of the body, so many bones were not elongate (e.g. teeth, vertebrae, etc.). The bone casts were created from adult male domestic sheep (Ovis aries) bones, and include 22 bones from a single skeleton, only six of which had distinct long axes (femora, tibiae, humeri, radio-ulnae, metacarpals, and metatarsals). Trials are ongoing, however, 212 seamed bones and 871 bone casts have been recovered, and 474 naturally occurring bones and bone fragments have been located. Data was used only from those bones and bone casts that were found submerged in water, with a 1:1.5 aspect ratio or greater, and where a clear flow direction was measurable (excluding bones in eddies, pools, etc.). The long axis orientations and polarities of elongate bones were measured relative to current directions, and plotted to observe any correlations. From the total data set, only data from three rivers, 112 bones, and 85 bone casts met the required criteria. When plotted, no correlation existed between bone long axis orientation and current direction, and no consistent polarity was exhibited by limb bones (though sample sizes for each limb element were small). The lack of consistent orientations relative to flow direction was also observed in bone cast orientations, though a weak preferred polarity was observed, probably caused by dense proximal ends formed during cast creation. Lack of correlation between flow direction and elongate bone orientation suggests this method of identifying fluvially transported and deposited remains is invalid, the method should be discontinued, and a new method developed.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

WAS STROMER RIGHT? THE AFFINITIES OF SIGILMASSAURUS BREVICOLLIS (THEROPODA, TETANURAEC)
EVERS, Serjoascha W., Ludwig-Maximilians-University, Munich, Germany; RAUHUT, Oliver W., Bayerische Staatsammlung für Paläontologie und Geologie, Munich, Germany; MILNER, Angela C., Natural History Museum, London, United Kingdom

Sigilmassaurus brevicollis is an enigmatic theropod dinosaur from the “middle” Cretaceous of northern Africa. Originally described as “Spinosaurus B” by Ernst Stromer on the basis of isolated vertebrae from Egypt, the formal name was erected for very similar axial material from Morocco. However, the validity of Sigilmassaurus is currently under debate. The fossil record of this taxon is problematic, because published material is limited to isolated vertebral remains. Several authors have suggested that Sigilmassaurus is a junior synonym of Carcharodontosaurus, but this is not generally accepted. In this study previously unpublished material housed in the Bayerische Staatsammlung für Paläontologie und Geologie in Munich and the Natural History Museum in London is examined. The material includes at least one anterior dorsal and several well preserved cervical vertebrae, including two vertebrae of strongly elongate anterior to mid-cervicals. The latter can be referred to Sigilmassaurus on the basis of several characters, including a centrum that is considerably wider than high, the presence of a pronounced rim around the anterior articular facet, and an anterior median tuberosity on the anterior articular surface. Cervical vertebrae of Sigilmassaurus show numerous differences to known carcharodontosaurid cervicals, including a cervical of the genotype of Carcharodontosaurus, in having more elongate anterior cervicals, a considerably lower height/width ratio, reduced neural arch lamination and a spike-like neural spine. Furthermore, CT-scans reveal camerate pneumatic chambers, in contrast to the cancellate structure of carcharodontosaurid vertebrae. The vertebrae share several characters with megalosaurids, and, specifically spinosaurid elements, such as elongate anterior and middle cervicals, very broad centra, a pronounced rim around the anterior articular facet, a prominent keel in posterior cervicals and anterior dorsals, a parapophysis that is set low on the centrum in anterior dorsals, and strongly elongate transverse processes in the posterior cervicals and anterior dorsals. Thus, Sigilmassaurus might represent a further taxon of spinosaurid, as originally suggested, indicating that spinosaurid diversity in the Cretaceous of northern Africa was currently higher than is generally recognized.

Technical Session XI (Friday, October 19, 2:30 pm)

PHYLOGENETIC ANALYSIS OF LATE TRIASSIC – EARLY JURASSIC NEOTHEROPOD DINOSAURS: IMPLICATIONS FOR THE EARLY THEROPOD RADIATION
ECZURRA, Martín D., GeoBio-Center, Ludwig-Maximilians Universität München, Munich, Germany
New discoveries and studies have improved our knowledge of early neotheropod dinosaurs in the last decade. However, an updated and comprehensive phylogenetic analysis of Late Triassic and Early Jurassic theropods is currently lacking. In order to assess the phylogenetic relationships of these taxa, a data matrix composed of 39 terminals and 633 informative characters was compiled. In the most parsimonious trees recovered by the analysis, Endothorax was found as the sister-group of Neotheropoda and Litotarsia, Procompsognathi, Lophostropheus, Gaviriosaurus and a specimen previously identified as a juvenile of Dracovenator were recovered within a polytomy at the base of Coelophysioidea. The latter taxa were the sister-taxon of a clade composed of a “Syntarsus” kaienartae + Kentavrenator clade and a group including Segisaurus, Coelophysis bauri, Coelophysid rhedinosis, Camarasaurus and an unnamed Mexican coelophysoid. The position of Kentavrenator elysiae indicates that it should be considered a junior synonym of “Syntarsus” kaienartae. The putative juvenile specimen of Dracovenator might actually represent a distinct form of basal coelophysoid. After a posteriori pruning of wildcard taxa, Litotarsia was placed as the most basal coelophysoid, Lophostropheus as the most basal member of Coelophysioidea, and Coelophysis bauri as the sister-taxon of a clade composed of Camarasaurus, Segisaurus and Coelophysid rhedinosis. Outside Coelophysioidea, Zapaysaurus was found as the sister-taxon of a group including Dilophosaurus and Averostra. Dilophosaurusidae was composed of Dracovenator, Cryolophosaurus and Dilophosaurus wetherilli, in agreement with some previous analyses. Within Averostra, Nansanosaurus woodi was recovered as a basal ceratosaur, probably representing the oldest member of the clade. Optimization of femoral length under a maximum parsimony criterion revealed a reduction of body size in Coelophysioidea and an overall increase in the lineal increase leading to Averostra. However, a conspicuous increase in body size is not documented during the Early Jurassic, contra to some prominent hypotheses of ‘ecological release’ for theropods following the Triassic–Jurassic extinction event. The results also indicate that basal coelophysoids (i.e. those outside the “Syntarsus” + Coelophysid clade) are currently the most abundantly sampled late Norian–Rhaetian theropods. However, following the Triassic–Jurassic extinction event, theropod assemblages are composed of derived coelophysoids, dilophosauroids and basal averostrians. Accordingly, this mass extinction appears to have had a deep impact on the early evolutionary history of Theropoda, resulting in a shift of the taxonomic content of the group across the Triassic–Jurassic boundary.

Technical Session V (Wednesday, October 17, 2:30 pm)

PREDATION OF BASILOSAURIS IIS (ADULT BODY LENGTH ca. 16 m) AND DORUDON ATROX (ADULT BODY LENGTH ca. 5 m) ARE FULLY AQUATIC ARCHACEOTO CETACEANS THAT ARE ABUNDANT AND WELL-DOCUMENTED IN THE LATE MIOCENE AND EARLY PLIOCENE OF NORTH AMERICA AND THE LATE PLEISTOCENE OF THE EASTERN PACIFIC.

Basilosaurus (adult body length ca. 16 m) and Dorudon (adult body length ca. 5 m) are fully aquatic archaeocete cetaceans that are abundant and well-documented in the middle-to-late Eocene Gehennam and Birket Qarun Formations of Egypt. It has been argued that these two adult individuals of Basilosaurus and Dorudon are prey of Triassic–Jurassic carnivores in Egypt. The results also indicate that basin coelophysoids (i.e. those outside the “Syntarsus” + Coelophysid clade) are currently the most abundantly sampled late Norian–Rhaetian theropods. However, following the Triassic–Jurassic extinction event, theropod assemblages are composed of derived coelophysoids, dilophosauroids and basal averostrians. Accordingly, this mass extinction appears to have had a deep impact on the early evolutionary history of Theropoda, resulting in a shift of the taxonomic content of the group across the Triassic–Jurassic boundary.

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**Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)**

**RECONSTRUCTING LIMB KINETICS OF SMALL BIPEDAL DINOSAURS TRAVERSING SEMI-FLUID SUBSTRATES**

FALKINGHAM, Peter L., Royal Veterinary College, London, United Kingdom; GATESY, Stephen M., Brown University, Providence, RI, United States

The fossil tracks described by Edward Hitchcock and housed at the Beneski Museum of Natural History, Amherst College, include a wide variety of track morphologies. Among them are a number of tracks from the Wethersfield Cove locality, which show considerable variation over successive exposed surfaces. Commonly referred to as undertracks, these successive prints have recently been interpreted as subsequent exposures of penetrative tracks, where the trackmaker’s foot has directly interacted with, and passed through, each layer throughout the course of the step cycle. Track morphology on uppermost surfaces displays extremely narrow slit-like digit impressions, highly elongated, often with a long posterior impression behind the apex of the digits. At the lowest levels, track morphology is reduced to 3 or less drag marks, formed during a sweeping motion of the foot in which only the digit tips deform the substrate. Intermediate exposed surfaces show transitional morphologies: digit tips appear to translate with increasing depth, becoming more parallel (thus altering interdigital angle). Common to most, if not all, surfaces within a volume is an exit trace, formed as the foot is withdrawn, digits together. This exit trace often occurs in a spatially consistent location throughout the track volume, indicating a vertical foot withdrawal rather than a forwards removal of the foot as in other dinosaurian tracks (e.g., those from Greenland). We interpret these features as resulting from a backwards sweeping motion of the foot and lower leg. The substantial deformation and considerable depth that some track volumes display, implies that the substrate was so soft as to behave in a semi-fluid manner. In order to understand the limb kinematics, including where, when, and how the substrate provided resistance and supported the foot during the step cycle, we used computer simulation and visualization. Digitised fossil footprints were used to three dimensionally reconstruct the path of the foot. This foot motion was then used to generate virtual tracks that show similar track morphologies to those seen amongst the Amherst collection.

**Technical Session XVI (Saturday, October 20, 8:00 am)**

**THE RELATIONSHIP BETWEEN LOPHODONTY, HYSPODONTY, BODY MASS AND DIET IN EXTINCT AND EXTANT UNGULATES**

FAMOSO, Nicholas A., University of Oregon Department of Geoscience and Museum of Natural and Cultural History, Eugene, OR, United States; FERANEC, Robert S., Research and Collections Division, New York State Museum, Albany, NY, United States; DAVIS, Edward B., University of Oregon Department of Geoscience and Museum of Natural and Cultural History, Eugene, OR, United States

The interaction between tooth morphology and wear has an important effect on how well herbivorous mammals, specifically ungulates, combat the effects of elevated tooth wear. The effects of elevated tooth wear can be either abraded, due to diet, or attritional, due to body size. The ornithopod genus Parasaurolophus is known to have exceptionally long, tubelike crests that contain a portion of the nasal passages, is well represented by adult crania from Campanian-aged deposits in Alberta, New Mexico, and Utah. In contrast with other lambeosaurines, however, the cranial ontogeny of Parasaurolophus is poorly known. Thus, a juvenile skull and articulated skeleton from the Kaiparowits Formation of southern Utah, referred to Parasaurolophus, provide important new data. The specimen, RAM 14000 (Raymond M. Alf Museum of Paleontology) has a humerus and femur measuring 180 mm and 315 mm long, respectively. Because the tail is incomplete, scaling from other juvenile hadrosaurs estimates total body length between 1.9 and 2.5 m, roughly 25% of maximum adult body size. The skull measures 240 mm long from the snout to the posterior margin of the quadrates, and the dentary is 138 mm long. The parallel, fluted impressions of the soft tissue associated with the upper beak shows that the tip of the beak extended up to 30 mm beyond the end of the premaxilla. This not only reduced bite force at the tip of the beak relative to the condition without a beak extension, but also would have increased the overall area cropped in each bite. In addition, the presence of the bill contributed to faster cropping of food. The crest is approximately 50 mm tall above the apex of the orbit and is semicircular rather than tubular in lateral profile. The crest-snut angle is approximately 55°, with a prominent premaxilla-nasal fontanelle. Although the morphology is similar to that in juvenile Corythosaurus, Lambeosaurus, and Hypacrosaurus, the crest in RAM 14000 is comparatively more strongly developed than in somewhat larger juveniles of the other taxa. This suggests that Parasaurolophus initiated growth of the crest at an earlier ontogenetic stage, as expected from the extreme adult morphology of the crest in this taxon. Unlike other juvenile lambeosaurines, the narial passages occupy nearly the entire volume of the crest in RAM 1400; additional morphological differences occur in the position and size of features such as the S-loop and common medial chamber. The comparatively early development of cranial ornamentation in hadrosaurs (and other dinosaurs) parallels the condition seen in extant mammalian (e.g., bovids), but differs from the late onset seen in extant birds (e.g., hornbills, casuaries). The integration of the ornamentation into the respiratory system perhaps necessitated the early development of the crest in juvenile hadrosaurs.

**Poster Session III (Friday, October 19, 4:15 - 6:15 pm)**

**A NEW REBBACHISAUROID SAUROPOD FROM TUNISIA**

FANTI, Federico, Museo Geologico Giovanni Capellini, Bologna, Italy; CONTESSI, Michela, Dipartimento di Scienze della Terra e Geologico- Ambientali, Bologna, Italy; ANDREA, Cau, Museo Geologico Giovanni Capellini, Bologna, Italy

New material of a rebbachisaurid sauropod from the Tataouine region of southern Tunisia, represents the first record of an articulated dinosaur from the Apatian-Albian deposits of northern Africa. The partial skeleton was recovered in the fluvial and marginal-marine beds of the Oum el Diab Formation, the youngest siliciclastic unit of the “Continental Intercalare,” that crops out extensively along the Jefara escarpment in southern Tunisia. The preserved skeleton includes an articulated sacrum, the anteriormost five caudal vertebrae and an incomplete pelvis. The sacral neural arches and spines form a continuous lamina productive of the fusion of the intercentrum and spinallamina. The neural and caudal neural spines are extensively laminated and pectal-shaped. The first five caudal vertebrae were recovered articulated with each other and the sacrum. The first caudal centrum bears a preurocoel. The neural arches are pneumatic. The caudal vertebrae bear hypsodont ridges, a spinopodialpsepalus lamina running along the lateral surface of the neural spine and distinct from the prespinal laminae (the latter confined to the anterior surface of the spine) and joined ventrally by an accessory vertical lamina. The ilium is acuminate anteroventrally and has a slender pubic peduncle directed ventrally. The iliac peduncle of the ischium shows a constricted neck, a dorsosartoral leaf and a large medial fossa. Phylogenetic analysis places this new taxon as the basalmost nigersaurine. In addition, a diverse vertebrae fauna has been recovered from the main quarry, including isolated elements of non-avian theropods, crocodilians (represented by three different taxa), actinopterygians, carpopterygians, and shark teeth. Detailed stratigraphic and sedimentological analyses performed at the main site indicate that at the time of deposition, sediments accumulated in a large estuarine system under arid climatic conditions. Similarly, the faunal assemblage (including microvertebrate remains) supports the co-existence of non-marine, brackish and marine taxa. Rebbachisaurid sauropods are primarily known from the mid-Cretaceous of Africa, South America and Europe. Albeit partially biased by poor sampling and the uncertain position of some fragmentary taxa, the paleogeography of the two recognised rebbachisaurid subclades may indicate some regionalism in their distribution: limaysaurine remains occur mainly in South America, while Nigersaurinae appears to be centered along the margins of western Tethys. In the peri-Mediterranean area rebbachisaurids play a fundamental role for paleobiogeographic hypotheses, whereas sites from South America provide information on ecological partitioning of these sauropods relative to contemporary titanosaurs.

**Poster Session III (Friday, October 19, 4:15 - 6:15 pm)**

**COMPARATIVE PECTORAL AND FORELIMB MORPHOLOGY OF ORNITHOPODA: DOES ORYCTODROMEUS CUBICULARIS EXHIBIT SPECIALIZATION FOR DIGGING?**

FEARON, Jamie L., Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States

This study examined the forelimb morphology of the mid-Cretaceous basal ornithopod Oryctodromeus cubicularis using traditional and geometric morphometric statistical analyses to assess the presence of burrowing adaptations relative to other ornithopods. The holotype
MIDDLE MIOCENE BARSTOW FORMATION, SAN BERNARDINO COUNTY, EARLY EVIDENCE FOR THE ABUNDANCE OF C4 GRASSES FROM THE
花园草和禾本科植物通过传统和几何形态测量来描述科的演化关系。一个成分分析（PCA）测量了标本的臀骨和股骨，描述了科的种类在多个研究区域的多样性变化。多样性相关性分析提供了对跨科多样性研究的另一种形式。

 אח הגדול של כל הפוטוגנטיות של הדינוזאורים המשפחתיים Enemy Pelvis Architecture, in Which the Pubis is Directed Posteriorly.Most Ornithischian dinosaurs are characterized by an opisthopubic pelvic architecture, in which the pubis is directed posteroventrally. The retroversion of the pubis is induced by changes in the biological roles of the associated structures. According to the extant phylogenetic bracket, the biological role of the pubis is to maintain locomotion, ventilation, and trunk stabilisation. Locomotion and ventilation are especially important aspects of the biology of an organism. Accordingly, our understanding of the biology of ornithischian dinosaurs strongly depends on precision in the reconstruction of these muscles. For several reasons the reconstruction of the muscles attached to the pubis of ornithischian dinosaurs is not trivial. Besides the well-known limitations of the extant phylogenetic bracket, the biological roles of the pubis are attached to the pubis of other ornithischian dinosaurs. For example, in Oryctodromeus studies of ornithopod musculature identify the posterior scapular blade as the attachment site for the deltoideus muscle, a muscle used in digging in mammals, supporting the hypothesis that Oryctodromeus exhibited some specialization for digging. Posterior Session I (Wednesday, October 17, 4:15 - 6:15 pm)

 EARLY EVIDENCE FOR THE ABUNDANCE OF C4 GRASSES FROM THE MIDDLE MIocene Barstow formation, San bernardino county, california

FeraneC, Robert S., New York state museum, Albany, ny, United States; Pagnac, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States

The rapid increase in the geographical distribution of C4 grasses in North America had a dramatic effect on paloenvironments and fauna during the late Miocene. The record of C4 grasses prior to this spread is limited, but the earliest fossil evidence in North America is derived from the middle Miocene dove spring formation (late barstovian-clariondlian) in central California. A permineralized fossil exhibiting typical C4 Krantz anatomy suggests the presence of these grasses in California by the middle Miocene. The age of the dove Spring formation at 12.15-15 Ma based on magnetostratigraphic correlation. New evidence in the form of carbon isotope values from ungulate tooth enamel suggests the abundance of C4 grasses during deposition of the middle Miocene Barstow formation. The Barstow formation is exposed in various sections throughout the western Mojave Desert. It records a diverse and abundant paleofauna of late hemingfordian to barstovian age. Radiometric dates have constrained the geochronologic age of the formation from 19.3-13.4 Ma. Tooth enamel δ13C values were measured from eight ungulate species including the hypsilophodontid, Actinohyrax stylodontus, Scaphokarpus sumani, and Scaphokarpus intermontanus, the camelids, Aepyacmea, Hesperacmea, and Proacmea, the antilocaprid, Merycodus, and the proboscidean, Gomphotherium sp. More positive δ13C values observed within the equids, camelids, and antilocaprids are suggestive of C4 grasses being included in the diet. The equid, S. intermontanus, exhibited the most positive δ13C values, indicating a higher component of C4 grasses in its diet (upto 20%) when compared to the other sampled ungulate taxa. The tooth enamel isotope values presented in this study show the presence of C4 grasses as a significant component of ungulate diets at least four million years earlier than the documented paleobotanical remains.

Technical Session VII (Thursday, October 18, 2:15 pm)

 USING PHYLOGENY AS A FRAMEWORK FOR DIVERSITY STUDIES

Ferrer, Elizabeth, U.C. Berkeley, Berkeley, CA, United States

Taxic counts are common in assessing diversity at multiple scales (temporal, taxonomic, and range). This provides a view of macroevolutionary dynamics, and is often put into a phylogenetic context, but having a phylgeny as the framework of the analysis can provide very different insight. It is common in community ecology to use metrics like “phylogenetic diversity” which account for the fact that the loss of the same number of taxa in different locations might produce very different evolutionary consequences. It is defined as the minimum length of all the phylogenetic branches needed to span a set of taxa on a phylogenetic tree (taxa defined as those present in communities being compared). Methods like this can be beneficial to palontology because it accounts for the level of relatedness in taxa present but paleobiodiversity studies differ from current biodiversity research in that the data are diachronous. I have taken the metric and modified it to focus on time bins instead of locations, now calling it phylogenetically weighted diversity (PWD). An example of this was previously shown on a species level canid tree, but since then the method has been extended through time and used to examine trait data. An African varamid molecular phylogeny was chosen as another case study and they show a generally conservative morphology throughout their history but have become more diverse in some locations and not others. The analysis was conducted in the statistical program R where a time calibrated tree is the framework, and at designated time bins from the base to tips the phylogeny is “chainsawed” where any taxa existed before and after the bin are removed and a new tree representing that time bin generated. The branch lengths for the new tree are relative to how long the taxa included have been in existence to that point. PWD is measured for the new tree, and this is repeated until the end of the phylogeny is reached. If there are many deep lineages, then PWD will continue to increase or stay constant, but show the opposite if later time bins are made up of mostly short lived taxa. Simply comparing this to taxon counts through time can provide a different picture of diversity dynamics, but focusing on how specific groups within the tree compare can also show which taxa might be the most influential on the patterns of PWD seen. Branch lengths can also be equated to disparity or Markov models of per-characters per-unit time can be tested alongside PWD, so instead of time one might be able to view how morphological disparity relates to phylogenetic diversity. These phylogenetic metrics provide another form of insight into diversity patterns in the fossil record, and can complement other diversity measures.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

EXTINCT AND EXTANT QUATERNARY MAMMALS FROM SAN LUIS POTOSI, EAST-CENTRAL MEXICO: FAUNAL TURNOVER AND CLIMATE CHANGE

Ferrusquía-VillafañA, Ismael, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; De AndA-HurtAdo, Patricia, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico; Ruiz-González, José, Instituto de Geología, Universidad Nacional Autónoma de México, México, Mexico. Pleistocene and Holocene mammal faunas across Mexico are distinctly different from each other in taxonomic structure and ecology. To address questions about the nature of these differences, we have analyzed Quaternary records from the central Mexican state of San Luis Potosí, as part of a long-term study on Pleistocene mammals, with comparisons on different aspects of the fauna, extending them beyond the state in order to assess the extent of the change and determine possible causes.

The single known Irvingtonian locality in San Luis Potosí is small, so the focus of this study is the late Pleistocene (Rancholabrean) and Holocene. The state has 12 Rancholabrean localities, which have collectively produced 11 orders, 33 families, 55 genera, and 75 species of mammals. In terms of size, megaherbivore species make up about 35% of the fauna, whereas
the neck. Neurocentral and cervical rib sutures are fused, an indication that the individual was relatively mature at the time of death. The smallest, but incomplete, vertebra is more than 60 cm long, and over 50 cm tall from the edge of the parapophysis to the dorsal tip of the neural spine. More posterior vertebrae are much larger, some measuring more than 70 cm long, a meter high, and nearly a meter wide across the diapophyses and cervical ribs. The lateral surfaces of each centrum are excavated by anteroposteriorly elongate pneumatic fossae. The tall, triangular neural spines differ from the dorsoventrally low spines described in an immature individual from the area. The base of each neural spine is excavated by a deep spinopodiumal fossa, and the postzygapophyses reach to or extend posterior to the end of the centrum as in some other titanosaurians. In the most posterior vertebrae, the prezygapophyseal centrodiaaphyseal fossa is divided into distinct dorsal and ventral sub-fossae by a definite accessory lamina, a potentially diagnostic feature. Given the importance of vertebral morphology in sauropod systematics, this articulated cervical series is a unique and important resource. These specimens and the full skeletal reconstruction of *Alamosaurus* erected at the PMNS provide new insights into the paleobiology and relationships of this taxon.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 9:45 am)

WESTERN APPALACHIAN DINOSAURIA AND ASSOCIATED VERTEBRATES OF THE LATE CRETACEOUS OF SOUTHEAST MISSOURI

FIX, Michael F., University of Missouri, Saint Louis, MO, United States; DARROUGH, Guy E., Bollinger County Museum of Natural History, Marble Hill, MO, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; GRANDSTAFF, Barbara S., School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, United States

The Late Cretaceous (Campanian) Chronister Site of southeastern Missouri is the only known locality in the state that contains Mesozoic terrestrial vertebrate remains. Current excavation by the Missouri Ozark Dinosaur Project is being conducted under an enclosure to keep out water, and utilizes a 60 m² hinging grid to facilitate detailed mapping and taphonomic record keeping.

Fossils occur within clay that shows considerable soft sediment deformation due to the close proximity of a normal fault, on whose downthrown block it has been preserved. The environment of deposition as indicated by faunal and stratigraphic evidence was a predominately low energy body of fresh water, with occasional influxes of higher turbulence as indicated by a prominent gravel zone. This deposit may represent a backwater, wetland, or oxbow lake.

The fauna includes three types of dinosaur that have been positively identified: *Hypsidema missourense*, a hadrosaur of uncertain affinities; an undetermined genus of tyranosaurid; and an undetermined genus of dromaeosaurid. Recently, skull material from *H. missourense* has been recovered. This material includes dentitions that suggest affinities to *Gryposaurus*. The associated fauna of hybodontids, batoids, lepisosteids, amiids, hadrodonids, aquatic turtles, and crocodylians found with the dinosaurs indicates that a substantial body of water was located not far from the eastern shoreline of the epicontinental sea. The selachian fauna suggests this body of water had some connection to the seaway in the adjacent southeastern lowlands. Virtually all major taxonomic groups thus far identified at the Chronister Site are also known from the Ellisdale Site, Campanian of New Jersey.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PALEOClimate of the Dinosaur-Bearing, Mid-Cretaceous Winton Formation, Central-Western Queensland, Australia: New Observations Based on Leaf Margin Analysis, Climate Leaf Analysis Multivariate Program, Bioclimatic Analysis and Fossil Wood Growth Indices

FLETCHER, Tamara L., University of Queensland, Brisbane, Australia

Over the last decade the mid-Cretaceous (late Albion–Cenomanian) Winton Formation of western Queensland, Australia, has proven to be a rich source of terrestrial vertebrates, boasting a fauna that includes dinosaurs, crocodilians, squamates, turtles and fishes. To study and understand this fauna I have investigated the climate and atmospheric indicators associated with vertebrate-bearing horizons at sites near Winton and Isisford. The former sites are dominated by saururopods, while crocodilians and fast-swimming teleost fishes are the most abundant remains at the latter sites. Significantly, many of these sites include well-preserved plant macrofossils. Using Leaf Margin Analysis, Climate Leaf Analysis Multivariate Program, Bioclimatic Analysis and fossil wood growth indices, the data collected with the Winton Wood dataset are seen to be of high quality. When the climate results are compared with current Cretaceous global climate estimates for the same paleolatitude (~54 degrees south), the signal is much more consistent with a late Cenomanian–Turonian age, rather than the current estimate of late Albion–Cenomanian (which is based mainly on palynology). The Issiford localities are significantly different in terms floral preservation; leaves are extremely rare, and wood associated with bone is typically preserved only as casts. This contrasts with the beds of finely preserved leaf impressions and wood that preserves microscopic internal characteristics at the Winton sites. These observations suggest that vertebrate-bearing sites in each of the two areas, previously considered to be near coeval, may be temporally separated. Refining the climatic signal and floral environments associated with these localities is improving our understanding of the
nature of the Winton Formation vertebrae fauna, the relationship between sites and details of related depositional settings.

Technical Session XVI (Saturday, October 20, 11:45 am)
SYNERGISM IN DENSER FOSSIL RECORDS: ECOLOGICAL COMPLEXITY EMERGES FOR MIDDLE MIocene SIWalIk RHIZOMYINE RODENTS
FLYNN, Lawrence J., Peabody Museum, Harvard University, Cambridge, MA, United States
The beauty of a dense fossil record, one with many superposed fossil samples, is that successive samples may be compared, and differences evaluated for passage of time or change in paleoecology. Increase in sampling density results in larger aggregate collections, records of more taxa, and finer scale metrical comparisons. For the Miocene Siwaliks of the Indian subcontinent, a multinational team has built a composite sequence on the Potwar Plateau, Pakistan. The sequence is well dated and spans 12 million years (18 to 6 Ma) and thousands of meters of sediment. Particularly densely sampled is the Middle Miocene Chinji Formation, with 29 small mammal levels distributed over a 3 million year interval (14.3 to 11.3 Ma). Although not evenly distributed, data are available for most 100,000 year subintervals. Previously, with very few of these sites studied, a simplistic view of faunal succession was developed under a model in which one or two small rhizomyines characterized Chinji faunas. Covers sets of samples widely spaced in time, small mammals appeared formerly to show evolutionary stasis. The paradigm of a Chinji mammal community with characteristic rodents including a single (or two) small rhizomyines underestimate true diversity and fails to distinguish subtle biotic trends. The greatly expanded fossil record presently available shows more small rhizomyines contributing to the Chinji community, with up to four species present at a single locality. These rhizomyines were early root rats adapted to burrowing and above-ground foraging; a new paradigm to make room for multiple lineages in close proximity. In addition to the greatly expanded data set indicates change in size in some lineages, which can be evaluated with global trends of isotopic change, such as that associated with the end of the mid-Miocene climatic optimum. One may begin to pose paleoecological questions about body size correlated to paleohabitat. The present denser fossil record allows exploration of more complex paleobiological questions than could be approached constructively with limited data.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)
THE OLDEST SCOleCOPHIDIAN SNAKE
FOLIE, Annelise, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITh, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium
Scolecophidians are primitive, tiny snakes represented by two extant families (Typhlopidae and Leptotyphlopidae) that live mainly in tropical areas. The only European representative of this group is Typhlops vermicularis that lives around the Mediterranean Basin. Here we describe two isolated prococeous trunk vertebrae from the early Paleocene locality of Hainin (MP1-5, Belgium). These vertebrae are clearly referable to a scolecophidian because of the following characters: they are 1.5 mm long and 1 mm high and wide; the centrum is narrow and does not bear a central carina; the orientation of the prezygapophyseal facets differs from the orientation of the prezygapophyseal processes; the neural arch is low and does not present a medial notch on its posterior border nor a neural spine. Fossil scolecophidians can be identified based on their vertebrae but they are not generally considered to be diagnostic to a familial, generic or specific level. However, some characters have recently been proposed to differentiate families according to the shape and placement of the synapophyses, shape of the cotyle, size of the zygosphene, and shape of the prezygapophyseal facets. We thus also discuss these characters in the Belgian Paleocene taxon.

Fossil scolecophidians are known from North America, Europe, Africa and Australia. The oldest representative of this group is known from the late Paleocene of Adrar Mgorn (Ouarzazate Basin, Morocco). In Europe, the oldest scolecophidian was identified from the earliest Eocene of the Dormaal locality (MP7, Belgium). The scolecophidian from the early Paleocene of Hainin thus represents the oldest occurrence of this group.

Technical Session V (Wednesday, October 17, 3:15 pm)
LONG-TUSKED ARCHAIC Oligocene Oodontocetes From oregon and Baja California sur, Eastern pacific Margin
FORDyCee, Robert E., Dept Geology, University of Otago, Dunedin, New Zealand; FITZGERALD, Erich M., Museum Victoria, Melbourne, Australia; GONzALEz BARBA, Gerardo, Universidad Autonoma de Baja California Sur, La Paz, Mexico
Two new species of archaic dolphin from the eastern Pacific represent a new genus of putative basal odontocetes. One is USNM (US National Museum) 205491, of late early Oligocene age (~30 Ma; Alesia Formation, Yaquina River, Oregon), comprising skull, mandibles, teeth, tympanoperiotics and fragmentary postcrania. USNM 205491 has been mentioned in print as a “non-squalodontid”, or an Eocene Eurhiodophilidae, or an Agorophiidae. The second species is known from a partial skull with one cheektooth and a bulla (Universidad Autonoma de Baja California Sur-UABCS collection) of middle late Oligocene age (~25 Ma; El Cien Formation, La Paz, Baja California Sur). In both, the skull has a prominent nasal “snout” separating bilateral facial fossae for nasofacial muscles implicated in high-frequency sound production. Archaic features include parietalis exposed at a prominent intertemporal constriction, anteriorly-placed narial fossa, and premaxilla without a postero lateral fold but with a narrow elongate premaxillary sac fossa. USNM 205491 has long, tusk-like, procumbent anterior teeth, and cheekteeth with wide diastemata, delicate high triangular crowns, and barely-discardable denticles. The rostrum is long and dorsally compressed, with an open mesorostral groove and gracile mandibles in which the large pungue is ventrally inflected. The incomplete feeding apparatus in the UABCS skull is of similar structure. These dolphins lack the highly disparate derived features of near-contemporaneous Xenorophidae and Simocetus, and are not closely related to other Oligocene families such as Waipatidae, Squalodelphinidae, and Squalodontidae. The rostral/tooth structure in the Oregon and Baja dolphins closely matches those of putative “dalpiazinid” dolphins from the New Zealand Oligocene. The latter, however, are more derived in many cranial features, raising the possibility of homeplasy in the feeding apparatus. New Zealand assemblages have not yet produced Late Oligocene dolphins of archaic grade comparable to those that dominate assemblages from the northeast Pacific.

Technical Session XV (Saturday, October 20, 10:15 am)
A NEW TAXON OF IguanodOnToid Dinosaur FROm ThE kIRkWOOD FORMATION (VAlANGiniAN) OF SOUTh AFRICA BASED ON AN ASSEMBLAGE OF JUVENILE SPECIMENS
FORSTER, Catherine A., The George Washington University, Washington, DC, United States; POOLE, Karen E., The George Washington University, Washington, DC, United States; DE KLERK, William J., Rhodes University and Albany Museum, Grahamstown, South Africa; CHINsAMy-TRUN, Amusuya, University of Cape Town, Cape Town, South Africa; ROBERTS, Eric M., James Cook University, Townsville, Australia
A new taxon of iguanodontid dinosaur from the Early Cretaceous (Valanginian) Kirkwood Formation, Eastern Cape Province, South Africa, is represented by the disarticulated remains of numerous immatures. Nineteen individuals from a single site. Based on non-overlapping parts of left femora, the most numerous element in our sample, at least 27 individuals are present. Complete femora range in length from 18.4 mm to 54.7 mm (n=12), which histological studies demonstrate to be recent hatchlings to young, rapidly growing juveniles lacking secondary osteons. Despite our scattered and disarticulated sample, nearly every element of the skeleton and skull is represented.

All specimens were recovered from a 30 cm thick zone within an upward-coarsening reddish brown, mottled, clay-rich paleosol in a localized area approximately 14 m². The bone-bearing paleosol is overlain by a sandy crevasse-splay deposit suggesting it developed on a flood plain. There is no preferred orientation of elements and only four instances of articulation between elements were noted during excavation and preparation despite the collection of well over 200 individual elements. Although many elements are complete, others exhibit pre-burial breakage and crushing. Immature iguanodontid elements comprise 96% of all remains at the site; rare turtle shell fragments, fish bones, a sphenodontian braincase, elements from a sub-adult iguanodontid, and crocodylians, sauropterygians, and stegosaur teeth also occur. These factors suggest that the site may represent seasonal attrition at or near a nesting area.

A phylogenetic analysis places the new Kirkwood taxon within the Iguanodontoida, along with Iguanodon, Mantellisaurus, Jinchousaurus, and others. Characters supporting its inclusion in this clade are marginal denticles of the teeth with mammillated edges and hatchet shaped sternal plates. Although all confirmed specimens of the Kirkwood iguanodontoid are immature, these characters are not known to change through ontogeny, lending confidence to its placement within Iguanodontidae. This is the first confirmed, well-represented iguanodontid from sub-Saharan Africa.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
Pleistocene CroCodylians FROM vEnuezuela, AND ThE DESCriPTION OF A NEW SPECIES OF CaiMAN
FORThER, Daniel C., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; BERON, Ascano D., Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela
The fossil record of post-Miocene caimans is sparse and fragmentary, but caimans have been recovered in many localities all over South America. Here, we present the first crocodilian remains from the Pleistocene of Venezuela, found in the asphalt deposits of El Breal de Orocal, which is a high diverse mammalian fossil locality. Most of the fossil crocodylians found in this locality are undiagnostic fragments. However, some of them could be either associated to indeterminable Caimaninae of Caiman sp. The most important material represents a new taxon which is described on the basis of fragmentary but diagnostic remains. The species is unique among caiman species by the possession of a premaxilla that is twice as long than it is wide in ventral view, with a long contact between the premaxillae posterior to the incisive foramen. The El Breal de Orocal is one of the most diverse localities in South America, and is probably the most important crocodilian bearing locality from the continent during the Pleistocene.
Capitosaurians are Triassic temnospondyl amphibians characterized by large, parabolic and heavy skulls as well as extensive pectoral girdles. They exhibit aquatic features such as flattened, skull, decreased bone ossification, and lateral line canals. Cosmostephan distribution, these amphibious top-predators haunted the brackish, fluvial, and sometimes coastal ecosystems. They are usually compared with crocodilians because they seem to capture prey by direct bite using active swimming, but their precise feeding ecology remains poorly known. To start to solve this problem, we analyzed the skull of Edingerella madagascariensis, a basal capitosaur from the marine Olenekian (Early Triassic) of Madagascar. Using 3D Finite Element Analysis (FEA), we created a 3D model of a 75% life-size adult skull. We analyzed this model under four different biting simulations (bilateral, unilateral and lateral cases). Previous tests working 2D FEA on capitosaurians suggested that the skull of E. madagascariensis is one of the weakest among capitosaurians during feeding. Our 3D analyses reveal that the skull displays an important amount of stress near the circumbibital region and the otic notch area during biting. In the palate, the stress is considerable on the parapsphenoid and pterygoid whereas the cultriform process shows low stress during biting. The stress also increases in the vomerine plate during unilateral biting. These results are interesting because they are similar with those obtained from archosaurian skulls in which the secondary palate provides lower stress values. This stress is especially important during unilateral bite. We therefore interpret that this unilateral type of bite was not optimal for taxa without secondary palates, such as temnospondyls.

TRICERATOPS specimens exhibit a suite of puncture, bite-and-drag, and drag marks, which in combination with tooth-spacing patterns are similar to traces previously attributed to tyrannosaurid theropods. This supports our assignment of these scars to Tyrannosaurs, the only accepted tyrannosaurid from the Hell Creek Formation. Two unassociated juvenile squamosals collected from extensive punctures up to 2 cm wide, and bite-and-drag marks up to 10 cm long. An associated young subadult juvenile squamosal and parietal show multiple parallel drag marks. These marks may have been formed as the Tyrannosaur attempted to move the frill to access the generous neck muscles connected to the skull. This would be consistent with deep parallel gouge marks observed on two occipital condyles, one associated with a punctured braincase. By contrast, 3-4 short, parallel drag marks on an unassociated nasal and premaxilla are more consistent with delicate and precise bites from the incisors premaxillary arcade.

The laterally thickened teeth of adult tyrannosaurids appear well-suited for resisting lateral stresses, which may have enhanced their ability to dismember carcasses. Relatively older Tyrannosaur individuals may have employed different feeding strategies than younger individuals as their tooth morphology thickened with a concurrent reduction in total tooth count in the dentary.
Miocene taxonomic gradients to modern communities, we also created locality data by randomly sampling the geographic ranges of all extant North American mammals. Mid Miocene taxonomic turnover was not well explained by latitude and longitude due to high primary productivity and the absence of Arctic sea ice. In contrast, late Miocene community composition varied more strongly with both latitude and longitude as a result of lower productivity and the formation of perennial Arctic ice. Finally, we found that the latitudinal and longitudinal biotic gradients are uniformly stronger than for the Miocene, supporting our hypothesis. The current presence of a strong latitudinal biotic gradient is the result of our relatively cool climate, and the associated steep latitudinal climate gradient. Given the rate of current warming, however, we can expect dramatic changes to high latitude faunas and the alteration of faunal patterns as we know them today.

Technical Session XIV (Saturday, October 20, 10:30 am)

A LONG-SNOUTED PROTOROSAURIAN FROM THE MIDDLE TRIASSIC OF SOUTHERN CHINA
FRASER, Nicholas C., National Museums Scotland, Edinburgh, United Kingdom; LI, Chun, Institute of Vertebrate Palaeontology and Palaeoanthropology, Beijing, China; RIEPPEL, Olivier, Field Museum of Natural History, Chicago, IL, United States

The “Xingyi fauna” of southwestern Guizhou and eastern Yunnan Provinces, China is characterized by a remarkable diversity of Middle Triassic (Ladinian or earliest Carnian) marine reptiles and fishes. These include the protorosaur genera Tanystropheus and Macroemmys, both of which are known also from Alpine Europe. We describe a new protorosaur on the basis of a single specimen from Guizhou Province. It is somewhat unusual among protorosaurs in possessing a markedly elongate snout. Like the tanytethrods, Tanystropheus and Tanytrachelos, it has a neck with 13 cervicals and, while the neck is longer than the trunk, it does not show the extreme neck elongation of Tanytethros and the cervical ribs do not extend across more than two intervertebral joints. The nature of the neck is therefore intermediate between the condition of Tanystropheus and Tanytrachelos. More significantly, the new form lacks a definitive thyroid fenestra. A re-examination of a fourth protorosaurian taxon, the bizarre long-necked Dinocephalosaurus from the Anisian of Guizhou Province, suggests that it too may have lacked a thyroid fenestra. The new form potentially adds to the growing diversity and disparity of protorosaurian taxa from the Middle Triassic of southern China. On the other hand it also casts some doubt on the diagnosis and constitution of the protorosaurs.

Technical Session II (Wednesday, October 17, 11:45 am)

THE GEOLOGICAL AGE AND BIOGEOGRAPHY OF CICHLID FISHES: SETTING THE (FOSSIL) RECORD STRAIGHT
FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom

Cichlids represent an important model system in many areas of biological research, but considerable controversy surrounds their deep evolutionary history and large-scale biogeographic patterns. Living cichlids are widely distributed in freshwater habitats across southern landmasses exclusive of Australia and Antarctica, and their pattern of evolutionary divergences matches area cladograms for the fragmentation of the Mesozoic supercontinent Gondwana. The earliest cichlid fossils are Cenozoic in age and substantially postdate the mid-Mesozoic onset of Gondwanan breakup, but paleontological evidence has been used to argue both for and against the hypothesis of drift-based vicariance. This ambiguity stems from uncertainty about the reliability of the fossil record of cichlids in southwestern and southeastern Asia. In order to constrain this uncertainty, two contrasting approaches to estimating plausible times of evolutionary origin were applied to the fossil record of cichlids. The first method uses the distribution of cichlid-bearing fossil horizons plus a function describing fossil recovery potential, while the second draws on the sequence of stratigraphically consistent outcrops to cichlids. Despite considering different paleontological data, both approaches yield similar estimated times for the evolutionary origin of cichlid fishes. The distribution of fossil cichlid horizons implies an age of origin between 83.1 and 55.8 Ma (Campanian-Thanetian), depending on whether analyses included all cichlid fossils or were restricted to articulated material alone. Even when secular variation in available fish-bearing fossil horizons is considered, preservation potential of cichlids must have been approximately one to two orders of magnitude lower in the Cretaceous than during their sampled history in order for the Gondwanan vicariance to be plausible. Analysis of ages of the oldest fossil representatives of cichlid outgroups yields similar age estimates for the clade. The divergence of cichlids is estimated between 87.8 and 56.3 Ma (Coniacian-Thanetian) depending on the hypothesis of outgroup relationships. These results strongly contradict the temporal predictions of the Gondwanan vicariance model of cichlid biogeography, and imply a role for dispersal in generating the modern geographical pattern of cichlid distribution. These results contribute to the broader debate on biotic connections between Africa and South America, with a growing body of evidence suggesting the migration of many groups with limited potential for oceanic dispersal from the latter continent to the former in the Paleogene.

Technical Session XVI (Saturday, October 20, 10:15 am)

TEMPO AND MODE OF ECOCOMORPHOLOGICAL DIVERSIFICATION IN CARNIVORA
FRISCAI, Anthony R., University of California - Los Angeles, Los Angeles, CA, United States; SLATER, Graham J., University of California - Los Angeles, Los Angeles, CA, United States

Carnivora (mammalian carnivores) are often used as a model group for evolutionary analyses because of both their taxonomic and ecological diversity. Recent studies have made excellent phylogenetic data freely available for both living and fossil taxa. We constructed a time-calibrated molecular phylogeny of Carnivora and used an ecomorphological dataset to examine rates of phenotypic diversification throughout the history of this group. The data show an early burst of evolution along the first ecomorphological axis, associated with degree of carnivoristy, early in the history of Carnivora, as families divided up this ecomorphospatical space. This is especially true at the extremes, with both felids and ursids moving to occupy the hyper- and hypocarnivorous (respectively) niches quickly, and staying in those areas of ecospaces. Along subsequent ecomorphological axes, dealing mainly with the midventral surface. Although the extososes resemble periosteal reactive areas, the erosive lesions indicate an infectious or inflammatory origin such as a granuloma, abscess, or viral plaque. Bacterial or parasitic infections can produce abscesses with a proliferative rim in extant archosaurs. In tyrannosaurid jaws, such lesions often perforate the bone; therefore, this is another lesion found in an “iondont.” Four mid-caudal vertebrae exhibit lesions with fracture and healing that angled the distal tips of the neural spines laterally. The first two neural spines have calluses with indentations that may represent osteomyelitis, displacement of fragmentary fragments, or blood supply to the remodeling bone. The third and fourth neural spines are less affected, with minor remodeling where they angle laterally. These neural spines may not have been fractured, instead remodeling due to pull of tendons in the affected tall region. The second specimen, a partial hadrosaurine, includes a articulated distal caudal series. Two vertebral centra are greatly expanded across their articular faces and fused ventrally by proliferative bone forming a spondyloarthropathy that extends dorsally to cover the lateral centra, but does not extend into their articular faces; neural arches are unaffected. Intervertebral distance is reduced. Articular faces between the two pathologic centra display normal bone texture, but possess an interlocking hook-and-socket structure that joins the centra without endplate fusion. Absence of a fracture restricts the differential diagnosis to mechanical stress-induced fusion or inflammation due to infection. A degenerative disorder induced by mechanical stress, such as spondyloarthrosis, is consistent with the ventral exostosis. However, extent of the exostosis and endplate remodeling is more consistent with diskospondylitis resulting from infection. Similar infection-derived exterior and endplate exostoses occur in Alligator and Varanus. Although osteopathy of hadrosaur neural spines has been commonly noted, pathologic centra are less well sampled. A global census of hadrosaur osteopathy is encouraged, to elucidate patterns in incidence rates and causes in populations over time.

Poster Session I (Wednesday, October 17, 4:15 – 6:15 pm)

CRANIAL DEVELOPMENT OF CENTROSaurus APERTUS: UNDERSTANDING HORN VARIATION AND EVOLUTION THROUGH AN ONTOGENETIC APPROACH
FREDERICKSON, Joseph A., Temple University, Philadelphia, PA, United States

Centrosaurus apertus, a large bodied centrosaurid from the Late Cretaceous of North America, is one of the most common fossils recovered from the Belly River Group. The known fossil record for this animal includes complete specimens, dozens of partial to complete skulls, and hundreds of isolated bones, which are derived from mass death assemblages found in the Dinosaur Park Formation of Alberta, Canada. This fossil record demonstrates a wide diversity in morphology and size, with specimens ranging from putative juveniles to fully-grown individuals. The goal of this study was to reconstruct the ontogenetic changes that occur in the skull of C. apertus through a quantitative cladistic analysis. Once all ontogenetic changes were ordered other sources of variation (sexual dimorphism or individual variation) could be determined. Eight nearly complete cranial specimens were coded for 53 hypothetical growth characters. The analysis was executed as an exhaustive search with all characters unordered and equally weighted. The results were a single most parsimonious tree of 74 steps. The resulting tree ordered specimens with the hypothetically least mature individuals near the base and progressively more mature specimens moving up the tree. The arrangement of specimens demonstrates no apparent pattern to horn growth on the parietal; relatively less mature specimens may have larger parietal processes than relatively more mature individuals. Conversely, the nasal horn shows a progression where the least mature individuals possess a recurved nasal horn, more mature individuals have a straight nasal horn, and the most mature individuals have a procured nasal horn. The development of the nasal horn may represent a heterochronic shift from the basal straight horned condition to the derived procurred condition.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

OSTEOPATHY IN HADROSAURINES (DINOSAURIA: ORNITHISCHIA) OF THE JUDITH RIVER FORMATION (CAMPANIAN) OF NORTHCENTRAL MONTANA
FREEDMAN, Elizabeth A., Museum of the Rockies, Bozeman, MT, United States; TANKER, Patrick H., Royal Tyrell Museum of Paleontology, Drumheller, AB, Canada; WOLFF, Ewan D., Dept of Medical Sciences, University of Wisconsin School of Veterinary Medicine, Madison, WI, United States

Hadrosaurid dinosaurs suffered from a variety of trauma or infectious/inflammatory-based pathologies, as evidenced by two hadrosaur specimens from the Judith River Formation of northcentral Montana. The first specimen, a member of Brachylophosaurus, possesses abnormalities in both dentaries and four caudal vertebrae. The dentaries have oval lesions surrounded by raised rings of remodeled bone. The right dentary has two lesions on its caudal surface superficial to the surangular articulation. The left dentary lesion is on October 2012—PROGRAM AND ABSTRACTS 97
with prey size and hardness, we find evidence for accelerating rates of ecomorphological evolution, indicative of late diversification within clades. Integration of fossil taxa into our phylogenetic model fitting strengthened our analyses and highlights Carnivora as a prime example of a Simpsonian adaptive radiation, with early diversification into major ecological roles, and later diversification within those roles.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

MORPHOMETRIC ANALYSIS OF INTRACLUMINAR AND INTRASPECIFIC VARIATION IN CERVICAL VERTEBRAE OF THE GREAT BLUE HERON (ARDEA HERODIAS): IMPLICATIONS FOR PHYLOGENETIC CHARACTER SELECTION IN SAUROPOD DINOSAURS

FROMMOS, John A., University of Michigan, Ann Arbor, MI, United States

The large number of distinct characters observable in sauropod vertebrae, combined with their great variability, has made these elements important to the interpretation of evolutionary relationships within the group, and many taxonomic proposals have been based upon the similarity or dissimilarity between the vertebrae of the taxa concerned. Determining whether vertebral characters are diagnostic above the species level requires understanding the extent of intracoluminar, ontogenetic, and intraspecific variability, as well as asymmetry associated with pneumatic features. As a consequence, the extent to which the character states of vertebrae, especially those isolated of sauropods, can be used to identify species or more inclusive taxa depends on a number of factors that are not always well described or even known for a given taxon. Investigating the relative contributions of these factors can be facilitated by the use of extant taxa for which species identifications are well-established, material is abundant and available, issues of incompleteness, damage, and distortion are avoided, and interspecific as well intraspecific comparisons can be more easily performed. A morphometric analysis was conducted on cervical vertebrae from great blue herons (Ardea herodias), which share with sauropods hyper-elongation of the neck and complex, pneumatic vertebrae. The analysis reveals a high degree of within-series variation in great blue herons, with much of the shape change occurring over short spans between regions of comparatively consistent morphology. Considerable shape variation exists between individuals but is insufficient to obscure intracoluminar trends. Asymmetry of pneumatic features on the centrum and neural arch and of the length of cervical ribs is widespread. Characters prone to asymmetrical development, such as pneumatic foramina and fossae, are more likely to be informative in their presence or absence throughout the column than in local variations in presence and position, for which developmental noise may overwhelm the phylogenetic signal.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW TOMISTOMINE FROM THE OSAKA GROUP IN KISHIWADA CITY, OSAKA PREFECTURE, JAPAN

FURUI, Sora, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan; KOBAYASHI, Yoshihito, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Hokkaido, Japan

A partial skeleton of a crocodylian, the Kishiwada tomistomine, was found from the sediments near the lower boundary of Ma5 (approximately 0.6 Ma) of the Osaka Group in Kishiwada City of Osaka Prefecture in 1994. A brief preliminary study suggested that the Kishiwada tomistomine pertained to Toystomatophinae machikanensis, known from a younger horizon (0.4 Ma) of the same group in Osaka Prefecture. Detailed comparison of these two specimens shows that the Kishiwada tomistomine differs in: a more slender snout, wide postorbital region of the skull, circular supratemporal fenestra, anteriorly concave frontoparietal suture, a distinct foramen on the ventral surface of quadrate, and a small foramen on the ventral surface of the quadratojugal. The difference in these characters implies that the Kishiwada tomistomine is not Toystomatophinae machikanensis. The Kishiwada specimen belongs to Tomistominae because it has a deep splenial symphysis and the anterior portion of the splenial is narrow and V-shaped. Its phylogenetic position within Tomistominae is not resolved yet because of its poor preservation; however, it is probably a new taxon because it shows some unique features (foramina on the ventral surface of the quadrate and quadratojugal). In addition to the Kishiwada tomistomine and Toystomatophinae machikanensis from the Osaka Group, there are at least two more tomistomines known from Japan (more than 14 individuals from Pleistocene cave deposits in Shizuoka Prefecture and a skull from Oligocene marine deposits in Fukuoka Prefecture), suggesting that tomistomines had dispersed to Japan by Oligocene and were abundant in Japan especially during the Pleistocene.

Technical Session II (Wednesday, October 17, 8:00 am)

THE ORIGIN OF THE VERTEBRATE JAW: INTERSECTION BETWEEN DEVELOPMENTAL BIOLOGY-BASED MODEL AND FOSSIL EVIDENCE

GAI, Zhikun, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; ZHU, Min, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

The origin of the vertebrate jaw has been reviewed based on the molecular, developmental and paleontological evidence. Advances in developmental genetics have accumulated that propose the heterotopy theory of jaw evolution, i.e., the jaw evolved as a novelty through a heterotopic shift of mesenchyme-epithelial interaction. According to this theory, the disassociation of the nasohypophyseal complex is a fundamental prerequisite for the origin of the jaw, since the median position of the nasohypophyseal placode in cyclostome head development precludes the forward growth of the neural-crest-derived craniofacial ectomesenchyme. The potential impact of this disassociation on the origin of dipterygian is also discussed from molecular perspectives.

Thus far, our study of the cranial anatomy of galeaspid, a 435–370-million-year-old ‘ostracoderm’ group from China and northern Vietnam, has provided the earliest fossil evidence for the disassociation of nasohypophyseal complex in vertebrate phylum. Using Soft X-ray microtomography, we further show some derivative morphologies of the trabeculae (e.g. orbitalan lamina, ethmoid plate) in jawless galeaspid, which provide new insights into the reorganization of the vertebrate head before the evolutionary origin of the jaw. These anatomical observations based on new techniques highlight the possibility that galeaspid are, in many respects, a better proxy than osteostracans for reconstructing the pre-gnathostome condition of the rostral part of the braincase. The cranial anatomy of galeaspid reveals a number of derived characters uniquely shared with gnathostomes. This raises the possibility that the galeaspid might be the closest jawless relatives of jawed vertebrates. Our study provides an intriguing example of intersection between developmental biology-based hypothesis and fossil evidence.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoecology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:45 am)

COMPARATIVE TAPHONOMY OF LATE CRETACEOUS VERTEBRATE FOSSIL OCCURRENCES IN THE ATLANTIC COASTAL PLAIN DEPOSITS OF APPALACHIA: TESTING THE HYPOTHESIS OF MASS MORTALITY AT THE K/PG BOUNDARY

GALLAGHER, William, Rider University, Lawrenceville, NJ, United States

Comparisons between the mode of vertebrate preservation in stratigraphic units of Late Cretaceous age were conducted to test the hypothesis that the basal Hornerstown Formation vertebrate fossil concentration in New Jersey is an entirely reworked assemblage. Bulk sampling, quadrat mapping, and museum collection censuses for sites in New Jersey and North Carolina show that vertebrate fossils commonly occur in one of several taphonomic modes in the Cretaceous sediments deposited on the eastern margin of Appalachia: (1) single partial skeletons, (2) one to several associated isolated bones; (3) single disarticulated elements (teeth, isolated bones) within well-defined fossil concentrations. Partial skeletons include Hadrosaurus foulkii in the Campanian Woodbury Formation, and Dryasaurus aquilanguis and “H. minor” from the New Egypt Formation (Maastrichtian). Single to several bones, elements (teeth, isolated bones) within well-defined deposits are more typical of the Campanian Merchantville Formation, glauconitic Marshalltown Formation and Navesink Formation (Maastrichtian). Thin beds of vertebrate fossils are well known from several horizons in the Upper Cretaceous section, including the Ellisdale fauna, Phoebus Landing and nearby sites in Bladen County, NC, the Mount Laurel Formation, and the basal Hornerstown Formation fossiliferous layer. These fossil concentrations are mixtures of recycled and fresh, single elements from terrestrial, estuarine and marine environments produced by physical transport. The exception is the basal Hornerstown fossil bed. This concentration contains partial and near-complete skeletons and is associated with an iridium excursion that shows extraterrestrial ratios of platinum group metals, remnant shocked quartz, and a K/ Pg boundary age on the basis of dinoflagellate biozonation. Some taxa occur as single elements, associated or partial specimens (birds, sharks, mosasaurs), but other specimens (fishes, crocodylians, chelonians) represent the best examples of their species. Deposition in a sedimentary setting probably occurred many times on the sea floor for carcasses, and hence more time for biological modification of remains. Intense bioturbation contributed to disarticulation and settling of skeletons and smearing of geochemical indicators of bolide impact. The evidence supports the hypothesis that this unusual concentration of vertebrate remains indicates a protracted mass mortality event modified by bioturbation and biological activity at the K/Pg boundary.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW LATE CRETOCACEOUS MARINE VERTEBRATE ASSEMBLAGE FROM THE BASAL GREENHORN LIMESTONE IN SOUTHEASTERN COLORADO, U.S.A.

GALLARDO, Christopher, DePaul University, Chicago, IL, United States; SHIMADA, Kuniharu, DePaul University, Chicago, IL, United States; SCHUMACHER, Bruce A., USDA Forest Service, La Junta, CO, United States

The Lincoln Limestone Member of the Greenhorn Limestone is an Upper Cretaceous rock unit largely consisting of calcareous shale interbedded with limestone and calcarenite beds that formed in the middle of an epicontinental sea in North America known as the Western Interior Seaway. Fossiliferous rock samples from the basal Lincoln Limestone were obtained from the Table Mesa locality (Baca County) in southeastern Colorado, USA. This horizon formed sometime between 95 and 94.7 Ma (middle-late Middle Cenomanian), and its vertebrate content has never before been examined. Vertebrate fossils were collected through episodic deposit or rock samples and are curated in the Sternberg Museum of Natural History in Hays, Kansas, USA. Twenty-nine marine vertebrate taxa were identified including chondrichthyans and osteichthyans fishes and reptilian taxa. The chondrichthians consist of 14 taxa, including Pycodus occidentalis, P. rhomboides, Crocodyrha mantelli, Archaeloaenema cf. A. kopingenesis, Megachasma comanchensis, Microcorax crassus, Squilcorax curvatus, Rhinobatos cf. R. incertus, Rajidae incertae sedis, and Cretodus canadensis. The most common chondrichthyan remains are teeth of Squilcorax curvatus, 2012 by the Society of Vertebrate Paleontology.
followed by teeth of Carcharias saskatchewanensis. Ostechthyian fishes include 14 taxa, including Micropycnodon kannasensis, Pycnodontidae indet., Protosphyraena sp., Elops sp., Pachyrhizodus minimus, Enchodus cf. E. gladiolus, Enchodus cf. E. shumardi, and three additional unidentified teleostra. The most common identifiable osteichthyan fossils are teeth of Enchodus E. gladiolus, followed by teeth of Pachyrhizodus minimus. Reptilian remains include two squamate taxa, Coniasaurus crassidens and an indeterminate terrestrial squamate, Scincomorda indet. The taxonomic composition of the fauna broadly resembles previously described mid-Cenomanian localities in North America that further demonstrates the high taxonomic homogeneity of vertebrates in the Western Interior Seaway. Although the occurrence of terrestrial lizard is noteworthy, proportions of common taxa at the Table Mesa locality are particularly similar to another basal Lincoln Limestone locality situated about 100 km to the west where remains of bony fishes also dominate.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleobiology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:30 am)

Chondrichthyan and osteichthyan material from Elizabethtown, NC and the Severn Formation of Bowie, MD (Maastrichtian) allows further understanding of the Cretaceous and Cenozoic fish fauna of the coastal plain of North Carolina. Elizabethtown, NC, and the Severn Formation of Bowie, MD is dominated by the taxon Odontaspis sp., which are present in small numbers. Material from Bow, MD is dominated by Cretolamna appendiculata, Squalicorax kaupi, Squalicorax pristodontus, Odontaspis sp., and Enchodus sp. To test whether faunal differences between localities reflect biogeographic influence, cluster analysis and non-metric dimensional scaling of generic-level presence/absence data of selachians from 26 Late Cretaceous localities reflect biogeographic influence, cluster analysis and non-metric dimensional scaling of generic-level presence/absence data of selachians from 26 Late Cretaceous localities from the Western Interior Sea, Gulf Coast and Atlantic Coast was conducted. The results indicate affinities among Atlantic Coast faunas, specifically between faunas from New Jersey and North Carolina. Common Late Cretaceous genera such as Squalicorax, Ichthyrobus and Odontaspis are cosmopolitan across North America and have little utility at the generic level in discriminating regional differences. Differences between regions were more pronounced when the analyses were conducted using data at the species-level, although similarities between clusters are low overall. Abundance data from Atlantic Coast faunas indicates significant ecological differences between faunas, possibly reflecting differences in environment such as proximity to shore or water depth. The abundance of terrestrial material from Elizabethtown supports this explanation.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

Variations in Ecomorphological Diversity of Shark Teeth from Late Cretaceous through Modern Marine Ecosystems of North Carolina

GATES, Terry A., Ohio University, Athens, OH, United States

Material collected from the Late Cretaceous at the Bladen County Landfill Annex in Elizabethtown, NC and the Severn Formation of Bowie, MD (Maastrichtian) allows further understanding of the Cretaceous and Cenozoic fish fauna of the coastal plain of North Carolina. Elizabethtown, NC, and the Severn Formation of Bowie, MD is dominated by the taxon Odontaspis sp., which are present in small numbers. Material from Bow, MD is dominated by Cretolamna appendiculata, Squalicorax kaupi, Squalicorax pristodontus, Odontaspis sp., and Enchodus sp. To test whether faunal differences between localities reflect biogeographic influence, cluster analysis and non-metric dimensional scaling of generic-level presence/absence data of selachians from 26 Late Cretaceous localities reflect biogeographic influence, cluster analysis and non-metric dimensional scaling of generic-level presence/absence data of selachians from 26 Late Cretaceous localities from the Western Interior Sea, Gulf Coast and Atlantic Coast was conducted. The results indicate affinities among Atlantic Coast faunas, specifically between faunas from New Jersey and North Carolina. Common Late Cretaceous genera such as Squalicorax, Ichthyrobus and Odontaspis are cosmopolitan across North America and have little utility at the generic level in discriminating regional differences. Differences between regions were more pronounced when the analyses were conducted using data at the species-level, although similarities between clusters are low overall. Abundance data from Atlantic Coast faunas indicates significant ecological differences between faunas, possibly reflecting differences in environment such as proximity to shore or water depth. The abundance of terrestrial material from Elizabethtown supports this explanation.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

A Bipolar X-Ray Method for 3-D Analysis of Track Formation

GATES, Stephen M., Brown University, Providence, RI, United States; ELLIS, Richard, University of Colorado, Boulder, CO, United States

Tracks arise through a complex interplay between animal and substrate. Studying this dynamic process is challenging because most foot-sediment and sediment-sediment interactions are rapid and hidden from view. We sought to resolve a fundamental question in ichnology: how do sedimentary particles move from their starting locations in unrotted ground to their ultimate resting places? Herein, we describe a new method for recording and quantifying the 3-D movements of a morphologically realistic indenter and sediment markers during track formation. Our method uses two (bipolar) x-ray systems and an animation-based workflow to reconstruct the trajectories of metal beads seeded throughout the sediment volume. X-rays allow sub-surface motion normally concealed by the foot and opaque matrix to be analyzed at sub-millimeter resolution. Video frequencies of 30 Hz and higher reveal temporal dynamics inaccessible by destructive methods, which provide only single snapshots of the track creation. Results from two case studies of tridactyl tracks in semi-liquid mud provide novel, animated visualizations of ensemble and particle-specific data. A bipolar x-ray approach has the potential to: mechanistically link specific track features to foot movement, clarify undertrack formation, validate computational models, and set a new standard for evidence-based reconstruction of locomotion from fossil footprints.

Technical Session XII (Friday, October 19, 3:00 - 4:00 pm)

Assembling the Squamate Tree of Life: Perspectives from the Phenotype and the Fossil Record

GAIETER, Jacques A., Yale University, New Haven, CT, United States; KEARNEY, Maureen, National Science Foundation, Arlington, VA, United States; MAISANO, Jessica A., The University of Texas, Austin, Austin, TX, United States; RIEPPLE, Olivier, Field Museum of Natural History, Chicago, IL, United States

We assembled a dataset consisting of 192 carefully selected species (51 extinct and 141 extant) and 976 apomorphies distributed among 610 phenotypic characters to investigate the phylogeny of Squamata (~“lizards,” including snakes and amphisbaenians). These data enabled us to infer a tree much like those derived from previous morphological analyses, but with better support for some key clades. There are also a number of novel elements, some of which pose striking departures from historical ideas about lizard evolution (e.g., that mosasaurs and polyglyphanodontians are on the scleroglossan stem, rather than being parts of the crown, and related to varanoids and teiids, respectively). Long-bodied and limb-reduced taxa such as snakes and ‘snake-like’ fossorial lizards (most notably dibamids, amphisbaenians) have been and continue to be the chief source of character conflict in squamate morphological phylogenetics. Carnivorous lizards (especially snakes, mosasaurs...
and varanoids) have proven a close second. Genetic data, presumably less burdened by the potential for adaptive convergence related to fossoriality, were expected to resolve these conflicts. Although recent gene phylogenies appear to do so, they also differ radically from any phylogeny based on the phenotype, especially for the most ancient crown-squamate divergences that occurred during the latter half of the Mesozoic. This result was all the more surprising as we anticipated that heavily burdened phenotypic characters and intermediate fossils would be especially useful for insights into deep-time phylogenetic events. Our study relied upon traditionally-prepared specimens as well as high resolution CT scans that afforded unprecedented access to the cranial anatomy of Squamata. This, along with the inclusion of stem fossils, provided an unparalleled sample of the phenotype enabling us to more fully explore the extreme incongruences between molecular and morphological topologies for the squamate Tree of Life. Despite this extensive new database, we were unable to find morphological support for the major rearrangement of the deep divergences in Squamata proposed by recent molecular studies. Instead, our data strongly support the same fundamental topology suggested by most previous morphological studies (an Iguania-Scleroglossa basal split, a sister-group relationship between gekkotans and autarchoglossans, and the divergence between anguimorphs and scincomorphs) and documents the extreme degree of morphological homoplasies required by those molecular topologies.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DOES THE EARLY JURASSIC KAYENTA FORMATION PRESERVE MORE THAN ONE SPECIES OF SCUTELLOSAURUS?

GAY, Robert, Mission Heights Preparatory High School, Casa Grande, AZ, United States

The Lower Jurassic Kayenta Formation preserves a wide variety of armored archosaurs. These include several crocodylomorphs, as well as the ornithischian dinosaurs Scutellosaurus and Scelidosaurus. These genera have traditionally been considered monotypic. Considering that the Kayenta Formation is usually dated to the Sinemurian–Pliensbachian stages of the Jurassic, representing approximately three million years of evolutionary time, it should not be surprising if the monotypic view of the fossil record is not reflective of the actual paleobiology of the Early Jurassic Period in the American Southwest.

An examination of specimens of Scutellosaurus at the Museum of Northern Arizona indicates that there may be more than one species of Scutellosaurus preserved in the Kayenta Formation. The preserved appendicular and axial skeleton of both S. lawleri and Scutellosaurus n. sp. are virtually identical. The dermal armor, however, shows marked differences. While the specimen does not preserve a full complement of osteoderms, the partial and complete osteoderms (n=41) allow recognition of differences between the two taxa. In particular, the new species has simplified armor morphologies (from between 4-6 morphologies in S. lawleri to only one in Scutellosaurus n. sp.) and lacks the medial concavity in the osteoderms diagnostic of S. lawleri. In addition, the armor of Scutellosaurus n. sp. also has scalloped margins, unlike the rounded edge found in S. lawleri. This evidence together indicates that the genus Scutellosaurus is not monotypic and that the fauna preserved by the Kayenta Formation changed during the formation’s deposition. Further work is also needed to determine if a fragmentary specimen from southwestern Utah is also attributable to Scutellosaurus n. sp. If so, this would represent a significant expansion of the known range of Scutellosaurus.

NEW POSTCRANIAL ELEMENTS FOR TEILHARDINA BELGICA, AN EARLY EOCENE FOSSIL PRIMATE

GEBEO, Daniel L., Northern Illinois University, DeKalb, IL, United States; SMITH, Thierry, University of Liege, Liege, Belgium

Teilhardina belgica is one of the most primitive fossil primates known to date and the earliest haplorhine with associated postcanines making it relevant to a reconstruction of the ancestral primate morphology. Here we describe newly discovered postcranial elements of Teilhardina belgica that were recovered from the collections housed at the Royal Belgian Institute of Natural Sciences (Brussels, Belgium) from the site of Dormaal. Teilhardina belgica is a small primate similar in size to a mouse lemur (between 30-40 g). Its hindlimb anatomy (e.g., tarsals, a distal femur, a first metatarsal and phalanges) suggests frequent use of the osteoderms diagnostic of S. lawleri and Scelidosaurus. This result was all the more surprising as we anticipated that heavily burdened phenotypic characters and intermediate fossils would be especially useful for insights into deep-time phylogenetic events. Our study relied upon traditionally-prepared specimens as well as high resolution CT scans that afforded unprecedented access to the cranial anatomy of Squamata. This, along with the inclusion of stem fossils, provided an unparalleled sample of the phenotype enabling us to more fully explore the extreme incongruences between molecular and morphological topologies for the squamate Tree of Life. Despite this extensive new database, we were unable to find morphological support for the major rearrangement of the deep divergences in Squamata proposed by recent molecular studies. Instead, our data strongly support the same fundamental topology suggested by most previous morphological studies (an Iguania-Scleroglossa basal split, a sister-group relationship between gekkotans and autarchoglossans, and the divergence between anguimorphs and scincomorphs) and documents the extreme degree of morphological homoplasies required by those molecular topologies.

Poster Session I (Thursday, October 18, 4:15 - 6:15 pm)

INFERRING SOFT-TISSUE ANATOMY IN FOSSIL VERTEBRATES

NEWS OF ALL CRANIAL NERVES, CAN BE FULLY VISUALIZED AND READILY RECONSTRUCTED USING 3D COMPUTER VISION METHODS

INFERRING SOFT-TISSUE ANATOMY IN FOSSIL VERTEBRATES

LUGOL'S IODINE AS A CONTRAST AGENT IN X-RAY μCT IMAGING: METHODOLOGICAL REFINEMENTS AND POTENTIAL SIGNIFICANCE FOR INFERRING SOFT-TISSUE ANATOMY IN FOSSIL VERTEBRATES

GIGNAC, Paul M., Stony Brook University, Stony Brook, NY, United States; KLEY, Nathan J., Stony Brook University, Stony Brook, NY, United States

Visualization methods vastly enhance our ability to appreciate complex anatomical relationships and to harness these relationships for understanding the nature of developmental and/or evolutionary changes in morphology. Most notably, the new widespread use of non-destructive X-ray computed tomography (CT) and micro-CT (μCT) has greatly augmented our ability to comprehensively detail and quantify the internal anatomy of fossil vertebrates. Refining these techniques for use on hard tissues such as bone, dentine, and enamel has led to substantial gains in both the quality and quantity of anatomical comparisons among extinct taxa and between fossils and their extant descendants or analogues. However, the utility of X-ray imaging for gaining similar paradigm-altering insights into the soft tissues of living vertebrates has yet to be fully realized, as animals have long been constrained by a large degree to the naturally low X-ray absorption of non-mineralized tissues and by a paucity of non-toxic and inexpensive staining agents. Here we systematically test and quantify contrast in μCT images of intact neonate and yearling Alligator mississippiensis heads that were prepared with a simple, non-toxic, and inexpensive staining protocol using Lugol’s iodine (I₂KI) that facilitates stunning visualization of soft tissue anatomy in high-resolution X-ray μCT images. To date, similar methods have been experimented with using collagen scaffolding, invertebrates, vertebrate embryos, adult mice, and a yearling alligator—in all cases yielding promising results. Our protocol expands upon these earlier studies by making possible extensive visualization of vertebrate soft tissues in X-ray μCT images. We demonstrate that the soft-tissue anatomy of the head and neck, including differences between white and grey matter of the spinal cord, nuclei of the brain, fascicle lengths of the cranial musculature, and the complete pathways of all cranial nerves, can be fully visualized and readily reconstructed using 3D imaging software. Similar to visualization work that has been done previously on sinuses and cranial nerve roots, this soft-tissue reconstructions can then be matched directly to the osteological correlates they leave behind for comparison to similar correlates in fossil forms. This technique will make rapid, non-destructive mapping of intricate anatomical relationships possible in a wide variety of extinct vertebrates. We briefly demonstrate its
utility by: (1) quantifying differences between brain size and shape to those inferred from cranial endocasts; (2) generating reconstructions of the cranial musculature; and (3) mapping the courses of cranial nerves throughout the head, between our A. mississippiensis specimens and their fossil crocodyliform relatives.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RENEWED PALEONTOLOGICAL INVESTIGATIONS IN THE UPPER AND LOWER SIWALIKS OF INDIA: IMPLICATIONS FOR PRIMATE EVOLUTION VIS A VIS PALEOClimATE CHANGE

GILBERT, Christopher C., Hunter College of the City University of New York, New York, NY, United States; PATEL, Biren A., Keck School of Medicine at the University of Southern California, Los Angeles, CA, United States; PATNAIK, Rajeev, Panjab University, Chandigarh, India; FLEAGLE, John G., Stony Brook University, Stony Brook, NY, United States

The fossiliferous Siwalik Hills of India and Pakistan are well known to vertebrate paleontologists. Over the past century, numerous specimens collected in the Siwaliks have proven vital to understanding the evolution and biogeography of many mammalian groups, with primates being no exception. At least three major groups of primates are found in the Siwaliks: hominoid apes and sivaladapine adapoids from the Lower and Middle Siwaliks, a C3 dominant environment, and cercopithecoid monkeys from the Middle and Upper Siwaliks, a C4 grassland dominant landscape. Particularly important primate specimens from the Siwaliks include early great apes (e.g., Sivapithecus), early Asian cercopithecoids (e.g., Pregnythys sivalensis), the easternmost specimen of the giant gelada Theropithecus oswaldi, and some of the latest occurring adapoids in the fossil record. Since 2010 we have renewed fossil prospecting in the Upper and Lower Siwaliks deposits in an attempt to better understand the evolution, biogeographic timing, and paleoclimatic context of primate radiations in Asia. To date, our expeditions in the Upper Siwaliks have documented that the site of Mirzapur, which produced the lone T. oswaldi specimen in India, is now submerged under water. Our exploration of the Lower Siwaliks (in the Jammu and Kashmir region) has resulted in the identification of at least two new fossil localities as well as the relocation of Ramchand Ridge, a little-known site that has produced dental specimens conflictingly identified as the earliest Asian hominoids by some researchers and as the said Conohyus by others. The results of our preliminary collection efforts in these areas are presented here, and recovered fauna includes typical Chiniji zone taxa such as rodents, tragulids, bovid, suids, carnivores, giraffids, rhinocerotids, squamates, and crocodylians, all of which have previously been found in association with primates in these areas. Many of these faunal elements are important biostatigraphic and paleoclimatic indicators as well. Thus, future geological, palaeontological and palaeoclimatological research in the Lower Siwaliks of India should result in the eventual recovery of new primate specimens and help to clarify the nature and timing of primate and mammalian evolution in Asia.

Technical Session II (Wednesday, October 17, 8:30 am)

ENDOESKELETAL ANATOMY OF THE STEM ACTINOPTYERYGIAN CHEIROLEPIS REVEALED BY HIGH-RESOLUTION COMPUTED TOMOGRAPHY

GILES, Sam, University of Oxford, Oxford, United Kingdom; BRAZEAU, Martin D., Naturalis, Leiden, Netherland; ATWOOD, Robert C., Diamond Light Source, Harwell Campus, United Kingdom; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom

The Middle Devonian Cheirolepis occupies a critical position in vertebrate phylogeny: it is the sister group of all other actinopterygians and the earliest definitive ray-finned fish. Despite its significance and a comparative abundance of material, Cheirolepis remains poorly known in many respects. Previous treatments of this genus have relied heavily on unprepared specimens, and provide only vague details of endo skeletal structure. The model for early ray-finned fish anatomy has instead been based largely on the Late Devonian actinopterygians Mimipiscis and Mayothyrsomus, which are known in stunning detail from acid-prepared, uncompressed specimens from the Gogo Formation of Australia. Re-examination of material of Cheirolepis from classic Old Red Sandstone localities of Scotland using lab-based and synchrotron X-ray computed tomography substantially alters older accounts of endo skeletal structure in this genus, with important implications for understanding patterns of character evolution deep within the osteichthyans crown. Here we focus on results from two individuals preserved in concretions, one from Garnie and another from Tynet Burn. The Garnie specimen preserves both pectoral-fin endo skeletone and a hyomandibular. The scapulocoracoid bears a long, narrow articular surface for the radius. In contrast to previous interpretations, the construction of the fin endoskeleton is similarly broad to that of other early actinopterygians, although the proterygium appears to be imperfectly fused. The hyomandibular is fused with the dermal, but assumes proportions more similar to those found in some early sarcopterygians (e.g., Onchodus) than those of Mimipiscis and Mayothyrsomus. Significantly, the Tynet Burn specimen yields a largely complete braincase showing anatomical detail comparable to that known from the Gogo ray fins. Many aspects of the neurocranium are comparable to those of later actinopterygians (e.g., a narrow interorbital septum), but important exceptions include the lack of any dermal ascending processes of the neurocranium and an unpaired canal, both of which likely represent pleiomorphic osteichthyian features. Collectively, these new data help clarify primitive conditions within ray-finned fishes, which in turn have important implications for understanding features likely present in the last common ancestor of living osteichthyans.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EVOLUTIONARY STASIS OF NORTH AMERICAN GLYPHODONT DURING THE GREAT AMERICAN Biotic INTERCHANGE

GILLETTE, David D., Museum of Northern Arizona, Flagstaff, AZ, United States; CARRANZA-CASTANEDA, Oscar, Centro de Geociencias Universidad Nacional Autonoma de Mexico, Campus Juriquilla, Queretaro, Mexico; WHITE, Richard, International Wildlife Museum, Tucson, AZ, United States; MCCORD, Robert, Arizona Museum of Natural History, Mesa, AZ, United States; THIRASHER, Larry, Bureau of Land Management, Safford, AZ, United States

Glyphodonts originated in South America in the Paleogene, diversified through the Neogene, and expanded into North America no later than about 4 million years ago during the Great American Biotic Interchange. Apparently only one genus (Glyptotherium) became established in Central America and eventually expanded into Mexico and southern United States. Until recently, three commonly recognized species seemed to fit an anagenetic model of evolution through the Pliocene and Pleistocene in North America: Glyptotherium texanum (Blancan), G. arizoneae (Late Blancan-Irvingtonian), and G. floridanum (Randolhabrean). The evolutionary positions of two other species (G. cylindricum and G. mexicanum) from Mexico were enigmatic due to poor stratigraphic records and incomplete skeletal material for the holotypes. Newly collected glyphodonts from Los Galavanes and Coccolas areas, Guanajuato, in central Mexico, and from the 111 Ranch fauna of southeastern Arizona add to the hypodigm of G. texanum and indicate that G. texanum and G. arizoneae are synonymous. The newly recovered specimens include babies, juveniles, and fully grown adults, as large as the largest individuals formerly assigned to G. arizoneae. All of the characters that seemed to distinguish the two species are now attributable to ontogeny and sexual dimorphism.

The species changed little, if at all, over the course of this 2.5 million year interval (Early Blancan, 3.9 mya, to Early Irvingtonian, 1.4 mya). The hypodigm of the late Pleistocene species, G. floridanum can be distinguished from that of the expanded hypodigm of G. texanum only in minor details of the carapacial armor, which may be related to growth acceleration that changed proportions of the external sculpturing but did not culminate in any recognizable autapomorphies. These observations lead to the hypothesis that the Glyptotherium texanum - G. floridanum lineage remained practically unchanged for at least four million years. The species definitions of G. cylindricum and G. mexicanum remain to be reevaluated in this context. The Gulf Coastal Plain was probably the principal center of dispersal for Glyptotherium, expanding during sea level retreats, and contracting but never disappearing during advances. Changing climatic conditions and tectonic activity affected habitats and distribution, but there is little evidence that climate change stimulated evolutionary change in the morphology of Glyptotherium.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PALEOPATHOLOGICAL ANALYSIS OF TAPIRUS SP. FROM FLORIDA AND TENNESSEE

GILMORE, Laura S., East Tennessee State University, Johnson City, TN, United States; BREDEHOEFT, Keila E., Hagerman Fossil Beds National Monument, Hagerman, ID, United States

The two largest samples of fossil tapirs known are from the Gray Fossil Site in Gray, Tennessee and Haile 7G in Newberry, Florida. Large numbers of individuals and high numbers of identified specimens (NISP) at these two sites present an unparalleled opportunity to analyze patterns in a fossil sample. Despite the age differences of the two sites, the late Miocene Gray Fossil Site and the early Pliocene (Blancan) Haile 7G have been referred to sister sites, due to their similar environments and unusually large proportion of tapirs. The results of our preliminary collection efforts in these areas are presented here, and recovered fauna includes typical Chiniji zone taxa such as rodents, tragulids, bovid, suids, carnivores, giraffids, rhinocerotids, squamates, and crocodylians, all of which have previously been found in association with primates in these areas. Many of these faunal elements are important biostatigraphic and paleoclimatic indicators as well. Thus, future geological, palaeontological and paleoclimatological research in the Lower Siwaliks of India should result in the eventual recovery of new primate specimens and help to clarify the nature and timing of primate and mammalian evolution in Asia.

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Ecoene Darwinius, Europeolom and Notharctus (Primates, Adapidae): What is a Claw, What is a Grooming Claw, and When Did Grooming Claws Evolve?

Gingerich, Philip D., University of Michigan, Ann Arbor, MI, United States

Living primates are distinguished from tree shrews and other mammals by their grasping hands and feet, which have distal phalanges bearing nails rather than claws. Exceptions include DuElephantimia and Callitrichidae with claws on all digits except the hallux. Various authors have argued that (1) claws on all digits; (2) nails on all digits; or (3) nails and pedal grooming claws are primitive for primates. Interpretation depends on the taxa included in the order, on phylogenetic relationships (as yet uncertain), and on identification of grooming claws.

Claws are laterally compressed, longitudinally curved, and have pointed distal ends, as do the underlying bony distal phalanges. Nails are broader and flatter with more columnar underlying phalanges. Grooming claws are thought to differ from nails on other digits in being longer and standing at a steep angle to the dorsal surface of the digit as a whole. Toilet claws are not always easy to identify from their underlying bony phalanges.

Micro-CT images were measured for all pedal distal phalanges (PDPS) of Tupaia and 25 primate species (14 prosimians, 11 anthropoids). Principal components analysis (PC or PCA) enabled clawed PDPS to be distinguished from other distal phalanges. Clawed PDPS are laterally compressed and longitudinally curved, falling in the lower left quadrant of a PC-II vs. PC-III morphospace. PDPS for grooming claws of 14 prosimian species overlap slightly with PDPS for other digits, but generally occupy the lower right quadrant of the morphospace. Addition of Eocene adapoids suggests that Europeolomur had grooming claws on digit II, and Notharctus had grooming claws on digits II and III.

Linear discriminant analysis (LDA) of the same measurements distinguishes most grooming-claw PDPS from non-grooming-claw PDPS. Europeolomur is again classified as having a grooming claw, but Notharctus appears not to have had grooming claws. LDA for all 40 measurements of PD-1 through IV in a foot collectively separates grooming-claw primates from the others, but here it appears that neither Europeolomur nor Notharctus had a grooming claw. Requisite measurements are not available for Darwinius, but it clearly had PDPS similar to those of Notharctus.

Ambiguity concerning the presence of grooming claws in Eocene Adapidae, and the lack of evidence one way or another in Eocene Tarsiodae, mean it is difficult to know whether grooming claws of Lemuroidea and Tarsiodae are homologous, and it is difficult to be certain when grooming claws evolved.

Technical Session I (Wednesday, October 17, 8:45 am)

Pneumatic Patterns in the Skull of Algoramus Altai, a Long-Snouted Tyrannosaur (Dinosaur: Theropoda), from the Late Cretaceous of Mongolia

Gold, Eugenia, Richard Gilder Graduate School, New York, NY, United States; Brusatte, Stephen L., American Museum of Natural History, New York, NY, United States; Norell, Mark A., American Museum of Natural History, New York, NY, United States

Algoramus altai is an aberrant tyrannosaurid theropod from the Late Cretaceous of Mongolia, which exhibits a long and gracile skull, slender postcranial skeleton, and smaller size compared to other tyrannosaurs such as the coeval Tarbosaurus and Tyrannosaurus. The holotype of A. altai is an exceptionally preserved juvenile that includes nearly all of the disarticulated cranial bones. Several of these bones exhibit extreme pneumaticity, including internal sinuses associated with the antorbital fenestra, tympanic system, and median gular. Because tyrannosaurs are basal coelurosaurs, and because the retention of these recesses indicates that the pattern of theropod cranial pneumaticity may be stable in the face of extreme morphological change, such as snout elongation.

Technical Session II (Wednesday, October 17, 11:15 am)

Exceptional Preservation and Unusual Features in a Distinctive New Tarpon-Like Fish [Elopomorphida] from the Late Cretaceous of the Chatham Islands, New Zealand

Gottfried, Michael D., Michigan State University, East Lansing, MI, United States; Fordyce, Robert E., University of Otago, Dunedin, New Zealand; Lee, Daphne E., University of Otago, Dunedin, New Zealand; Koehler, Richard, University of Otago, Dunedin, New Zealand

We report on a large and nearly complete elopomorph fish from the Cretaceous (possibly Paleogene) of Pitt Island, Chatham Islands, New Zealand. The distinctive specimen, which is three-dimensionally preserved in a volcanic tuff, is the most complete and informative fossil elopomorph reported to date from the Southern Hemisphere. Features supporting elopomorph affinities include the lack of a separate retroarticular ossification on the lower jaw, and a plesiomorph median gular. Assignment to the elopomorph Family Megalopidae (tarpons) is indicated by the specimen’s superior mouth position, large posttemporal fossae, and laterally compressed body covered in large and extensively overlapping cycloid scales. A number of distinctive features, including the elongate body, high and strongly developed coronoid process on the mandible, an enlarged median gular, a relatively low-profile head, a series of anamorphic bones in the cheek region, and the continuation of the lateral line scales onto the base of the caudal fin, indicate that the Pitt Island fish represents a distinctive new taxon within megapolid fishes. One highly unusual feature is a transverse fissure that extends across the skull roof just posterior to the orbits; this structure appears internally continuous on CT-scans and symmetrically disposed, and is therefore interpreted as likely representing a real structure and not an artifact. The overall morphology of the specimen suggests a fish similar in many respects to the extant tarpons Megalops atlanticus and M. cyprinoides but with a more slender head profile and more attenuated body, and with several unique skeletal features not previously reported on megapod fishes.

New Vertebrates from the Late Cretaceous Kallahmedu Formation, Caubay Basin, South India, Including a Troodontid Dinosaur, a Gondwanatherian Mammal, and a Simosuchus-Like Notosuchian Crocodyliform

Goswami, Anjali, University College London, London, United Kingdom; Prasad, Gunapalli V., University of Delhi, Delhi, India; Benson, Roger B., University College London, London, United Kingdom; Verma, Omkar, Indira Gandhi National Open University, New Delhi, India; Flynn, John J., American Museum of Natural History, New York, NY, United States

Late Cretaceous vertebrate faunas of India are known predominantly from intertrappean deposits in the Deccan volcanic province. A thick sequence of Early Cretaceous to Early Paleocene fossiliferous sediments exposed in the Caubay Basin of South India has been comparatively poorly explored. Here, we present a preliminary description of a new fauna consisting of vertebrate fossils discovered from the continental Upper Cretaceous (late Maastrichtian) Kallahmedu Formation. The Kallahmedu Fauna includes ganoid fishes, amphibians, turtles, crocodyliforms, dinosaurs, and mammals, with many taxa suggesting Late Cretaceous biotic links between India and other Gondwanan landmasses. Teeth of abelisaurid dinosaurs and gondwanatherian mammals support pan-Gondwanan distributions for these clades. Of great significance is the first discovery of a Simosuchus-like notosuchian crocodile outside of Madagascar. This clove-shaped tooth with multiple homogeneous cusps and a ventrally flaring root is reminiscent of the crown morphology of Simosuchus clarki, known from the Upper Cretaceous Maaswaramo Formation of Madagascar. The single known tooth is tentatively placed within the posterior series of the right dentary, due to the presence of eight cusps and flaring of anterior part of the root similar to that described for some of the dentary teeth of Simosuchus. Previous analyses suggested close relationships among Late Cretaceous Indian and Madagascar species across a number of vertebrate groups, including gondwanatherian mammals, nigerophid snakes, and bothremydid turtles, and this report of the first Indian Simosuchus-like notosuchian further strengthens the evidence for close biotic links between India and Madagascar in the Late Cretaceous.
October 2012—PROGRAM AND ABSTRACTS

Romer Prize Session (Thursday, October 18, 9:30 am)

ARTICULAR SURFACE MORPHOLOGY AND THE EVOLUTION OF CURSORIALITY IN PALEOGENE UNGULATES: THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSIS OF COMPLEX TOPOLOGIES

GOULD, Francois D., Johns Hopkins School of Medicine, Baltimore, MD, United States

Joint surface morphology reflects joint function as indicated by biomechanics and anatomy. Thus, the quantitative study of articular surfaces is a fruitful avenue of research for inferring functional morphology in fossils. In mammals, qualitative differences in distal femoral shape have been tied to, among others, arboreal and cursorial modes of locomotion. However, complex topology has made quantitative testing of evolutionary hypotheses tied to these observations difficult. In particular, specialization for cursoriality has been suggested as a key factor in the origination of the modern ungulate orders Artiodactyla and Perissodactyla. Studies of comparative anatomy have shown that the paraplatygeic group Condylarthra, which is thought to contain the sister taxa to these orders, contained arboresal forms, but these taxa also had small distal elements. The aims of this study were to test quantitatively the relationship between distal femoral morphology and locomotion, and to use changes in femoral morphology in condylarths and early North American artiodactyls and perissodactyls to examine the changes in locomotion in ungulates through the Paleogene. Using three-dimensional geometric morphometrics I analyzed the shape of the entire distal femoral articular surface. Surface scans were collected from 42 extant mammal genera classified into 5 locomotor categories. Geometric morphometric analysis showed significant differences between arboreal and cursorial taxa across different taxonomic orders (Multivariate Analysis Of Variance on principal component (PC) scores Wilkes λ (2.688, 60)=0.01919, p<0.001). Shape variation recovered on the first PC is significantly associated with differences in locomotor mode and supports previous biomechanical and functional anatomical assessments of ecologically different taxa: antero-posterior elongation and extension of the patellar groove in cursorial forms, versus medio-lateral broadening of the condyles in arborose taxa. A discriminant analysis is highly significant, with percent correct classifications between 80% and 100%. All fossil artiodactyls and perissodactyls are recovered as either cursorial or terrestrial locomotion, whereas condylarths occur in all locomotor categories, including arboresal and cursorial. Thus the diversification of the modern ungulate orders is not associated with the origin of cursoriality but rather with a reduction in the range of locomotor ecologies. Three dimensional geometric morphometrics of articular surfaces though labor intensive are a powerful quantitative tool for testing qualitative hypotheses of anatomical variation. They are therefore invaluable in studying ecological changes associated with major evolutionary transitions and adaptive radiation.

Technical Session III (Wednesday, October 17, 3-00 pm)

PHALANGEAL MORPHOLOGY OF SUSPENSORY MAMMALS: IMPLICATIONS FOR THE LOCOMOTION OF MALAGASY SUBFOSSIL SLOTH LEMURS (PRIMATES: PALAEOPROBOSCIDEA)

GRANATOSKY, Michael C., Duke University, Durham, NC, United States; MILLER, Charlotte E., Duke University, Durham, NC, United States; LEMELIN, Pierre, University of Alberta, Edmonton, AB, Canada; SCHMITT, Daniel, Duke University, Durham, NC, United States

Based on osteological similarities in the back, arm, and wrist, the subfossil sloth lemur of Madagascar have been reconstructed as committed invertsquadrupedal similar to extant sloths. However, in contrast to extant sloths and other suspensory species like bats and colugos, sloth lemur characters are not unique to the primates, though few metric studies of phalangeal anatomy exist to support this contention. To investigate the extent to which sloth lemur may differ in phalangeal morphology compared to primates and other mammals, we compared a broad sample of suspensory and non-suspensory taxa to sloth lemur—Palaechiropterus, Megopithecus, and Babahokia—using both univariate analyses and principal components analyses (PCA).

Results from the PCA indicate that the intermediate phalangia of non-primate suspensory mammals and bats, rats, and colugos has a narrower proximal articular surface, and a dorsoventrally expanded distal trochlea when compared with primates and other non-suspensory mammals. Additionally, phalangeal proportions of non-primate suspensory taxa vary considerably from other species. While primates tend to have longer proximal phalanges and shorter distal phalanges, non-primate suspensory taxa all have long claws on the distal phalanges and relatively longer intermediate phalanges. These differences are most likely to represent a trade-off between passive digital flexion vs. enhanced prehensility. Non-primate suspensory taxa have anatomical features that provide both proximal and distal advantages. The postures of the hand and foot to support the body against gravity during suspension. Primate hands and feet have none of the features associated with such passive resistance mechanism, but in turn have much greater grasping prowess and dexterity. Sloth lemur hands were clearly committed invertebrates that retained prehensile hands and feet with nails rather than claws, a feature typical of other primates. This anatomical arrangement was potentially energetically costly, requiring muscular rather than passive stabilization and weight support mechanisms. However, the retention of the primate-like grasping extremity would have been advantageous for effective movement between substrates of varying diameters and effective manipulation during food acquisition.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleoeocology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 8:00 am)

SKELETONS IN THE CRETACEOUS CLOSET – AN OVERVIEW OF THE HISTORY OF PALEONTOLOGY IN APPALACHIA

GRANDSTAFF, Barbara S., School of Veterinary Medicine, University of Pennsylvania, Philadelphia, PA, United States; PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States

While vertebrate paleontology in North America began during colonial times, the earliest to gain prominent status was among the earliest vertebrates. Cretaceous vertebrates. Cretaceous vertebrates. The giant ground sloth, Paleomylodon, ne North America was born in New Jersey with Joseph Leidy's 1855 description of a dinosaur skeleton (Hadrosaurus foulkii) discovered in Haddonfield NJ in 1830. In 1865 Leidy published an overview of Cretaceous reptiles of the United States; most of the fossils described came from New Jersey marl mines. Hadrosaurus was included in this review, as were crocodilians and turtles from New Jersey. Hadrosaurus became one of the first of dinosaurs to have its skeleton, reconstructed by B. Waterhouse Hawkins, displayed in museums. Cope described the theropod 'Laelaps' (Dryptosaurus) in 1866, also from the New Jersey marls. This dinosaur was the first to be reconstructed in a 'modern' dynamic pose; the famous 'leaping Laelaps' of Charles Knight. Coastal waters of Cretaceous New Jersey supported a diverse fauna of fishes and marine reptiles, which were also among the earliest fossils described from North America. Even the infamous 'Bone Wars' lead between Cope and Marsh began in New Jersey when fossils that were coming to Cope for study curiously got diverted to Yale, beginning shortly after the two toured Cope's New Jersey fossil sites.

New Jersey was not the only part of Appalachia producing fossils during the late 19th and early 20th centuries. Cretaceous fossils were described from the Potomac Beds of Maryland and Virginia and from North Carolina (including Hypsipops crassincauda, a notorious chimera). Western sections of Appalachia have also been productive. Missouri yielded Hypsiphsa missourienne, a dinosaur found in a well. Alabama has a rich Cretaceous fauna, and the eastern part of Texas (the 'west coast' of Appalachia) has yielded Cretaceous terrestrial and coastal marine fossils. Vertebrate fossils from Appalachia were well represented in the earliest history of our science in North America. This was not to last: while Cretaceous vertebrate remains continued to be found in the eastern subcontinent the focus of vertebrate paleontology largely shifted to more spectacular finds from the American west in the latter half of the 19th century. Recently, paleontologists have begun to re-explore the rich and diverse vertebrate fauna of Appalachia and its coastal waters. New work in the eastern subcontinent could be said to have begun with discovery of the Ellisdale Site in the early 1980s.

INFERRING LEVELS OF ARBOREALITY OF EXTINCT SLOTHS THROUGH A GEOMETRIC MORPHOMETRIC ASSESSMENT OF SCAPULA MORPHOLOGY

GRASS, Andy, University of Iowa, Iowa City, IA, United States

One of the most persistent challenges with studying the fossil record is assessing the behavior of extinct organisms. Often times this can be addressed by identifying correlations between morphology and behavior in a closely related extant taxon, which can then be used to infer similar behaviors from similar morphologies in the extinct taxon. The mammalian scapula is well suited for these purposes, as it has been shown in many groups to have a high correlation between form and function. In primates in particular there is a very distinct difference in scapula morphology between arboreal and terrestrial groups. This is directly relevant to extinct sloths, which are all commonly referred to as "ground sloths," despite that several groups were much smaller and possibly less terrestrial than the archetypal giant ground sloths. Varying levels of arboreality have been demonstrated in these smaller sloths by comparing limb measurements which have been shown to distinguish arboreal and terrestrial primates, as well as modern arboresal and terrestrial anteaters, which are sloths’ closest living relatives. A geometric morphometric study was performed to determine if patterns of arboreality could also be parsed out through the scapula morphology of these sloths. Three-dimensional landmarks and sliding semi-landmarks were taken on the scapulae of extant and extinct sloths as well as extant anteaters, and a principal components analysis was performed on the procures residuals of these landmarks. The arboreal and terrestrial anteaters have little overlap in morphospace; however the putatively semi-arboreal sloth Hapalops tended more towards the giant ground sloths. This could potentially indicate that Hapalops was more terrestrial than previously thought. However, the giant ground sloth Megalonyx tended towards the area of morphospace occupied by modern tree sloths. Current phylogenetic estimates place Megalonyx and Choloepus, the modern two toed sloth, in the same family, Megalonychidae. This may reflect that, in sloths at least, scapula morphology is influenced less by adaption and more by phylogenetic constraint. Bradypus, the modern three toed sloth, which is in the monotypic family Bradypodidae, and thus not closely related to Choloepus, plotted in the same area of morphospace as Choloepus. This may have implications for the supposed extreme convergent evolution between Choloepus and Bradypus, and indicate that their similar scapula morphology is instead a result of the retention of similar ancestral forms rather than adaptations to their suspensory lifestyle.

Technical Session III (Wednesday, October 17, 3:30 pm)
Morphological variation indicates that at least two taxa of hadrosaurines are present in this assemblage. All of the adult cranial and postcranial specimens belong to hadrosaurine taxa. Fossil discoveries over the past 30 years have radically transformed old views of the evolution of Mesozoic mammals. Similarly, recent research on early angiosperm radiation has provided a more detailed account of the roughly contemporaneous diversification of angiosperms and Mesozoic mammals. Though studies have speculated about the possible co-evolution of angiosperms and mammals, there has been no recent quantitative palaeontological study on mammals that examines parallel patterns between groups. In this study, three hypotheses were considered: 1) angiosperm radiation had little or no effect on the overall taxonomic and morphologic disparity of Cretaceous mammals; 2) angiosperm radiation led to an increase in the overall disparity of mammals, possibly due to dietary changes; and 3) angiosperm radiation led to a decrease in mammalian diversity, with herbivorous and insectivorous mammals flourishing, as these groups would have been most likely to profit from the co-evolution and radiation of insects with angiosperms. Diversity curves were created to analyze taxonomic changes. New measurements were used as a proxy for body size and disparity, and geometric morphometric analysis of jaws was used to examine changes in morphological and dietary disparity. Results indicate significant morphologic and taxonomic changes in mammals at the time of angiosperm radiation, including a decrease in the number of eutracodontans and ‘symmetrodontans.’ The two mammalian clades that appear to have been most successful in the Late Cretaceous are the herbivorous multituberculates, which show evidence of morphologic radiation through increased jaw and teeth disparity, and insectivorous therians, which experienced a taxonomic radiation. Body size and morphologic disparity of non-multituberculate mammals, primarily therians, appear to decline with the advent of angiosperms, suggesting the possibility of a morphological “bottleneck” that resulted in a shift towards small insectivores. The results of this study call for more exhaustive research concerning the possibility of mammal-angiosperm-insect co-evolution.

All of the adult cranial and postcraniomandibular specimens belong to hadrosaurines. A partial quadratojugal, the smallest element, a scapula that is 66 mm in length, is comparable in size to those of hatchling hadrosaurs of other genera. The lateral profile of the dorsal margin of this scapula is craniocaudally straight, suggesting that the hatchling represents a basal hadrosaurid taxon. A partial dentary, 53 mm in length, is approximately half the size of the other adult dentaries found, signifying the presence of more advanced juvenile hadrosaurs. At the opposite extreme, are adult elements that represent hadrosaurid individuals that are among the largest known. A large humerus, hadrosaurid based on deltoplectoral crest proportions, measures 861 mm in length.
The evolution of powered flight in birds remains a contentious issue in vertebrate paleontology. The small dromaeosaurid dinosaur *Microraptor gui* preserves evidence of extensive, lift-generating feathers on each manus and forearm, but also preserves evidence of lift-generating feathers associated with the hindlimbs, effectively forming a pair of “hindwings”. Similar morphology has also been described for the hindlimbs of *Pedopenna, Anchisaurus* and *Xiaotingia*. Phylogenetic analyses consistently place all of these taxa as paravians and thus close to the origin of birds. Combined with anatomical and functional studies, this indicates that flight evolved at least once within the lineage originating with the common ancestor of birds and dromaeosaurs. Thus, the four-wing design and its inferred flight performance may represent an ancestral four-winged stage in avian flight evolution. Alternatively, the evolution of flight may not have represented a single monophyletic event and there could be multiple abandoned body plans attempting to solve flight performance issues. Under such a case, *M. gui* may represent an alternative solution to aerodynamic issues experienced by early flying theropods.

Prior authors modeled the hindlimb of *M. gui* in a strongly abduced four-winged gliding position that may require an anatomically implausible orientation of the hip socket. We suggest an alternative model in which the hindlimbs were generally held below the body during steady flight, but deployed unilaterally, or bilaterally, to produce additional roll and yaw during unsteady flight maneuvers, such as turning. In this way, the hindwings could serve as control surfaces, enhancing maneuverability. The effect of a single, laterally deployed hindwing can be calculated for any bank angle. We calculate a 38% decrease in turning radius for a 45 degree bank angle and a 36-179% (20-90 degrees bank angle). Deployment of the hindwings as control surfaces held below the body generates substantial potential locomotor advantage, is supported by aerodynamics and requires no unusual positioning of the hindlimb.
EVIDENCE FOR SUSPENSORY LOCOMOTOR ADAPTATIONS IN A LATE MIocene FOSSIL APE BASED ON IN VIVO-VALIDATED MODELS OF HIP JOINT ABDUCTION

HAMMOND, Ashley S., University of Missouri, Columbia, MO, United States

Suspensory locomotion plays an important role in hypotheses for the origins of great ape locomotion. When and how suspensory behaviors evolved is currently debated. Early Miocene apes are hypothesized to have been above-branch quadrupeds with suspensory capacities inferred to have originated in the middle to late Miocene, but few data have been available with which to test this hypothesis. Hominoid suspension is thought to require an increased range of hip joint abduction compared to monkey-like above-branch quadrupedal behaviors. If hip joint mobility can be accurately reconstructed from bone morphology, this would provide an opportunity to evaluate locomotor abilities based on hip joint function in fossil apes. Here I present results of in vivo and in silico measures of hip joint abduction capacity in suspensory species (Symphalangus, Hylobates, Pongo, Gorilla, Pan, Ateles) and non-suspensory (Cercopithecus, Cebus) extant anthropoids. Angular abduction at the hip was measured on anesthetized living primates using a goniometer. Pelves and femora of the same taxa were laser scanned and 3D polygonal models were digitally articulated. Maximum hip abduction was modeled using PolyWorks software using strictly-defined morphological criteria for joint movement. In silico and in vivo data are strongly correlated, validating the use of digital reconstructions of hip joint mobility. Suspensory taxa have greater ranges of hip abduction than non-suspensory primates using both types of data. When these methods are applied to Miocene apes, results show that the early basal hominoid Proconsul had hip abduction similar to non-suspensory quadrupedal anthropoids, whereas the late Miocene crown hominoid Budapesticus displays hip abduction capacity comparable to suspensory extant apes and Ateles. This project provides the first evidence for suspensory abilities from the hindlimb of any Miocene ape.

IN VIVO
Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW SPECIMENS OF ELASMOTHERIIN (RHINOCEROTIDAE, PERISSODACTYLA) FROM THE NAMURUNGULE AND NAKALI FORMATIONS (EARLY LATE MIocene) OF NORTHERN KENYA

HANDA, Naoto, Kagoshima University, Kagoshima, Japan; NAKAYA, Hideo, Kagoshima University, Kagoshima, Japan; NAKATSUKASA, Masato, Kyoto University, Kyoto, Japan; KUNIMATSU, Yutaka, Kyoto University, Kyoto, Japan

The early Late Miocene Namurungule and Nakali Formations are distributed in northern Kenya. Previously, Kenyatherium bishopi is the only elasmotheriin described from the Namurungule and Nakali Formations. The Japan-Kenya joint expedition team has discovered several Rhinocerotidae fossils from these formations. We report new Elasmotheriini fossils from the Namurungule and Nakali Formations.

The specimens from the Namurungule Formation consist of a maxilla with molars (M2 and M3), a mandible with lower p4 to m2 and isolated teeth of upper P4 and upper M3. These specimens were preliminarily identified as Iranotheriinae sp. nov. The specimens from the Nakali Formation include isolated teeth of upper M1 or M2 and upper M3.

These specimens share the following diagnostic characters of the tribe Elasmotherini: crown cement, constricted protocone of the upper molars and bucco-lingually elongated postfossette of upper P4. These species are distinguished from Kenyatherium bishopi by lacking characters such as united protocone and hypocone of the molars and developed enamel folding. These specimens are characterized by lingually elongated protoloph and metaloph, undeveloped enamel folding and small crochet. These characters indicate that these specimens resemble following the middle Miocene Elasmotherini: Victoriaceros kenensis from Maboko of Kenya, and Huahingtherium lintunganse from Lintung, Shaanxi, China.

However, the specimens of the Namurungule and Nakali Formations have a small enamel plication in the medusina of the upper molars. This character is not seen in the upper molars of V. kenensis and H. lintunganse. Additionally, molar size of these specimens is smaller than those of V. kenensis and H. lintunganse. Therefore, these specimens belong to a new taxon.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

INVESTIGATING THE IMPACT OF COMPETING INTERPRETATIONS OF PECTORAL GIRDLE PLACEMENT AND APPENDICULAR FUNCTION ON SAUROPOD HEAD HEIGHT

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Previous attempts to reconstruct the posture and potential range of motion in the cervical series of sauropod dinosaurs have focused on restoring the osteological neutral position (ONP) of the axial column, and attempts to link ONP with the degree of habitual vertebral flexion observed in extant vertebrates. While placement of the pectoral girdle has met with passing discussion, the roll of differing interpretations of appendicular posture has been largely ignored.

To evaluate the impact of competing functional interpretations of the pectoral girdle and appendicular skeleton, a quantitative analysis was conducted on the three most commonly used interpretations of pectoral girdle placement in the literature, and several models of limb kinematics. Testing was carried out on a 3D digital dataset of Camarasaurus, as well as dimensionally-accurate skeletal diagrams of Camarasaurus and several other neosauropods to increase taxonomic sampling.

Results show that differing interpretations of the angle of the scapula on the body had a minimal impact on the elevation of the presacral column, while the location of the pectoral girdle had a significant impact, with more ventrally and posteriorly located pectoral girdles leading to progressively higher head height.

Published interpretations of forelimb posture in sauropods vary mostly in the orientation of the humerus and the degree of erosion in the elbow. Neither was found to have a significant impact on head height. Hind limb kinematics were found to have a larger impact on head height, as knee and ankle flexure reduced pelvic height, which in turn raised the cervical series. Differences in restoring the pes of sauropods differ markedly, from digitiigrade to plantigrade; lowering the foot into a plantigrade stance was found to increase head height.

These findings demonstrate that restoring the ONP of vertebrae is insufficient to accurately estimate head height in sauropods. Competing interpretations of pectoral girdle position and hind limb kinematics can influence the angle of the cervical series significantly, suggesting that a more holistic approach must be taken with regard to sauropod neck posture.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A NEW SPECIES OF CANID FROM THE MALAPA HOMININ SITE, GAUTENG, SOUTH AFRICA

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The recently discovered hominin bearing site of Malapa (Gauteng South Africa), type locality for Australopithecus sediba, has yielded a mammalian fossil assemblage that is remarkable in both its taxonomic breadth and preservational quality. Many of the species that have been identified from this assemblage are represented by multiple elements from single individuals -- a rarity for the South African fossil record. Numerous specimens of carnivores have also been described from the site including both large and small species. Here we examine a smaller sample of specimens that represent the second new species (after A. sediba) to emerge from the 1.977 million year old Malapa sample -- a small canid that we attribute to the genus Vulpes.

The type specimen, University of the Witwatersrand (UB) 88-812 is a right mandibular fragment that includes part of the alveolus of the p3, the complete p4 and m1, the alveoli of m2 and m3 and the entire distal portion of the mandible. The coronoid, condylar and angular processes as well as mandibular foramen and masticatory muscle insertion scars are well preserved. Another specimen (UB 88-814) is a complete right m2 crown that we believe is from the same individual. Likewise, a complete right rib (UB 88-813) from a small canid was also recovered from the same breccia block. Given the preservational state of Malapa (almost no taphonomic mixing of the sample), this specimen likely came from the same individual.

Relative to a large sample of individuals and modern and fossil Vulpes as well as other small canid genera (which can be excluded based on morphology), the new Malapa species of Vulpes is defined by the lack of distal accessory cusp on its p4, mesiodistally compressed and highly-crowned m1, large m2 and relatively small condyle. Overall, this new species is gracile with high-crowned sharp teeth, suggesting, despite its lack of accessory cusps, a tendency toward hypercarnivory or insectivory.

Romer Prize Session (Thursday, October 18, 10:15 um)

DYROSaurID CROCODyLIFORMs ATTAIN PEAK TAXONOMIC DIVERSITY AND CRANAL MORPHospace DISparity IN FRESWAtTER FOLLOWING LATE CRETAceouS LARGE MARINE TETRAPOD EXTINCTION

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The Cretaceous-Paleogene (K-Pg) boundary marked the extinction of most large marine tetrapods. While other large marine tetrapods were nearly absent in the following Paleocene, dyrosaurid crocodyliforms have been recovered from marine depositional environments from the Late Cretaceous through the Eocene, when their extinction coincides with the diversification of cetacean mammals. The lack of competition by other large marine tetrapods during the Paleocene may have enabled dyrosaurids to radiate into new habitats and occupy new morphospace. Dyrosaur fossils from the Paleocene Cerrejón Formation of South America indicate adult individuals occupied entirely freshwater with very different skull morphologies from their saltwater counterparts. Past studies of stable isotopes from dyrosaurids have indicated similar behavior to extant Crocodylus porosus which inhabits freshwater as a juvenile then moves to more saline waters with maturity. This suggests the possibility that originally saltwater dyrosaurids inhabited freshwater as adults through homoplasyic modification of ontogeny. The Cerrejón dyrosaurid fossils provide a test for the hypothesis that dyrosaurids diversified into new habitats and occupied new morphospace through paedomorphic modification in a non-marine habitat during the Paleocene. To quantify and compare fresh versus saltwater dyrosaurids, skulls of each dyrosaur species, for which nearly complete fossils have been recovered (n=10), were analyzed using geometric morphometrics and compared to the same analyses for four extant crocodylian
species (all n=20). Results of modern morphospace analyses show a significant correlation (all p<0.0001) between Relative Warp 1 (mostly variance in snout length) and size (a proxy for age). This same shift in Relative Warp 1 is seen in dyrosaurids from adult freshwater species to adult saltwater species. This similar shift is consistent with the hypothesis that dyrosaurids diversified in freshwater through retention of juvenile skull morphology. This paedomorphic shift in ontology increased diversity and disparity of Dyrosauridae during the Paleocene.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)
A SNAPSHOT OF THE ANATOMY, LOCOMOTION AND SOCIAL BEHAVIOR OF EARLY MODERN HUMANS AS EVIDENCED BY FOSSIL FOOTPRINTS AT ENGARE SERO, TANZANIA
HATALA, Kevin G., The George Washington University, Washington, DC, United States; RICHMOND, Brian G., The George Washington University, Washington, DC, United States; HARcourt-Smith, William E., American Museum of Natural History, New York, NY, United States; LiUTKUS, Cynthia M., Appalachian State University, Boone, NC, United States; ZIMMER, Brian, Appalachian State University, Boone, NC, United States
Fossil human footprints provide a rare but exciting opportunity to directly observe the fossilized behavior of our extinct ancestors. Here we report on a new late Pleistocene fossil human footprint site at Engare Sero, Tanzania. We have uncovered over 350 human footprints at the site, making it the most numerous East African hominin footprint site known to date. The footprint assemblage contains at least 24 distinct trackways and some isolated prints of multiple individuals walking on a surface of wet volcanic ash about 150 m² in area over a short period of time (hours to days). This assemblage of fossilized footprints offers a unique window through which we can directly test hypotheses regarding the foot anatomy, gait, and social behavior of early modern humans in the late Pleistocene. We conducted footprint formation experiments with the habitually unshod Dasaan tribe of northern Kenya, to aid in our interpretation of the Engare Sero fossil prints. We recruited 38 adults (19 male, 19 female) to produce footprints in soft sediment of various moisture levels, at a variety of speeds including a normal walk, fast walk, jog, and sprint (3 trials at each speed). In our experiments, we found that relative stride length (stride length/footprint length) was a significant predictor of walking velocity (least squares regression, r²=0.81, p<0.0001). We used this relationship to predict velocities from the Engare Sero footprint trackways, which ranged from about 1 to 2.2 m/s. The orientation of the fossil trackways suggested two groups, one headed northeast and the other southwest. While the six northeast-bound trackways represented a variety of speeds of travel (about 1.25 to 2.2 m/s), over a dozen southwest-bound trackways were likely formed by individuals traveling at very similar speeds (about 1.25 to 1.25 m/s). The facts that these southwest-bound individuals were moving in a common direction, at almost the same speeds, within a very short window of time, suggest that they may have been traveling together. If this group were traveling together, then the Engare Sero footprint assemblage may offer the only form of fossil evidence that can be used to directly inform hypotheses about early human group structure. We used resampling statistics and a large (n=2000) data set of modern human foot metrics to calculate the probabilities that each trackway represented foot sizes similar to those of modern men, women, or children. Our statistical results suggest the most probable scenario that the southwest-bound fossil footprint trackways were produced by over a dozen adult females and juveniles, and only one clearly identifiable adult male, who appear to have been traveling together.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)
ANALYSIS OF THE THEROPOD HALLUX FOR UNRAVELLING THE EVOLUTION OF FOOT FUNCTION
HATTORI, Soki, Nagoya University, Nagoya, Japan
Among the four pedal digits of non-avian theropods, only pedal digit I (hallux) could not reach the ground mainly because of its size relative to other digits. The presence of an opposable hallux is regarded as an important indicator of increasing arboreality because it had a crucial function in perching ability. There are, however, only a few studies of the function of the non-reversed hallux in non-avian theropods, even during cursorial locomotion. Therefore, the purpose of this study is to clarify the form and function of the hallux and foot of non-avian theropods during bipedal locomotion, based on an analysis of both extant birds and non-avian theropods. In ornithischians, sauropodomorphs and basal theropods, metatarsal I is articulated with the ankle joint like other metatarsals, but this contact is lost in more derived theropods (i.e. neotheropods). I observed several specimens of neotheropods such as Coelophysis, Allosaurus, Albertosaurus, Klaas, Citipati, Deinonychus and Troodon. The Coelophysis specimens did not provide information on the detailed structure of the pes because of their state of preservation, but all observable parts of the hallus could be seen to lie on the plantar side of the metatarsus. Metatarsal I in the other taxa has a pointed proximal end, a trochlea surface at its distal end, and deeper lateral collateral ligament fossae than medial ones. In the studied specimens of Allosaurus and Albertosaurus, this trochlea is well-developed on the flexor surface, but rounded like a ball joint on the extensor surface, and there is a mediodiaterally directed groove adjacent to this rounded joint. In Klaas and Citipati, extensor or medial views are observable but they seem to have the same features as described above. Deinonychus also has a half-rounded trochlea, but the mediodiaterally directed groove invisible. Troodon has a more unusually shaped metatarsal I, where the distal end is strongly twisted towards its extensor side. An articular facet for metatarsal II is located on the lateroplantar surface of the proximal end of metatarsal I: however, the detailed morphology of this facet varies in Allosaurus, Albertosaurus and Deinonychus. The torsion of metatarsal I, which causes completely reversed hallux and significant grasping ability, is commonly seen as a crucial difference between extant birds and non-avian theropods. However, some features such as deeper lateral collateral ligament fossae and mediolaterally directed grooves are commonly seen in both non-avian theropods and extant birds. Therefore, additional research and comparison of form and function of metatarsal I potentially enables us to understand the unique function of the hallux in non-avian theropods.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)
INTEGRATING DENTAL MICROWAVE TEXTURE ANALYSIS AND GEOCHEMICAL DATA IN AN EXTANT CARNIVORE (PUMA CONCOLOR): LESSONS LEARNED FROM MODERN ECOLOGY OF APPLICATION TO PALEOECOLOGICAL STUDIES
Haupt, Ryan J., Vanderbilt University, Nashville, TN, United States; Desantis, Larisa R., Vanderbilt University, Nashville, TN, United States
Dental microweave texture analysis (DMTA) and stable isotope geochemistry are powerful tools for understanding the ecology and palaeoecology of animals. In particular, the study of carnivores can benefit from integrating data on potential prey resources and relative bone consumption, inferred from stable isotope and DMTA data, respectively. Stable isotope geochemistry (δ13C and δ15N data from bone collagen) have shown that Florida panthers (Puma concolor coryi) subsist mainly on deer and feral hogs, but will also consume taccoons, nine-banded armadillos, and rabbits. Males were also found to have a more varied diet than females, possibly because of larger home ranges and/or less time spent at kill sites of larger prey. Previous DMTA work on extant carnivores demonstrates the ability to infer relative amounts of durophagy between extant taxa. Thus, we use DMTA of lower carnassial teeth to determine if demographic factors affect carcass utilization. We expect to see distinct differences based on sex, age, and location consistent with previous generalization data. Our results show a slight negative relationship between anisotropy (epLsr) and average ml length (R²=0.23, p=0.007) that approaches significance, indicating that bone avoidance (inferred from greater epLsr) occurs in smaller individuals. Furthermore, 8°C values are positively correlated with anisotropy (epLsr) (R²=0.42, p<0.01), suggesting differences in prey resource utilization in different environments, which was previously suspected based on the tight correlation between 8°C and 8°N values. Furthermore, no significant differences were seen between other DMTA characters and geographic variation, age, or body size. However, females do have lower mean complexity values than males (3.384 and 4.747, respectively; p=0.052) that are almost statistically significant, indicating greater processing of harder objects by males. These results suggest more complex relationships between demographics and food habits than inferred based on geochemical data. We ultimately conclude that these proxies are complementary, not identical, and can be used in tandem to explore observable distinctions and variations in dietary behavior than either proxy could alone. Lastly, when comparing P. concolor to other extant carnivores, they are statistically indistinguishable from the African lion Panthera leo (in complexity · Asfc, epLsr, and texture fill volume · Tfv) while significantly different from the cheetah Acinonyx jubatus (Asfc and epLsr, p<0.01) and spotted hyena Crocuta crocuta (Asfc and Tfv, p<0.05), consistent with observational data. Collectively, these data provide a necessary baseline understanding of an extant carnivore, allowing for comparisons to extinct carnivorous taxa in deep time.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
TESTING EVOLUTIONARY SIZE TRENDS IN THE OPHIACODONTID (SYNAPSIDA, EUPELYCOSAURIA) SKULL
HAWTHORN, Jessica R., University of Toronto at Mississauga, Mississauga, ON, Canada; Reisz, Robert R., University of Toronto at Mississauga, Mississauga, ON, Canada
Members of the synapsid family Ophiacodontidae provide the earliest record of amniote diversification, and are known from the Middle Pennsylvanian to Early Permian of North America and Europe. There is a clear trend of increasing body size within the family, from the small Middle Pennsylvanian genus Archaeothyris florensis to the much larger Ophiacodon major from the Early Permian. Increasing skull length relative to trunk length through time has also been reported within Ophiacodontidae, with the latest and largest species thought to have proportionally larger heads. Large heads are unusual among Palaeozoic amniotes, and the dimensions of the elongate, lightly constructed skulls of ophiacodontids differ greatly from the contemporaneous eupeptidosaurians; however, the apparent emergence of this highly atypical morphological trend has not previously been tested to determine if it is merely an artifact of an overall increase in body size. Elongation of the antorbital region of the skull, another trend reported within ophiacodontids, has also not previously been tested. Total skull length was regressed against presacral vertebral column length, and antorbital skull length is regressed against total skull length using log-transformed data in order to test the hypotheses of increasing skull relative to trunk length and antorbital elongation, respectively. The residuals from each analysis were plotted against stratigraphic order. The results support allometric antorbital elongation through
time for Ophiacodon, but not all ophiacodontids. The trend of increasing relative skull length through time is not supported, though this may be an artifact of the current paucity of specimens with both measurable crania and postcrania positively associated with the same individual. Evaluation of these perceived trends is critical to understanding the taxonomic diversity of ophiacodontids and constructing hypotheses of lifestyle, such as the possible adoption of a secondarily aquatic mode of life, within the family through time.

Posterior Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLGENETIC AND ONTOGENIC VARIATIONS OF BONE HISTOLOGY IN THYREOPHORAN OSTEODERMS

HAYASHI, Shoji, University of Bonn, Bonn, Germany; ZHAO, Qi, University of Bristol, Bristol, United Kingdom; WATABE, Makito, Hayashibara Museum of Natural Science, Setouchi, Japan; CARPENTER, Kenneth, Prehistoric Museum, Utah State University - College of Eastern Utah, Price, UT, United States; XU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China

Within vertebrate evolution, only thyreophorans have evolved huge and bizarrely shaped osteoderms. Their function and extreme size evolution remain controversial; possible functions include defense, display, species recognition, and thermoregulation. In this study, we explored ontogenetic and phylogenetic changes in thyreophoran osteoderm histology to shed light on the evolutionary history and functional implications of osteoderms in thyreophorans. Late juvenile ankylosaurs (Pinacosaurs) lack large postcranial osteoderms, with the exception of the cervical half-rings and small bony ossicles. This developmental delay of osteoderm formation with respect to the body skeleton is similar to living reptiles. Contrary to this, a juvenile Stegosaurus (Denver Museum of Natural History and Science 33359) already has a well-developed dorsal plate. Additionally, a histological comparison between the body skeleton and osteoderms of a growth series of Stegosaurus shows that the osteoderms continue to grow well after skeletal maturity has been reached. In terms of evolutionary heterochrony, these observations indicate preadult replacement and hypermorphosis in stegosaurus osteoderm evolution. Ontogenetic variations of thyreophoran osteoderms are observed in their cortical thickness. The thickness of collagen fiber bundles in ankylosaur osteoderms and cortical bone of Stegosaurus spikes increases from juvenile to adult. Similar histological variations are also observed throughout their phylogeny. In ankylosaurs, derived taxa exhibit more extensively developed collagen fiber bundles with respect to the primitive taxa, and in stegosaurs, thick cortical bones of spikes are seen in derived taxa, but are lacking in any primitive taxa. All thyreophoran osteoderms are comprised of metaphytic bone, but important histological differences exist between derived ankylosaur and stegosaur osteoderms. In ankylosaurs, the structural and histological features of large osteoderms (cortical osteoderms, cervical halfrings, spikes, and clubs) are similar to those of small osteoderms embedded in the skin that both have thin compact bone surrounded by cancellous bone and abundant collagen fibers. In contrast, the spike-shaped osteoderms of derived stegosaurs have a uniform structure that differs markedly from the plates in having thick cortical bone. Both spikes and plates lack abundant, thick collagen fiber bundles. This suggests that stegosaur spikes and ankylosaur osteoderms both were reinforced but by different strategies and for different purposes, i.e., protection against penetration on one hand and inflicting wounds on the other. Stegosaur plates, on the other hand, have a weaker structure due to their spongy structure and their function was more likely for species recognition, display, and/or thermoregulation.

Technical Session I (Wednesday, October 17, 11:15 am)

AN OVIRAPTORID ADULT-EGG ASSOCIATION AND THE ORIGIN OF AVIALAN REPRODUCTIVE STRATEGIES

HE, Tao, Zhejiang Museum of Natural History, Hangzhou, China; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States; JACKSON, Frankie D., Montana State University, Bozeman, MT, United States; JIN, Xingsheng, Zhejiang Museum of Natural History, Hangzhou, China; POUSt, Ashley W., Department of Integrative Biology and University of California Museum of Paleontology, Berkeley, CA, United States

Although avian reproduction is unique among living animals, some aspects derive from their non-avian theropod ancestry. Here we describe a new oviraptorid specimen from the Upper Cretaceous Nanxiong Formation of Jiangxi, China. This partial skeleton with two closely associated eggs provides insights into the theropod transition to avian reproduction. The adult is preserved in the posterior half of the skeleton (from the mid-sacral region) with the femur and left tibia showing no evidence of medullary bone. One of the long, asymmetric eggs (19.3 x 7.2 cm) lies behind the sacrum, below caudals 4-7. Ornamentation consists of linear ridges aligned with the long axis. The second egg sits between the ischia adjacent to the left side with its blunt end apparently directed caudally. The 1.0 mm-thick eggshell consists of two calcite layers, separated by a distinct and irregular boundary. Although the eggs are of similar shell thicknesses the membranes to continuous layers ratios vary significantly. The eggs belong to Elongatoolithidae, but overlapping sizes and shell thicknesses within this oofamily complicate more definitive assignment. Consistent with un laid eggs, there is no evidence of embryonic bone. The eggs’ arrangement relative to the adult parallels the occurrence of young external to and partially exiting adult ichthyosaurs. Similar extrusion of young has been observed in drowned pregnant cattle, suggesting that the eggs were fully or partially extruded post-mortem due to the buildup of decay-related gases internally. The displaced gastralia concur with an extended or exploded abdomen. The narrow fit of the egg in the pelvic canal argues against the hypothesis that theropods laid eggs in bound pouches. The blood out arrangement of the internal egg differs from the typical oviposition alignment found in most extant birds. The presence of two equal cavities suggests monovoutochorial ovulation as hypothesized for Maniraptora on the basis of within-clutch egg pairing in Troodon and oviraptorids. This iterative style of laying may have allowed production of larger eggs relative to adult body mass.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:00 am)

PALEOGENE SQUAMATES FROM THE NORTHERN NEOTROPICS: ECOLOGICAL IMPLICATIONS AND BIOGEOGRAPHIC HISTORIES

HEAD, Jason J., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; RINCON, Aldo F., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; MORENO-BERNAL, Jorge W., Department of Earth and Atmospheric Sciences, University of Nebraska-Lincoln, Lincoln, NE, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Ancon, Panama

The modern northern Neotropics possesses some of the highest diversity among extant squamates, but the sparse fossil record from this region has previously limited the ability to reconstruct their evolutionary histories. New discoveries from the early Paleogene of northern South America reveal biogeographic patterns and paleoecology of modern clades. Squamates have been recovered as components of vertebrate faunas from the early Paleocene Cerrejón Formation and late Paleocene of the early Eocene Boyún Formation of Colombia. The Cerrejón Formation represents large-scale fluvial deposits with associated rainforest flora and herpetofauna. The squamate record consists of snakes, including multiple individuals of the giant aquatic boa Titanoboa cerrejonensis and a single, poorly preserved precolosal vertebra assigned to Aniliusidea on the basis of extreme reduction of the neural spine, broadly concave dorsal margin of the neural arch and comparatively narrow zygosphene. The presence of a fossorial leaf-litter specialist provides the first for the first terrestrial component to the reptile record and indicates geographic proximity of the aquatic record to rainforest habitats within the Cerrejón Formation. The Mucumelo Creek locality in the Bogotá Formation is dated to just before the early Eocene Climatic Optimum (EECO). It represents smaller-scale fluvial deposition, and preserves a diverse squamate fauna consisting of iguanians, including the fossil record of hoplocercines, and boine, caenophidian, and ungaliophiiine snakes. The squamate record represents a forest herpetofauna. Extant tropical forest squamates undergo thermal stress at high ambient temperatures, and inferred thermal tolerances of the Bogotá squamate record may constrain temperature estimates at the beginning of the equatorial EECO. The Colombian squamate record indicates that the continental-scale biogeographic zonation of the modern northern Neotropics was established no later than the middle Eocene. Both the Bogotá and Cerrejón formations include representatives of extant clades that are either endemic or predominately South America (“anilioids”) or whose Central American distributions are limited or represent more recent immigration from South America (hoplocercines, boines). These records additionally indicate that the biogeographic events that initially assembled Neotropical squamate faunas, including New World immigration of iguanians and first occurrence of South American boines, were likely late Mesoic in age.
Ornithischian dinosaurs are plesiomorphically bipedal, with quadrupedality evolving in the course of evolution. For example, the angulas mandibulae is strongly elongated in Procerculus and the processus coronoides is upright, both indicating differences in the mandibular muscle attachment compared to modern cervids. An elongation of the skull and especially the snout can be observed in the course of evolution. Procerculus possessed upper molars, which are wider than long, and bear lingual and sometimes even labial cingula. The long, upright pedicles are a result of the relatively big orbits, differing from the more inclined and further posteriorly positioned pedicles in living cervids. All these observations suggest an adaptation to a different environment and diet than extant cervids are adapted to.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
THE CURRENT KNOWLEDGE OF TRIASSIC VERTEBRATE ASSEMBLAGES OF THE DEEP RIVER BASIN (NEWARK SUPERGROUP: CHATHAM GROUP) NORTH CAROLINA, BASED ON RECENT DISCOVERIES
HECKERT, Andrew B., Dept. Geology, Appalachian State University, Boone, NC, United States; SCHNEIDER, Vincent P., North Carolina Museum of Natural Sciences, Raleigh, NC, United States; MITCHELL, Jonathan S., University of Chicago, Chicago, IL, United States; SLOAD, Eric J., Dept. Geology, Appalachian State University, Boone, NC, United States; OLSUN, P.E., Lammont Doherty Earth Observatory, Columbia University, Palisades, NY, United States
Recent discoveries and the application of microvertebrate techniques, particularly screenwashing, at artificial outcrops (quarries) have substantially increased the known diversity of fossil vertebrates in the Deep River Basin of North Carolina. New discoveries come from all three sub-basins (Wadesboro, Sanford, and Durham) and from multiple stratigraphic horizons. The Pekin Formation in the Sanford sub-basin yields semionotids, coelacanths, temnospondyls, dicynodonts, the traversodont cynodont Boreogomphodon, and numerous archosaurs (physisaurus, a rauisuchian, Lycasuchus and two new taxa of coelurosaurs). Fossils from the overlying Cummock Formation in the Wadesboro sub-basin include redfieldiids, lungfish, metoposaurid temnospondyls, and three phytosaur skulls, two with associated skeletons. The Cummock Formation in the Sanford sub-basin yields the richest and most diverse assemblages, including redfieldiids (Cionichthys and Synichthys), semionotids, the coelacanth Diplurus, the lungfish Arganostrus, temnospondyls, the enigmatic amiote Colognathus, lepidosaurs, phytosaurs (including the type of Rapton carolinensis Emmons), a rauisuchian, the venomous archosauriform Unichitonidodon schneideri, Revueltosaurus olseni, Boreogomphodon, and the dromatheriid cynodonts Dromatherium sylvestre Emmons and Microconodon tenairosaur Emmons. The Sanford Formation assemblage is limited to trisaurodontids and a rauisuchian tooth. The stratigraphically problematic "Lithofacies Association II" of the Durham sub-basin yields additional lungfish and an exceedingly rare record (for the Newark Supergroup) of a hybodont (aff. Lissodus) in addition to the published assemblage of a temnospondylo, the rauisuchian Postosuchus allisonae, crocodylomorph Dromochusosaurus grallator, actosaurus Actosaurus, a dicynodont, and the cynodont Plinthogomphodon herpetarius. These assemblages reveal sites with both more fully aquatic (sharks, lungfish) and typically terrestrial (derived archosauromorph) taxa. The lungfish and sharks are both closely related to taxa known from western North America, Africa, and Europe, and are only found as extremely small fossils. In linear dimensions the lungfish toothplates are approximately half the size (and thus less than 4/5 the occlusal surface) of broadly contemporaneous toothplates from the American southwest, and far smaller than otherwise similar toothplates from Late Triassic deposits in Europe. Although these specimens are preserved as microparticles, the specimens reveal tubercles, indicative of juvenile morphology, others are more worn and plausibly could represent a dwarfed, endemic species. Aetosaurs, Postosuchus, sphenosuchians, and revueltosaurs are all fully terrestrial animals that are comparatively rare in other Newark Supergroup basins.
lacking a mechanical signal would exhibit either randomly oriented crystallites with regard to the outer enamel surface (OES) or homogeneity in crystallite orientation, since there would be no selective advantage to having differing orientation on different tooth surfaces. In order to evaluate these assumptions, eight shed teeth from seven extant crocodilian taxa were longitudinally sectioned and examined using a scanning electron microscope (SEM); images were taken using QuantaPCL. The images were analyzed using ImageJ to record crystallite orientation relative to the OES or enamel-dentine junction (EDJ) and statistical analyses were completed using PAST statistical software, analyzing raw angle measures and deviation from 90 degrees (calculated by subtracting measurements from 90 and taking the standard deviation). Apical enamel shows significantly different crystallite orientations from lateral enamel (defined as enamel along the labial and lingual tooth surfaces) in six of the seven taxa using the raw angle measures (Mann-Whitney U-test, p<0.0014); tests using deviation from 90 degrees returned high levels of significance (Mann-Whitney U-test, p<5E-4) in all seven taxa. The statistical program R was used to generate a random series of angles from 0 to 90 to simulate random crystallite orientation; comparison to deviation from 90 demonstrated significant values (Mann-Whitney U-test, p<5E-22) in all taxa. The hypothesis that crocodilian enamel does not exhibit a response to stress placed upon teeth is rejected; different orientations are seen in the apex where the tooth first encounters the prey item. In addition, the apex encounters the prey in a different orientation than does the lateral surface of the tooth, which may help to explain the results. However, there is no clear relationship between orientation and either trophic niche or cranial morphology. Given the unspecified nature of locations within the jaw for our specimens, detailed interspecific comparisons were inapplicable for this investigation. In order to resolve functional adaptations in crocodilian teeth, a larger dataset and continued examination is needed; we believe such work may lead to new strategies for inferring the biology of ancient vertebrates.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

THE NONAVIAN THEROPOD QUADRAT: SYSTEMATICS USEFULNESS, MAJOR TRENDS AND PHYLOGENETIC MORPHOMETRICS ANALYSIS

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The quadrate in nonavian theropods is incredibly diverse morphologically; however this morphological disparity has been underestimated for taxonomic purposes. The quadrate topological homologies and anatomy, as well as the terminology, among nonavian theropod clades are reviewed. In order to evaluate the phylogenetic potential and investigate the evolutionary transformations of the quadrate, we conducted a Catalano-Goloboff phylogenetic morphometric analysis using 3 morphometric characters, a total of 28 landmarks coded for 23 taxa, as well as a cladistic analysis using 115 characters. In quadrate-related characters coded for 43 taxa. The cladistic analysis provides a fully resolved tree mirroring the current classification of nonavian theropods. The quadrate morphology by its own provides a wealth of data with strong phylogenetic signal. Several unambiguous synapomorphies support nonavian theropod relationships and the resulting consensus tree allows inference of major trends in the evolution of this bone. Important synapomorphies include: for Abelisauridae, a lateral ramus extending to the ectocoonyle; for Fotanetanara, the absence of the lateral process; for Spinosauridae, a medial curvature of the ventral part of the pterygoid ramus occurring just above the mandibular articulation; for Neotetanurae, an anterior margin of the pterygoid flange formed by a roughly parabolic margin; and for Tyrannosauroidae, a semi-oval pterygoid flange shape in medial view. The Catalano-Goloboff phylogenetic morphometric analysis reveals two main morphotypes of the mandibular articulation of the quadrate linked to function. The first morphotype, characterized by an anteroposteriorly broad mandibular articulation with two oval/ subcircular condyles roughly subequal in size, is found in Ceratosaurus, Tyrannosauroidae and Oviraptorosauria. This morphotype allows a very weak displacement of the mandible laterally. The second morphotype is characterized by an elongate and anteroposteriorly narrow mandibular articulation and a long and parabolic/sigmoid ectocoonyle. Present in Megalosauroidae, Carcharodontosauridae and Dromeosauroidae, this morphotype permits the lower jaw rami to be displaced laterally when the mouth opened.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST REPORT OF AN ANURAN FROM THE FOSSIL BUTTE MEMBER (EARLY ECocene, WASATCHIAN) OF THE GREEN RIVER FORMATION, WYOMING

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The Green River Formation is primarily deposited in three lakes, Lake Uinta, Lake Gosiute, and Fossil Lake, during the Eocene. Although the formation is famous for the numerous exceptionally well-preserved fossils that it has produced, the remains of anurans are extremely rare with only three currently known specimens. One is an unidentified specimen preserved as a mostly carbonized skin imprint from the Wasatchian-Bridgerian Parachute Creek Member deposits of Lake Uinta. The second consists of an impression of a nearly complete, articulated skeleton of the pelobatid, _Eopelobates sp._, from the Bridgerian Laney Member deposits of Lake Gosiute. The third, and most complete, is an articulated skeleton of a new genus and species from the Wasatchian Fossil Butte Member deposits of Fossil Lake.

The new anuran was recovered from a whitish, laminated, calciticrite limestone as part (FMNH PR2384) and counterpart (held in a private collection). Most of the nearly complete and articulated skeleton is retained on the part where it is exposed in dorsal aspect. The counterpart is heavily restored and contains only a few pieces of original bone and very poor impression of the skull. The specimen is very small, with a snout-vent-length (measured from tip of snout to end of pelvic girdle) of 19.3 mm, which could indicate an immature ontogenetic age. An ossified columella and sphenethmoid are present, however, which indicates that the frog is postmetamorphic because these bones, when present, ossify after metamorphosis is completed. It is most likely a young adult, because the carpal bones are ossified but the distal tarsal bones, which generally ossify late, are not.

This anuran possesses an interesting mix of characters that initially did not readily ally it with any currently known anuran family. A phylogenetic analysis that incorporated representative constatains, anamoeocclans, and neobatrachiats was undertaken to determine its relationships. Results of this analysis places the Green River frog within Anomoeocela, as the sister taxon to Potosyminae. This clade is the sister taxon to the remainder of the anamoeocella. The clade Anomoeocela is the sister taxon of Neobatrachia, with Hadromorpha natatensia basal to this clade.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:15 am)

BONY ATTACHMENTS OF FLIGHT FEATHERS IN NEORNITHINE BIRDS: ANATOMY, HISTOLOGY AND FUNCTIONAL VARIATION

HERONYMUS, Tobin L., NEOMED, Rootstown, OH, United States; SIMONS, Erin L., Midwestern University, Glendale, AZ, United States

Attachments of the major forelimb feathers (remiges) of paravians are sometimes associated with bony features rather than movable muscular counterparts. This has in turn led to the inclusion of remigial ligament attachments to the ulna, the minor metacarpal, and the phalanges of the manus. Elevations on the shaft of the radius and ulna which are thought to correspond to remigial ligament attachments can be identified within the Nihewan Basin, specimens have been identified to the most specific taxonomic level possible. Despite a large amount of unidentifiable specimens (20.21%) and unidentifiable long bone fragments (29.32%), the analysis of identifiable specimens thus far indicates a high frequency of Equidae in addition to Elephantidae, Rhinocerotidae, and Bovidae. The high proportion of Equidae may suggest a generally open environment during the time of deposition while _H. erectus_ was moving into this new geographic area. However, further identification of the faunal specimens is required for a more specific paleoenvironmental reconstruction.
with the following observations: (1) proportionally elongate ulnae appear to be related to prominent caudal ulnar papillae; (2) rounded wing tips show a similar pattern for the ulna with the inclusion of carpometacarpal papillae; and (3) pointed wing tips seem to co-occur more often with prominent digital fossae. The distribution of bony correlates for feather attachment in neornithine wings may be due to a trade-off between primary and secondary feathers in their contribution to the second moment of area of the wing, and thus the force generated in flapping flight. Bony correlates of feather attachment provide an additional line of evidence, alongside intramembral indices and limb cross-sectional properties, that may be used to infer the shape and function of forelimb feathers in extant paravians.

The Severn Formation of Maryland (Campanian) and the Bladen Formation of North Carolina (Maastrichtian), while not strictly contemporaneous, are important Late Cretaceous vertebrate localities that have produced an abundant and diverse assemblage of terrestrial and marine vertebrates. The taphonomic condition of the teeth was often preserved; however, in some cases the teeth were broken or abraded. The taphonomic condition of the teeth was often preserved; however, in some cases the teeth were broken or abraded. The taphonomic condition of the teeth was often preserved; however, in some cases the teeth were broken or abraded.

Preparators’ Session (Thursday, October 18, 8:30 am)


HUSKO, Leslea J., University of California Berkeley, Berkeley, CA, United States; NJAU, Jackson K., Indiana University, Bloomington, IN, United States

Olduvai Gorge was first brought to the attention of paleontologists in 1913 and has since provided tremendous insight to the last two million years of vertebrate evolution in East Africa. Thousands of fossils have been recovered from this site over the almost 100 years of field work, including numerous type specimens and records of first and last appearance dates. However, due to the long history and multiple investigators, the material is scattered across numerous museums, personal collections, and countries with no comprehensive database of the material. We have developed the Comprehensive Olduvai Database Initiative with the goal of creating an electronic repository of information about these fossils that includes bibliographic information, photographs, element identification, stratigraphic context, and current repository. As of April 2012, 20 monographs and other scientific publications dating from 1934 – 1990 had been entered into the database (approximately 3,700 specimens). Data entry from published work and visits to museums holding collections are underway, including the inventory of fossils held returned to the National Museum of Tanzania, Dar Es Salaam, from the Kenyan National Museums in 2011. With the launch of the CODI website at www.olduvai-paleo.org we have initiated the second phase of the project. This relies on scientific crowd-sourcing--to draw on the knowledge of other vertebrate paleontologists to identify unpublished or underpublished material. In our presentation we will introduce the audience to the on-line database, demonstrate some of its unique features, and request assistance in covering information about fossil material from Olduvai Gorge, calling for the scientific community at-large to work collaboratively to record this information before it is lost to the passage of time.

Posters Session III (Friday, October 19, 4:15 - 6:15 pm)

SILICA INGESTION IN GRAZING BISON AND ARIDITY: IMPLICATIONS FOR MICROWEAR ANALYSIS

HOFMAN, Jonathum M., University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States

Microwear tooth analysis is used to interpret the diet and ecology of herbivorous mammals. However, microscopic wear (e.g., scratches and pits) has been attributed to both diet (i.e., plant type) and abiotic sources (i.e., exogenous grit or soil), complicating interpretations. Additionally, it is unclear whether environmental factors, such as aridity, affect levels of abiotic silica consumption and ultimately microscopic wear. To strengthen the interpretive power of microwear analysis, we have assessed the relationship between local aridity, silica consumption by grazers, and microwear features. Loss-on-ignition analyses were conducted to measure the ingested silica content (as a proxy for abiotic silica consumption) in fecal samples from two populations of American bison (Bison bison), which represent environmental extremes in relation to aridity. The Tallgrass Prairie National Preserve is a temperate grassland in southeastern Kansas with a mean annual precipitation (MAP) of 1080 mm. By contrast, the Henry Mountains Wilderness of southeastern Utah is a cold desert that experiences much drier conditions (MAP ~ 204 mm). Fresh fecal samples were collected during the dry season for each locality. Additionally, bison teeth previously collected from each site were molded and cast for microwear analysis to test for correlations with aridity and silica consumption. If local aridity affects abiotic silica ingestion (e.g., grazers in arid areas consume more soil/ sand than grazers in wetter areas), then we would expect to see a significant difference in the mean fecal silica content of the two bison populations (21.57% and 22.44% inorganic by dry weight for the Henry Mountains and Tallgrass Prairie populations, respectively), indicating no correlation between aridity and silica consumption. These results suggest that local aridity does not impact abiotic silica consumption by grazers and this environmental factor does not influence microwear. Microwear analyses of bison teeth in this regard, with only a few studies investigating the relationship further, lend insight into how microwear features are affected by environmental conditions. A better understanding of the factors affecting microwear in ungulates will ensure more meaningful interpretations in future ecological and paleoecological studies using this method.
Technical Session IV (Wednesday, October 17, 1:45 pm)

LIASSIC DAWN: PHYLETIC DIVERGENCE ANALYSIS SUPPORTS EARLY TO MIDDLE JURASSIC ESTABLISHMENT OF PRIMARY DINOSAURIAN DIVERSITY
HOZT, Jr., Thomas R., Dept. of Geology, University of Maryland, College Park, MD, United States
Recent analyses by a number of workers have yielded a significant increase in our understanding of the standing taxonomic diversity (i.e., number of taxa present per unit time) of Mesozoic Dinosauria, and these measures have been compared to changing environmental parameters (including paleogeographic and atmospheric transformations) in an attempt to study the factors which contributed to dinosaurian success. This analysis is complementary to these other efforts, as it evaluates not only standing diversity but estimates of phyletic divergence patterns within this clade.

A set of new species-level supertrees for Dinosauria have been assembled, taking advantage of the substantial numbers and scope of recent phylogenetic analyses. Unnamed fragmentary specimens are incorporated into these topologies if they represent stratigraphic and/or biogeographic range extensions of the clade in question, and are placed on the tree at the most recent possible branching time so as to reduce the duration of ghost lineages. Alternative topologies are constructed to reflect presently unresolved issues within Theropoda and Sauropoda. Standing diversity and phyletic divergence counts are counted in 5 Myr intervals over the whole of the Mesozoic; these counts are based on both standard cladistic divergence models and on alternative anagenetic alternatives (in which congeneric sister taxa with non-overlapping known stratigraphic ranges and which inhabited the same or adjacent depositional basins are counted as a single lineage with no divergence event.)

These data are then compared to geochronology and to various paleoenvironmental factors. Time bins of the late Early and Middle Jurassic epochs stand out statistically as the primary intervals for diversification: subsequent diversifications represent elaborations within major lineages established at this earlier phase. Diversification patterns do not seem to be correlated with changing oxygen or carbon dioxide levels. Weak statistical support was found for a correlation between increased levels of diversification of dinosaurs and increased sea level and decreased degree of contiguosness of depositional basins. Larger-stemmed effects strongly influence estimates of diversities for eumaniraptorans (= deinonychosaurus + avialan) clades, but not for other dinosaurs.

Expansion of these analyses to explore patterns of phyletic divergence in other terrestrial tetrapod clades (e.g., Mammaliaformes, Chordiurians, Theriodontia) could be used to examine if comparable trends exist in these groups.

Technical Session VI (Thursday, October 18, 2:30 pm)

POSTER SESSION II (Thursday, October 18, 4:15 - 6:15 pm)

On hypotheses, which are identified by other taxonomic names. As a consequence of this view, new definitions should follow the intentions of the original author in terms of which taxa are critical for inclusion and exclusion. This view of taxonomy minimizes synonymy, provides a clearer picture of the scientific purpose and application of taxonomy and nomenclature, and lends itself to practical digital applications of taxonomy.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DENTAL MICROWEAR IN THE MAASTRICHTIAN MOSASAUR CARINODENS BELGICUS
HOLWERDA, Femke M., Faculdade de Ciências e Tecnologia da Universidade Nova de Lisboa, Portugal & Museu de Lourinhã, Lisbon, Portugal; BEATTY, Brian L., New York College of Osteopathic Medicine, Old Westbury, NY, United States; SCHULP, Anne S., Natuurhistorisch Museum Maastricht & VU University Amsterdam, Maastricht, Netherlands

Teeth of the small dophagous mosasaur Carinodens belgicus are known from the Maastrichtian of the North- and South-American, and the Tethyan realm. Its peculiar dentition inspired debate and speculation on its dietary niche ever since its first description almost a century ago. New discoveries in recent years allowed for a more detailed evaluation of its feeding preferences. Biting performance of Carinodens has been modeled in a previous study, which helped bracket the dophagous diet options within reach of this taxon; stable isotope analysis of tooth enamel suggests a shallow marine/shoreline foraging. In this contribution, we studied the dentition of Carinodens for microwear patterns on the apical and lateral enamel wear facets so as to further (and independently) evaluate the possible feeding behavior and diet of this animal.

The study focused on five well-preserved isolated teeth from the type Maastrichtian. Macroscopically, wear was observed on the apex and on the mesiodistal side; microwear was observed using SEM at several magnifications. Scratches were largely bimodal in size and shape. These scratches were categorized as fine and coarse. Measurements of each of these scratch orientations were made along the mesiodistal axis. Coarse scratches were found to be the most common pattern and pits are relatively rare. More detailed analysis was conducted across the mesiodistal plane. Coarse scratches were the most common pattern and pits were the least common. The orientation was primarily along the mesiodistal plane or in the labiobuccal plane with an angle of ~130°.

In general, these microwear features are most likely explained by either mastication or abrasion by sediments or food. As scratch width only indicates the minimum width of the abrasion particle, the material causing the wear here could have ranged from silica-based sands to larger abrasives. However, in this case, abrasion by sediments might not explain this wear, because the type Maastrichtian sediments are predominantly carbonate; quartz silicislastics are virtually absent. Therefore it is most likely that hard food particles, such as benthic organisms with hard exoskeletons, caused the wear on the enamel of Carinodens. One might speculate whether these were the intended diet of Carinodens or rather an unavoidable result of feeding on benthic macroalgae; however, the carnivorous nature of related taxa as well as the stable isotope signal as recorded in the teeth leave predation on larger benthic prey items the most likely explanation.

The mesiodistal and labiobuccal directional of the microwear scratches might suggest that Carinodens showed more complexity in the use of its teeth than simple grasping, and that a gripping and pulling motion during feeding akin to that employed by modern varanids may have been the case.
other three groups, using dental characters, has been conducted. Most results produce a monophyletic Pseudorhynchoconeidae, including ‘P’. leveli and Diaphylopectes, which were previously regarded as European leptics. Palaeonodons nest within Leptics, whilst pantolestans are unstable in position, relating either to Leptics + Palaeonodonta or to Pseudorhynchoconeidae. The pattern of relationships suggests European endemism for the Pseudorhynchoconeidae from early in the Palaeocene and a probable North American origin.

Technical Session VIII (Thursday, October 18, 2:00 pm)

FAUNAL HETEROGENEITY IN BARSTOVIAN MAMMALS OF THE NORTHWEST: WHAT DOES FAUNAL DIVERSITY TELL US ABOUT TECTONICS AND HABITAT DIVERSITY?
HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; MAGUIRE, Kaitlin C., University of California, Berkeley, Berkeley, CA, United States; MCLAUGHLIN, Win N., University of Oregon, Eugene, OR, United States

The Middle Miocene contains the greatest diversity of North American mammals since the Eocene, and possibly the greatest in the history of mammals. This period has drawn extensive interest in studies of ecological evolution, of the role of climate in the generation of diversity, and of the impact of immigration events on diversity. Many of these studies, however, have focused on the tectonically quiescent Great Plains. Efforts to understand the role of tectonic activity in diversity generation have come to differing conclusions about whether the diversity of the Great Basin is greater than the Great Plains in the Middle Miocene, confounded somewhat by differences in publication bias and sampling and in the methods applied to correcting for these biases. Our collecting and taxonomic efforts in the fossil record of Oregon have improved the completeness and consistency of sampling and taxonomy across many localities with highly divergent publication histories, so we have a superior sample with which to address the diversity of mammals in Oregon at a variety of scales. We compare all the Barstovian sites in Oregon and Northern Nevada using presence-absence and relative abundance data to determine the diversity patterns within and between collecting areas. In looking at the differences among sites, we find that the faunal heterogeneity in the Barstovian of Oregon is remarkably high, almost certainly greater (perhaps substantially so) than that found in the same time period in the Great Plains. This diversity seems to represent habitat heterogeneity in Oregon in the Middle Miocene, rather than simple isolation and local adaptation. The diversity of supported habitats is to be expected in a tectonically and topographically complex landscape, but finding fossil evidence in support of this expectation shows us the quality of the ecological samples available in this well-preserved time period. This habitat heterogeneity is visible even within a single lithostratigraphic unit, as illustrated by the diverse faunal affinities of mammals from the Mascal Formation. This result makes sense in light of the suggestions of earlier workers that the diversity of mammals in the Mi-Mioocene is maintained in part by a remarkable diversity of habitats during the Barstovian.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

STURGEON DORSAL OSTEODERM ONTOGENY: A TRANSFORMATIONAL MODEL FOR MARGINOCEPHALIAN SQUAMOSAL ORNAMENTS
HORNER, Vanessa S., Ohio State University, Columbus, OH, United States; HORNER, John R., Museum of the Rockies, Bozeman, MT, United States

The squamosal and parietal border ornaments of Triceratops (episquamossals and epiparietals) and Pachyrhinosaurus (squamosal spines and nodes) are hypothesized to undergo marked changes during ontogeny that includes a period of expansion and elongation proceeded by a period of reduction and shape change. A late-stage morphological shape change of a mineralized ornamental structure is highly unusual, and has led to recent arguments suggesting Stygimoloch to be an unlikely ontogenetic phase of Pachyrhinosaurus. To evaluate the possibility of such a transformation, we undertook a survey of vertebrate taxa in search of ossaceous ornamental structures that both expanded and reduced in height or length during ontogeny. One candidate was found, the midline dorsal osteoderms of sturgeons (Acipenseridae), reported to grow dorsoventrally to sharp, pointed structures in juveniles, and then flatten dorsoventrally and widen as the animals reach maturity. Osteohistologic studies were undertaken of a series of sturgeon (the extant taxon Scaphirhynchus platorynchus) and an extinct taxon, Acipenseridae indeterminate from the Late Cretaceous (Hell Creek Formation) dorsal osteoderms to determine the process involved in height reduction. The results indicate that osteoderm transformation in the sturgeon is similar to the processes hypothesized to alter the marginocephalian ornaments even though the overall microstructure of these ornaments are quite different. As hypothesized for the marginocephalian ornaments, size reduction of sturgeon dorsal osteoderm ridges coincide with a phase of osteoclastic resorption, revealed by a scalloped texture on the external surfaces near the apex of the ornaments. These scallops match the size of osteoclast cells. As osteoclasts removed mineralized tissues from the ornament apex the tissues were apparently redistributed around the periphery of the base, essentially giving the structures a flattened appearance. This study shows that although ontogenetic ornamental height reduction is unusual, it is not unknown. As hypothesized for the marginocephalians, the ornament height reduction phase in sturgeons most likely visually signals the onset of maturity.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NEW PERMIAN AND TRIASSIC VERTEBRATES FROM TURKEY (SE ANATOLIA)
HOSGOR, Izet, TransAtlantic Exploration Med. Int. Pty. Ltd. - Viking Int. Ltd., Ankara, Turkey; FORTUNY, Josep, Institut Català de Paleontologia, Cerdanyola del Valles, Spain

Permain and Triassic vertebrates from Turkey are poorly known. From the Middle-Late Permain actinopterygians and tetrapod footprints were previously reported whereas chondrichthyes and actinopterygians are known from the Lower Triassic. Herein, we report new results from southeastern Anatolia. Recent fieldwork in this area has provided new vertebrate remains from the Middle-Late Permain of the Tanin Group and Early Triassic of the Çigili Group, including the first occurrence of temnospondyls in Turkey. From the Tanin Group a semi-articulated specimen is here referred to Branchiosauridae, and probably represents a new taxon. The skull proportions and the high degree of ossification of the postcranial elements are indicative of an adult specimen. This clade is well known from the Early Triassic of Central Europe and Saudinia. Early Permian fauna in Siberia, the genus Tungussaurus was described in Late Permain-Early Triassic sediments but its affinity with Branchiosauridae is controversial. The finding of a new taxon of Branchiosauridae in the Middle-Late Permain of SE Turkey has important paleobiogeographical implications, revealing a general distribution for branchiosaurids, and will help to understand the evolutionary history of the group.

From the Early Triassic of the Çigili Group, several teeth were recovered, mostly assignable to actinopterygians, whereas a single tooth belongs to a hybodontiform shark (Chondrichthyes). An additional dental bone with external ornamentation is referred to an indeterminate stereospondyl temnospondyl.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

FIRST OCCURRENCES OF FELIDAE AND CANIDAE (MAMMALIA: CARNIVORA) FROM THE CHITING FORMATION (PLEISTOCENE) OF SOUTHWESTERN TAIWAN
HU, Huai-Pin, South Dakota School of Mines and Technology, Rapid City, SD, United States; PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States; MARTIN, James, South Dakota School of Mines and Technology, Rapid City, SD, United States; WU, Ming-Chee, National Cheng Kung University, Tainan, Taiwan (Republic of China); FANG, Jiann-Neng, National Taiwan Museum, Taipei, Taiwan (Republic of China)

Taiwan contains abundant, diverse, and unique Pleistocene paleofaunas that have been virtually undescribed outside of the Taiwanese, Chinese and Japanese literature. Pleistocene fossils are derived from two main sources. The “Penghu Fauna” consists of remains dredged from the Penghu Channel in the Strait of Taiwan. The “Chochen Fauna” is a diverse assemblage of mammals collected at various exposures in the city of Tainan, southern Taiwan. Mammalian constituents include the families Felidae, Canidae, Rhinocerotidae, Suidae, Cervidae, Bovidae, and the orders Primates and Rodentia. Absolute dating of the Chiting Formation sediments has yet to be accomplished. Specimen NTM 104005, a partial cranium of a large pantherine felid, closely related to Panthera tigris, housed at the National Taiwan Museum, was recovered from the middle Pleistocene Chiting Formation near Chochen, Tainan City, Taiwan. This specimen allows for the most complete comprehensive description of a large felid specimen from Taiwan, and is one of the most complete Pleistocene specimens from southeastern China. Specimen NTM 104005 is characterized by overall cranial size intermediate between that of the earliest Pleistocene species Panthera zdanskyi and modern P. tigris, thereby confirming previous interpretations suggesting an increase in size within Panthera throughout the Pleistocene. Additional diagnostic features include massive zygomatic arches with pronounced, laterally extended mandibular fossas, an extremely well developed sagittal crest with a thickened anterior flare, and a slender braincase and occiput. The specimen TCTM OL 0002, housed at the Tainan City T’sai-Liao Museum, consists of an incomplete portion of the dorsal skull of Nyceretace. The braincase and part of the orbital and rostral regions are preserved, including the frontals, parietals, occipitals and portions of the maxillaries. The ventral portion of the braincase is broken. The tetradiasternal narrowing of the orbital region, the elongate braincase, the posterior flaring and vertical posterior surface of the occipital region, and the split sagittal crest are typical of Nyceretace. These carnivores no longer exist in Taiwan, and their Pleistocene record in southern China is surprisingly limited in comparison to their common appearance in northern China.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EQUUS SPECIES RICHNESS IN THE RANCHOLABREAN OF THE SOUTHEASTERN U.S. COASTAL PLAIN: A QUANTITATIVE ANALYSIS OF ISOLATED CHEEK TEETH
HULBERT, Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States

Fossils of Equus are very abundant in Pleistocene deposits in the southeastern USA, but consist primarily of isolated teeth and postcranial skeletal elements, not the complete skulls and mandibles favored by equid systematists. Previous workers, using relatively small sample sizes, recognized at least two and more often three ontogenetic species of Equus of differing body and tooth size throughout this region during the Rancholabrean land mammal age. To answer the most basic systematic question, how many species were present...
in this region during the Rancholabrean, standard measurements were taken on over 2000 cheek teeth. Univariate and multivariate statistical analyses were used to determine if either the two- or three-species hypotheses was supported, or if an alternative hypothesis best explained the results. Each of the 12 cheek teeth (P2–M3 and p2–m3) was analyzed separately. Each sample was divided into four wear-stage categories by the amount of remaining crown height on each tooth relative to unerupted specimens, with boundaries at 75, 50, and 25 percent of unerupted crown height. The results of the analyses support the presence of only a single morphospecies of Equus in Florida and the coastal regions of Georgia and South Carolina (FL/GA/SC) during the Rancholabrean. In this region, the coefficient of variation (CV) for tooth lengths and widths for the 12 samples range between 6 and 9, while the CVs decrease to 4–8 when the samples are partitioned into wear stages. These, along with the observed ranges of these variables, are of similar magnitude as those found in well-established extant and fossil species of Equus. With few exceptions, teeth from Louisiana and Mississippi represent a morphologically similar, but much larger taxon (by about 25%) than the one found in FL/GA/SC. Samples from the intervening area in Alabama, southwestern Georgia, and western Florida remain to be analyzed to determine if there is an east to west size gradient, or a sharp boundary of demarcation between the populations of Equus in the two regions. Further work on other systematically important elements, especially metapodials, will test this novel single-species hypothesis for FL/ GA/SC Rancholabrean Equus. Based on dental characters, such as protocone shape and relative length, shape of the metaconid-metastylid complex, and depth of the ectoflexid, the FL/GA/SC taxon belongs to the caballine species-group (i.e., Equus caballus and close relatives). These results are in broad agreement with studies of ancient DNA that a single, geographically highly variable species of caballine Equus ranged across the Americas and Eurasia in the late Pleistocene.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 10:15 am)

EVALUATION OF DYNAMICS OF LARGE BODY SIZE IN NON-AVIAN DINOSAURS

Hunt, Gene, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; Fitzjohn, Richard, University of British Columbia, Vancouver, BC, Canada; Carrano, Matthew T., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States

With body masses spanning at least five orders of magnitude, non-avian dinosaurs have only recently attracted the attention of scientists interested in the dynamics of body size evolution. Using femoral length as a proxy for overall body size in dinosaurs, we apply several statistical models to explore its evolution in a phylogenetic context. Targeted comparisons of regression models can be used to shed light on aspects of body-size evolution, and here we focus on two issues: (1) the pervasiveness of directional trends, and (2) the presence of detectable upper limits for body size. Directionality was assessed by comparing the fit of the non-directional model of Brownian motion (BM) to a scenario of BM with an underlying trend. Results indicate support for a trend of increasing body size (“=Cope’s rule”) in some, but not all dinosaur clades. To assess the macroevolutionary evidence for an upper limit to dinosaur body size we compared fit of the BM model to that of BM in the presence of reflecting boundaries that forbid body sizes larger than a specified value. This latter model was fit using a novel likelihood function, and its improvement in fit relative to BM was judged using a likelihood ratio test with the null distribution generated by simulation. These analyses have found strong evidence for an upper limit to body sizes in theropods but not sauropods or ornithopods.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 10:15 am)

ORIGIN OF THE GREATER ANTILLEAN PRIMATE FAUNA

Hunt, Kevin D., Indiana University, Bloomington, IN, United States; Kay, Richard F., Duke University, Durham, NC, United States

The timing of arrival and means of dispersal of primates in the Greater Antilles has been the subject of continued debate, mirroring the same debates for other taxa of vertebrates. Some suggest that there was a single ancient (Oligocene-Early Miocene) vicariant arrival of primates, cloths, and rodents from South America. Others argue for an alternative scenario calling for multiple cross-water dispersal events of some or all of these taxa, not necessarily at the same time. Recovery of new cranial, dental, and postcranial specimens of Antilleania together with added data from other Antillean taxa Paralouatta and Xenothrix prompts a revised phylogenetic analysis to explore these different models. A ‘GAARlandia’ vicariance model proposes arrival by 32 million years ago. Molecular models of extant platyrhine cladogenesis suggest that the oldest crown platyrhine lived between 21 and 24 Ma. So, if Antilllean primates cluster as a platyrhine taxon, the vicariance model would be supported. Alternatively, if different taxa link with one or another of three crown platyrhine clades (Atelidae, Pitheciidae, and Cebidae) overwater dispersal would be a more likely scenario. Our phylogenetic analysis suggests first, that the extinct Antillean taxon belong to the crown clade and, second, that they are not a monophyletic group. These finding lend support to the hypothesis that primate reached the Antilles by overwater dispersal and subsequently dispersed between the islands either overwater or by vicariance.

Technical Session X (Friday, October 19, 9:15 am)

BODY SIZE EVOLUTION IN PERMO-TRIASCIC EURHODONTIDS AND THE EFFECTS OF THE END-PERMIAN MASS EXTINCTION

Huttenlocker, Adam, University of Washington, Seattle, WA, United States; Sidor, Christian A., University of Washington, Seattle, WA, United States; Bothia-brink, Jennifer, National Museum, Bloemfontein, South Africa

The “Lilliput effect,” a temporary decrease in body sizes of daughter lineages observed in post-extinction communities, may be a pervasive feature of mass extinctions. Such reductions have been identified following the end-Permian extinction (ca. 252 Ma) in Triassic marine invertebrates and anecdotally in South African temnospondyls and nonmammalian therapsids. Here, we quantify patterns of body size evolution in Permian to early-Middle Triassic eurhodontians, an ecologically varied therapsid clade that outnumbered contemporary dicynodont herbivores in terms of species richness during the earliest Triassic and eventually gave rise to mammals. We address the question: Were there significant body size decreases in Eurhodontia and its subclades following the end-Permian extinction? Basal skull length (Bsl) as well as femur and humerus midshaft diameter were used as proxies for relative body size. Preliminary analysis on measurements from more than 343 eurhodont specimens suggests large maximum body sizes (Bsl > 300 mm) and increasing size disparity in Late Permian Cistecephalus and Dicyonodon assemblage zones, followed by a decrease in cranial size disparity with smaller maximum and median sizes in the Triassic Lystrosaurinae Assemblage Zone. Our findings corroborate earlier results on Bsl in the Permio-Triassic (P-Tr) therapsidian genus Moschorhinus, which suggested significant within-lineage cranial size reductions in a P-Tr survivor lineage. More general patterns corroborate significant decreases in Bsl and limb bone dimensions in eurhodontians as a whole. Finally, to account for the effects of longer term phylogenetic trends, it is necessary to recognize potential phylogenetic constraints on observed body size patterns. In other words, are apparent body size trends stochastic or “driven” and, if driven, are they explainable by extrinsic processes (e.g., selective pressures) acting on body size distributions during the P-Tr transition? We explore statistical approaches including (1) regression on dissimilarity matrices (Mantel tests) and (2) model-based tree randomization procedures in order to identify the extent to which size distributions are explainable by phylogenetic distance and tree structure. Our null prediction is that size shifts are stochastic and tree structure should be more similar in size than phylogenetically disparate clades). However, initial results from Mantel tests indicate that size disparity correlates poorly with pairwise phylogenetic distance within the therapsidian subclade. Alternatively, if extrinsic factors accelerated rates of life history evolution across clades, then observed size distributions should show significant anti-signal in earliest Triassic clades.
Discriminating in situ from transported eggshell assemblages further our understanding of nesting behaviors, and predator-like or scavenger-like actions. Previous research suggested that one could assess the transport of skeletal assemblages by comparing the clast size of associated sediment with the quartz equivalent diameters of represented fossil bones. If bones and matrix sediment share similar transport properties, they may have experienced synchronous deposition. This work explores the applicability of this approach to eggshells and their fossil assemblages. We used three models based on empirically derived sediment-transport equations to estimate flow competence for eggshell deposition, and the performance of each model was tested using repetitive laboratory flume trials. Values of critical shear stress at deposition (τbc) of chicken eggshell fragments were 1/4 to 1/2 of the whole shell were estimated using three models. Model 1 estimates τbc from eggshell volume, model 2 from eggshell density, and model 3 from eggshell settling velocity. These new data demonstrate that early crocodylomorph disparity was included an upright stance, small body size (<100 kg), and are interpreted to have been a variety of ecological roles prior to the end-Triassic extinction, resulting in specialized posture relative to each other and a sciell-like action, as usually assumed. A comparison can be made with the cookiecutter shark, Isistius brasiliensis, which uses its lower teeth to cut pieces of flesh from the flanks of much larger prey, but with a circular, rather than a linear, motion of its head. E. minor and E. heinrichi differ from E. newtoni in having less curved tooth whorls. This could have been an adaptation to allow them to reduce swimming drag by closing their jaws, but to effectively slash prey with their jaws open. The prey must have been massive, so as not to have been pushed out of the way rather than sliced, as a tooth row of E. minor and E. heinrichi is so close together that little or no wear is observed on the teeth of these species. The prey might have been large, soft-bodied invertebrates, such as large jellyfish or nonspherical cephalopods, or something without a modern analog. The large, presumed upper, tooth whorls of E. heinrichi and E. giganteus (probably a junior synonym of E. heinrichi) seem more massive than needed to hold the teeth. The large mass might have been used to increase the force of a downward slashing motion, with the assistance of its strong neck, which was more robust than that of the other species. The increased mass shows moderate wear to the serrations of the older teeth, presumably due to use in feeding, and significant damage to the posterior edges of two adjacent teeth. The origin of the damage is not known (and might even be postmortem breakage), but if it were caused by occlusion with the opposing dentition of the same individual, other scratches would be expected.

Technical Session IX (Friday, October 19, 9:45 am)

THE EVOLUTION OF EARLY CROCODYLOMORPH DISPARITY AND LOCOMOTOR STYLES: NEW EVIDENCE FROM THE LATEST TRIASSIC OF NEW MEXICO
IRMIS, Randall B., Natural History Museum of Utah and Dept of Geology & Geophysics, University of Utah, Salt Lake City, UT, United States; NESBITT, Sterling J., Department of Biology, University of Washington, Seattle, WA, United States

Crocodylomorphs are the only pseudosuchian lineage that survived the end-Triassic extinction. The bauplan of most early Mesozoic non-crocodiform crocodylomorphs included an upright stance, small body size (<100 kg), and are interpreted to have been generalist faunivores. Consequently, early crocodylomorphs are often stereotyped as all conforming to these characteristics, defining a single ecological role that did not vary significantly from the Late Triassic to Late Jurassic. The type species of E. newtoni, which was reexamined for this study, shows moderate wear to the serrations of the older teeth, presumably due to use in feeding, and significant damage to the posterior edges of two adjacent teeth. The origin of the damage is not known (and might even be postmortem breakage), but if it were caused by occlusion with the opposing dentition of the same individual, other scratches would be expected.

Posters Session I (Wednesday, October 17, 4:15 - 6:15 pm)

EGGSHELLS AS SEDIMENT: A FLUME STUDY TO DETERMINE THE APPLICABILITY OF SEDIMENT-TRANSPORT EQUATIONS TO EGGSHELLS
IMAI, Takuya, Montana State University, Bozeman, MT, United States; EVANS, Thomas, Montana State University, Bozeman, MT, United States; CAHOOIN, Joel, Montana State University, Bozeman, MT, United States; VARRICCHIO, David J., Montana State University, Bozeman, MT, United States

The function of the paired upper and lower symphseal tooth whorls of the Carboniferous chondrichthyan genus Edestus is obscure. A Pristis (sawfish) rostrum-like function to disable small prey with a slashing motion, suggested by others, seems inefficient with the teeth arranged as they are. Grazing or cutting prey between the paired tooth whorls with a pincer- or scissors-like action would be hindered by the curvature of the valves, which prevents the occlusion of more than a few teeth. This is particularly evident for Edestes newtoni, where the tooth whorls form nearly a half circle. The anterior teeth would be nonfunctional, but would exact a cost in added mass and drag. The serrated edges of Edestus teeth seem adapted to slicing flesh, so as to disable prey and possibly to slice it into pieces. I propose that such a slicing action was carried out with a vertical motion of the head, with the teeth fixed relative to each other, a sciell-like action, as usually assumed. A comparison can be made with the cookiecutter shark, Isistius brasiliensis, which uses its lower teeth to cut pieces of flesh from the flanks of much larger prey, but with a circular, rather than a linear, motion of its head. E. minor and E. heinrichi differ from E. newtoni in having less curved tooth whorls. This could have been an adaptation to allow them to reduce swimming drag by closing their jaws, but to effectively slash prey with their jaws open. The prey must have been massive, so as not to have been pushed out of the way rather than sliced, as a tooth row of E. minor and E. heinrichi is so close together that little or no wear is observed on the teeth of these species. The prey might have been large, soft-bodied invertebrates, such as large jellyfish or nonspherical cephalopods, or something without a modern analog. The large, presumed upper, tooth whorls of E. heinrichi and E. giganteus (probably a junior synonym of E. heinrichi) seem more massive than needed to hold the teeth. The large mass might have been used to increase the force of a downward slashing motion, with the assistance of its strong neck, which was more robust than that of the other species. The increased mass shows moderate wear to the serrations of the older teeth, presumably due to use in feeding, and significant damage to the posterior edges of two adjacent teeth. The origin of the damage is not known (and might even be postmortem breakage), but if it were caused by occlusion with the opposing dentition of the same individual, other scratches would be expected.

Posters Session II (Thursday, October 18, 4:15 - 6:15 pm)

FUNCTION OF THE SYMPHSEAL TOOTH WHORLS OF EDESTUS
ITANO, Wayne M., University of Colorado Museum of Natural History, Boulder, CO, United States

Chondrichthians from the Middle Permian of Russia
IVANOV, Alexander, St.Petersburg University, St.Petersburg, Russian Federation

The Middle Permian chondrichthians are poorly known in Russia but a new collection from the Kazanian deposits of the East European Platform and CIS-Urals demonstrates a taxonomic diversity of sharks. The isolated teeth of ctenacanthiform Glikmanianus occidentalis and londichid "Lissodus", and fin spines and teeth of a new sphyacanthid were found in the Kazanian localities of the Vyrm River Basin, Komi Republic. The teeth of symmoriform Stehacanthus altokensis and anachronistic Coelacanthus amazonsis, polyacrodontid teeth indented as a soft genus, and various elasmobranch scales have been recovered from the borehole in the Vladimir Region, from the Chimbulak quarry in the Kirov Region, from the Kotlovka locality at the Kama River in the Perm Region, and from the Pechische locality at the Volga River in the Tatarstan Republic. A block containing a fragment of jaw cartilage, teeth, and scales from one individual of the new sphyacanthid also occurs at the Pechische site. The impression of a hybodontiform caudal fin skeleton was reported from the Kazanian locality at the Kama River. The occurrence of Coelacanthus amazonsis in the Middle Permian (Roadian) on the west side of the Guadalupe Mountains, West Texas supports a relation between the Delaware Basin and the Kazanian Basin during the Middle Permian previously suggested based on brachiopod data. The diversity of chondrichthyan assemblages in the East European Platform and Uralis decreased from the Early to Late Permian. The most diverse assemblage from the Artinskian of the Urals includes various sminiaformians, ctenacanthiforms, elasmododonts, scaphactodonts, eduids, petalodontiforms, orthodontiforms, and coelacanthiforms. The sphenacanthids, polyacrodontids, anachronistids are common in the Kazanian assemblage. The Late Permian (Tatarisan) assemblage of Russia is represented by the abundant sphenacanthids and polyacrodontids, rare ctenacanthiform and menaspids.

Posters Session II (Thursday, October 18, 4:15 - 6:15 pm)

CONTROL OF HAZARDOUS PARTICULATE EXPOSURE DURING FOSSIL PREPARATION THROUGH THE USE OF LOCAL EXHAUST SYSTEMS
JABO, Steven J., Smithsonian Institution, Washington, DC, United States; KROEHLER, Peter A., Smithsonian Institution, Washington, DC, United States; MAKOS, Kathryn A., Smithsonian Institution, Washington, DC, United States; PETERS, David M., Smithsonian Institution, Washington, DC, United States

Preparation of fossils for scientific study involves a variety of chemical and physical methods to remove the rock matrix surrounding the specimen. The matrix may contain several elements, depending on the tissue and species of the organism. Preparative studies on this system towards the preparation for inhalation of airborne particulates generated during physical preparation. The elements of most concern to health (due to carcinogenicity and progressive pulmonary disease) include respirable-sized particles of crystalline-free silica, asbestos fibers, and radioactive particles. A local exhaust ventilation (LEV) system was installed in the National Museum of Natural History’s Vertebrate Paleontological Preparation Lab to reduce staff exposures. The LEV consisted of six capture (snorkel-type) hoods on flexible ducts, the LEV consisted of six capture (snorkel-type) hoods on flexible ducts, the LEV consisted of six capture (snorkel-type) hoods on flexible ducts, the LEV consisted of six capture (snorkel-type) hoods on flexible ducts.
connected to hard ductwork leading to a combination High-Efficiency Particulate Air filtered cyclone plus bag house dust collector. The flexible LEV hoods are easily positioned over the rock matrix work area for efficient removal of preparation generated particles and vapors from associated chemicals. Analysis of personal exposure (breathing zone air) samples collected during various representative tasks associated with the preparation of vertebrate paleontological specimens indicated that use of the LEV both reduced and controlled staff exposures to silica-containing dust to within permissible exposure limits established by the U.S. Occupational Safety and Health Administration. Redesign of the ductwork is needed to reduce excessive sound pressure levels, which currently necessitate hearing protection for comfort over prolonged work periods. The use of respirators is not required when using this LEV system, although staff is still enrolled in the Institution’s respiratory protection program for use when working in field conditions or at other sites without the benefit of local exhaust.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEARLY COMPLETE TURTLE (TESTUDINES: EUCRYPTODIREE) FROM THE UPPER JURASSIC OF CENTRAL GERMANY, AND ITS PALEOECOLOGY JANIS, Maren, Leibniz-Institut für Evolutions- und Biodiversitätforshung, Berlin, Germany; KLEIN, Nicole, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, University Bonn, Bonn, Germany

Late Jurassic turtles from Western Europe are frequent finds in sediments representing fluvial to lagoonal and marine environments. However, those turtles show a mixture of basal and derived characters, which makes it difficult to interpret their habitat preferences and life style. The overall morphological description of the Upper Jurassic fossil turtles of the Langenberg Quarry, Oker, Lower Saxony, Germany, gives further insight into the paleoecology, as well as the distribution of known taxa, and indicates a possible endemic Late Jurassic turtle fauna of Oker. Two skulls, a nearly complete, articulated specimen, as well as isolated shell plates and postcranical bones could be assigned to Plesiocheleidae, Thalassemydidae, as well as one previously undescribed encydopodire taxon. The small but nearly complete specimen (FV 853), still in situ in sediment matrix, was scanned using computer tomography, morphologically described in detail, and compared with extinct and extant turtles. The combination of basal characters, such as the development of the pygal region, with derived characters, such as the lesser ossified bridge region between carapace and plastron, define the specimen as derived relative to Plesi-chevron. However, a definite assignment is difficult, due to the ontogenetic stage of FV 853. Several character define FV 853 as juvenile: the small size (7.28 cm carapace length) of the specimen, the grade of ossification of the skull elements and preserved limbs, as well as the large lateral carapacial fontanelles that surround the costals. Furthermore, the sculpturing of the vertebral centra, which was previously seen as either a character shared only between plagiosaurs and taxa or an unrelated juvenile feature, can now be confirmed as a juvenile character for both pleurosternid taxa and encydopodire taxa. Aside from these juvenile characters, FV 853 shows clear aquatic adaptations. Forelimb ratios of the specimen and various other Mesozoic encydopodire turtle taxa were compared to an existing study of selected extant cryptodires, which had shown that these ratios reflect habitat preferences independent from ontogenetic stages. The specimen plots together with freshwater turtles and more moderately to fully aquatic turtles, indicating it inhabited the nearshore to offshore area of the coastal region. Since the locality is interpreted as representing a shallow marine environment in a coastal region with periodic expansions and regressions, it is reasonable to expect a higher degree of aquatic adaptation during transgressive periods. Other Mesozoic turtles of Western Europe with similar morphologies and supposed lifestyles support this conclusion.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 12:00 pm)

FOSSIL VERTEBRATES FROM NEOTROPICAL LATITUDES: A VAST RECORD WAITING TO BE DISCOVERED JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama, Panama

The tropical region of South America (Neotropics) is a vast place, ~8 million km², similar in area to USA, and plays a major role on global climate, carbon and fresh-water budgets, and global weathering rates. It also contains the highest biodiversity on Earth, of both plants and animals. The history of the Neotropical is essential for understanding the evolution of the tropical ecosystem. How this high diversity was achieved, how it has been maintained, and how it has responded and will respond to major environmental crises still remain central questions in ecology and evolutionary biology. Compared to its massive size, there have been very few studies focused on understanding the evolution of its climate and biota. However, the lack of studies is not the product of poorly preserved fossils but rather a result of researchers working in rather isolated areas. In the last decade, we have been working in seven different Neotropical localities (both Panama and Colombia), including the lower Cretaceous of Zapataca, the Maastrichtian coal mines of Guaduas, the Paleocene coal mines of Cerrejon, the late Paleocene-Eocene early Bogoleta formation, the late Oligocene-early Pliocene of Panama, the Middle Miocene La Venta, and the Miocene-Pliocene Castillejas formations. The overall vertebrate fossil record indicates 1) Tropical mean annual temperature (MAT) is not stable. Estimates using both a stage paleothermometer in Cerrejon and biomarkers (TEX86) indicate that MAT during the late Paleocene was ~2°C Celsius, 1.5 Celsius higher than modern tropical temperatures. 2) MAT during the Early Eocene reached ~32-33 Celsius, and yet neither the mammoth fauna/ flora of Bogoleta formation shows a collapse as some global climatic models had predicted. 3) The Paleocene fossil faunas are characterized by massive sizes including snakes, turtles, crocodiles and lungfishes. 4) Despite years of searching, no Paleocene mammal has been found yet. 5) Xerophytes and savanna landscapes dominates the northern region of the Neotropics today, however, that was not the case until ~3-5 My ago. Faunas from Castillejas indicates a much more humid environment, suggesting a massive transformation of the neotropical landscape during the Pliocene. 6) A weak interchange between South American and North American
mammalian faunas started at ~10 My, followed by a strong interchange pulse during the latest Pliocene-early Pleistocene. In contrast, the rich fossil record of Panama indicates an active interchange of turtles, crocodiles and **Boa** as early as ~22 My. The fossil record of the Neotropics is vastly unexplored. Decades of paleontological exploration are still ahead of us, but the rewards will be immense as the tropics are a constant source of evolutionary innovation.  

**Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)**

**AN ARMADILLO AND A LEG: INFERRING BEHAVIORAL DIFFERENCES OF DASYPSUS BELLUS AND DASYPSUS NOVEMCINCTUS FROM MORPHOLOGY OF THE CALCANEUS**

**JASINSKI, Steven E., East Tennessee State University, Johnson City, TN, United States**

**WALLACE, Steven C., East Tennessee State University, Johnson City, TN, United States**

**Dasyops bellus** (beautiful armadillo; Xenarthra), assuming it is within Dasypsus, is from the Pleistocene of North America (Rancholabrean NALMA) and has often been considered identical to the extant *D. novemcinctus* osteologically when disregarding size. Consequently, many behavioral interpretations for the former have been derived from the latter. By comparing the calcanea of these two dasyopodids, distinct osteological differences were observed including a mediodlaterally-expanded astragalar facet region, an anteriorly-elongated calcaneal head, and a ventrally-elongated calcaneal foot in *D. novemcinctus*. Such characters were not allometric and are believed to correlate to distinct behavioral differences. We suggest that *D. novemcinctus* maintains a more fossorial lifestyle due to its expanded facet areas, while the larger *D. bellus* was likely more terrestrial, with little digging behavior. Such a disparity in lifestyle could not only explain the osteological differences present, but also why fossils of *D. bellus* have been recovered farther north, particularly northeast, of us, but the rewards will be immense as the tropics are a constant source of evolutionary innovation.  

**Technical Session XII (Friday, October 19, 1:45 pm)**

**TWO NEW EARLY TRIASSIC MARINE REPTILES FROM CHAOHU, ANHUI PROVINCE, SOUTH CHINA**

**JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China; MOTANI, Ryosuke, Department of Geology and Geological Museum, Peking University, Beijing, China**

**Utatsusaurus wushanensis**, sauropotterygnids *Glyphodermus kuni*, *Nothosaurus youngi*, *Lariosaurus xinyingensis*, *Keichousaurus hui* and *Yungisaurus liae*, and protorosaurs *Macronemus* cf. *M. fuyuanensis* and *Tanystrus* cf. *T. longobardicus*. However, most specimens lack exact stratigraphic and geographic data.  

A scientific excavation has been carried out since August of 2011 at the Naima Village of Wusha District, Xingyi City, Guizhou Province and has yielded over 300 reptilian remains in the 28 layers (layer 26 to layer 53) of the 5.2m ~ 5.9m thick beds out of the 96m-thick Zhuganpo Member of the Falang Formation. The Xingyi Fauna is mainly represented by *Keichousaurus* with a continuous occurrence between layers 26 and 44. Research on the ammonoids above the fossil layer suggested a latest Ladinian age. The new findings included two ichthyosaurs (*Guizhouichthysaurus* and *Qianichthysaurus*) and thalattosaurs that were collected from the upper bed of the fossiliferous level (layer 42 to layer 53), revealing close affinity to the younger Guanling Biota (Carnian, Late Triassic). Contrarily, the sauropterygian material only appears in the lower bed of the fossiliferous level including nothosaurs (layer 30), pietosauro (layer 36) and *Keichousaurus* (layer 26 to layer 44), which are typical Middle Triassic members. Therefore, it is possible that Xingyi Fauna displays a transition of marine reptile faunas and will provide new information on the reconstruction of the paleoecology and paleoenvironment.

Within the Xingyi Fauna, the durophagous member (*Glyphodermus*) only reaches up to 10 of species while the ratio is 5 out of 15 in the Panxian-Luoping Fauna and 5 out of 9 in the Guanling Biota. The biodiversity of the Xingyi Fauna is highly in accordance with the recent hypothesis on the positive correlation between taxonomic abundance of durophages and sea level change possibly resulted from the remarkable sea level drop during the late Ladinian.
concerning if the genus is a junior synonym of Hainosaurus and original descriptions, and subsequent treatments, do not support generic distinctions between H. pembinensis resulted in its generic reassignment to Hainosaurus despite the fact that all other North American species of tylosaurine mosasaur had been (upper Campanian, Manitoba, Canada) was assigned to the genus, Taniwhasaurus and are generically distinct from either Hainosaurus and Tylosaurus.

The Geraldine Bonebed was discovered by A. S. Romer in 1932. It eventually yielded a large number of mostly complete skeletons of four tetrapod taxa, for which it is famous, and also a diverse flora as well as other vertebrates. It occurs in the Nocona Formation, Wichita Group, Sakmarian age. With the help of Bill May (Norman, Oklahoma), bulk samples of matrix were screen-washed and sorted to produce a variety of vertebrate microfossils, including shark teeth (SMU 69641, 76693-76714, 76717), especially xenacanths. The xenacanth sharks are rare and include a petalodont tooth (Jamassoi), Helodus sp. (2 teeth), and four partial hybodont teeth (probably representing 3 species). These are all considerably more common higher in the Wichita Group. Among the xenacanths are two typically small Xenancanthus sp. occipital spine fragments, two Orthacanthus sp. occipital spine fragments (one small, one very small) and hundreds of Orthacanthus teeth. Orthacanthus tevisen teeth are much more common in the group (e.g. T. kansanmore, T. nepausi) that is identical to the claims made for Hainosaurus. The maxilla/premaxilla suture is sinuous (zig-zagged), and the quadrates presents a prominent internal suprastapedial process, both features being reported in genus Tylosaurus, as well. The remaining Northern and Southern Hemispheres tylosaurines have all been assigned to the genus Taniwhasaurus and are generically distinct from either Hainosaurus and Tylosaurus.

The tylosaurine mosasaur genus CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada
JIMENEZ-HUIDOBRO, Paulina, University of Alberta, Edmonton, AB, Canada; THÉ LATTER?

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CAPTORHINUS AGUTI
A FUNCTIONAL INTERPRETATION OF THE CRANIAL SUTURE MORPHOLOGY IN CAPTORHINUS AGUTI (REPTILIA)
JONES, Marc E., UCL, University College London, London, United Kingdom; ZIKMUND, Tomas, Queen Mary’s School of Medicine & Dentistry, London, United Kingdom

Permain captorhinomorphs were geographically widespread and showed diversity in body size, skull shape, and dental apparatus. Captorhinus aguti is one of the best known representatives having been described in detail from complete skulls and almost complete skeleton elements. However, the detailed structure of certain cranial joints (e.g. lacrimal-prefrontal) remains poorly known and the functional implications of the overall joint arrangement has not been fully explored. We surveyed a range of cranial material from Fort Stilt, Oklahoma, USA, (Arroyo Formation) referred to Captorhinus aguti using binocular microscopy, micro Computed Tomography (CT), and scanning Electron Microscopy to examine the cranial joints in greater detail. Many of the peripheral cranial joints involve broad overlaps occasionally terminating in serrated edges whereas other joints involve more complex interdigitations such as those closer to or along the midline. The lacrimal-prefrontal joint has been considered of particular interest to the functional morphology of early amniotes because of its location above the dental arcade and in front of the orbit. When the constituent elements of Captorhinus are found in isolation the corresponding facets are invariably damaged. However, a micro CT computer model of an articulated lacrimal and prefrontal demonstrates that in this taxon the joint is more complex than previously appreciated and may have served a key role in accommodating stresses transmitted from the dental arcade to the facial bones. It involves several interdigitating plates of bone which are particularly large in the medial part of the joint. A dorsal view of the lacrimal facet shows that the plates are oriented as if to radiate from a point central to the posterolateral corner of the nasal cavity. Any micromovement within the joint must have occurred in the dorsoventral plane (in parallel to the long axis of the plates) or these plates would be vulnerable to breakage. The successive overlaps would provide a large surface area for collagen fibres running between the facet surfaces. These would restrict or dampen movement in a dorsoventral direction. A compressive loading of this kind is likely to arise during feeding when the maxillary dentition meets resistance. Comparisons with testudines and lepidosauromorpha show a greater overall similarity to the joint complexity of testudines, an observation that may have implications relating to skull fenestration and muscle arrangement.

Technical Session XVII (Saturday, October 20, 2:15 pm)

TURNING IN THERIOPODS
KAMBIG, Robert E., Brown University, Providence, RI, United States; GATASY, Stephen M., Brown University, Providence, RI, United States

In extant animals, maneuvering plays a crucial role in navigating complex terrain, finding food, or escaping predators; extinct theropods were likely no exception. Despite its importance, maneuvering’s complexity and intermittent nature have resulted in little study compared to steady locomotion.

In this study, we used the helmeted guineafowl, (Numida meleagris) to study one type of maneuvering: turning to face a new direction while standing. We used bilateral cineradiography and radiopaque bone markers to acquire high-resolution six degree of freedom segment kinematics. Observed turns rely primarily on long axis rotation of the femur or tibiotarsus to reposition the foot mediolaterally. At the hip, the antitrochanter likely limits abduction while the bicipodial shape of the knee prevents abduction/adduction. Limiting this degree of freedom requires the use of long axis rotation.

Further analysis of the guineafowl hindlimb should help provide the link between joint shape and soft tissue anatomy and range of motion. For instance, relatively thin condyles and long collateral ligaments at the knee may signal large long axis range of motion. We hypothesize that almost full reliance on long axis rotation is an avian feature while extinct theropods with more erect posture used a combination of abduction/adduction and long axis rotation at the hip. Abduction/adduction at the hip is hypothesized to decrease in importance on the line from primitive archosaurs to birds.

Data such as these provide the functional and mechanical perspective needed to infer the behavior of extinct theropods.

Technical Session X (Friday, October 19, 9:30 am)

PERMIAN ORIGINS OF THE POST-EXTINCTION THERAPSID RECOVERY FAUNA
KAMMERER, Christian F., Museum für Naturkunde, Berlin, Germany; FRÖHISCH, Jörg, Museum für Naturkunde, Berlin, Germany; ANGIELCZYK, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; SMITH, Roger M., Iziko, the South African Museum, Cape Town, South Africa

The Permo-Triassic mass extinction caused total reorganization of the terrestrial vertebrate fauna, with therapsids experiencing nearly complete turnover. The Early Triassic therapsid recovery fauna characterizes a brief interval dominated by highly autapomorphic clades like Lystrosaurusidae. Previous hypotheses for the origin of the therapsid recovery fauna supposed that these clades either originated post-extinction or invaded fossiliferous basins from elsewhere in Pangea. Though some species must have originated post-extinction, new discoveries and reexamination of poorly known taxa reveal that the typical clades of the recovery fauna extend well into the Late Permain. These results contradict the prevailing view of acute extinction followed by rapid recovery—Early Triassic records represent lineage survival across the boundary rather than post-extinction radiation. Four dicynodont clades are known in the Triassic: lystrosaurids and kannemeyeriiform cynodontoids and kingosaurids and mosasaur emydopoids. Previous research has demonstrated that two species of the quintessential therapsid disaster taxon Lystrosaurus, traditionally considered an index fossil for the start of the Triassic, appear in the terminal Permian. These species already exhibit the extreme Lystrosaurus cranial morphology, however —our research reveals an expanded Lystrosaurusidae stretching back to at least the Cistecephalus Assemblage Zone: Eurychognathus from Tanzania and undescribed taxa from Zambia and South Africa. These undescribed taxa are very similar to Lystrosaurus but with a narrow intertemporal bar, helping to bridge the morphological divide between other dicynodontoids and the Lystrosaurus lineage. In Emydopoida, the recent discovery of Early Triassic Kombuisia has filled the Permain-to-Middle Triassic kingosaurid ghost line. Additionally, new material of the enigmatic dicynodont Emendorrhina from near the Permo-Triassic boundary reveals that this taxon forms the sister-group of the Early Triassic Myosauridae. Within theriodonts, akidognathid and bauriid theriocephalians include genera that cross the extinction boundary. In cynodonts, phylogenetic study of the rare Permain taxon Nanicosaurus supports its placement as an eucynodont, dragging this predominantly Triassic group back beyond the boundary. These records show that, at least in southern Africa, the therapsid clades making up the post-extinction recovery fauna were already present but rare in the terminal Permain. Autapomorphic morphological features of these
clades predate the extinction and thus cannot be extinction responses. Most elements of the recovery fauna do not survive beyond the Early Triassic—ancestors of the post-recovery fauna (eucynodonts, kannemeyeriiforms) remain elusive.

**Poster Session I** (Wednesday, October 17, 4:15 - 6:15 pm)

**ARTIFICIAL CHEWING WITH REAL TEETH**

KARME, Aleksis, University of Helsinki, Helsinki, Finland; KALLONEN, Aki, University of Helsinki, Helsinki, Finland; GALAMBOSI, Szabolcs, University of Helsinki, Helsinki, Finland; ENGSTROM, Pauli, University of Helsinki, Helsinki, Finland; FORTELJUS, Mikael, University of Helsinki, Helsinki, Finland

In remarkable contrast to the widespread use of tooth wear in paleoecology and paleoenvironment reconstruction there has been very little experimental study of the causes of different tooth wear types. We have therefore built an artificial chewing apparatus for simulating wear on real teeth under controlled circumstances of mechanical mastication. The core design principle of the machine is repeated, full-occlusion single stroke movement. The majority of the device design was done with CAD-modeling, and the needed parts were then milled from stainless steel. The electric motor and power source were selected to be easily obtainable and affordable. An in-house designed water-cooling system for the motor was built to facilitate long-term testing and allow high number of chewing cycle repetitions. Full adjustment of the occlusion and chewing force are available for experiments. The setup is reasonably sized, weighing in total less than 5 kg, which in addition to the affordability of the component parts should allow easy and flexible use.

Teeth worn with the chewing machine were first cut straight and polished to a flat and even “occlusal” surface for the initial experiments. Horse teeth were selected for their hypodentine and compact structure, with enamel, dentine and cement almost uniformly distributed along the tooth’s height. Mastication was performed with and without abrasive substances. Mastication without abrasive substances was done in a pure water medium, whereas a viscous glycerin-based liquid was used to keep the particles in suspension when abrasive substances were introduced.

Teeth were subjected to over 200 000 chews during a time span of 60 hours. Results were estimated visually and quantitatively using 3D-scann data. Elevation, slope, aspect and facet development were quantified and estimated from the worn surface using GIS techniques. In pure attrition, tooth against tooth, facet development and differential wear to dentine, cement and enamel was observed, whereas in abrasion results were dominated by the added particles, which induced rounded wear surfaces and clear overwriting striations.

**Poster Session II** (Thursday, October 18, 4:15 - 6:15 pm)

**LATE OLIGOCENE BEAVER (CASTORIDAE, RODENTIA) FROM WESTERN JAPAN**

KATO, Takafumi, K还想chi University of Science and the Arts, Kurashiki, Japan

The late Oligocene to early Miocene rodents found in Nagasaka Prefecture, Kyushu, Japan, have been identified as belonging to the following 3 taxa: (1) Steneother sp. from the late Oligocene Sasebo Group, (2) Youngother sp., and (3) Diatomy shuntangensis from the early Miocene Nojima Group. These Miocene species are considered endemic taxa distributed in China and Japan. In contrast, Steneother is a European genus that is not known to be from the Late Oligocene in China.

Recently, additional specimens of Steneother were found in the basal part of the Fukui Formation of the Sasebo Group of Sasebo City, Nagasaki Prefecture. The fossiliferous layer is approximately 1 m thick, containing pebbly transgressive lag deposit unconformably overlying the coal-bearing non-marine shale and sandstone of the Shichibaru Formation of the Sasebo Group. The new material of Steneother is represented by seven isolated cheek teeth and seven incisors probably belonging to the same species, associated with fragmentary skeletal remains of artrhacothere, rhinocerotids, and tortoises.

The materials exhibit the following features: semi-hypsodont teeth completely devoid of cement, relatively simple enamel pattern with uncomplicated fossettes, round and broad fossettes and flexi, parastra absent on P4, long and curved mesoflexus (or mesosofette) almost reaching the posterior end of the crown, short and broad hypoflexus, and an additional fossette between the parafossette and the mesoflexus. These dental characters are similar to the late Oligocene species Steneother but are different from the simpler enamel pattern. These specimens might be a new species of Steneother.

During the late Oligocene and early Miocene periods, the number of Castoridae genera and species increased and became widespread in the Northern Hemisphere. The occurrence of Japanese Oligo-Miocene beavers probably reflects this episode.

**Poster Session III** (Friday, October 19, 4:15 - 6:15 pm)

**A PALEOECOLOGICAL ANALYSIS OF LATE PLEISTOCENE CERVID REMAINS FROM GUY WILSON CAVE, SOUTHERN APPALACHIANS, TENNESSEE**

KAUFMAN; Amanda K., East Tennessee State University, Johnson City, TN, United States; SCHUBERT, Ira W., East Tennessee State University, Johnson City, TN, United States; DESANTIS, Lisa R., Vanderbilt University, Nashville, TN, United States

The paleoecology of late Pleistocene cervids at Guy Wilson Cave is based on 1) systematic identification of cervid material, 2) taphonomic analysis with a focus on carnivore utilization and 3) carbon isotope proxies from modern and fossil cervids and fossil herbivore tooth enamel (δ13C). Systematic identification reveals that there are four to five cervid taxa in the cave fauna based on dental remains: Odocoileus cf. O. virginianus, Rangifer tarandus, cf. Cervus, and Cervus/Alces. Taxonomic separation of Cervus and Alces was not possible given the fossil material, and no dental characters were found to separate the two living species of Odocoileus. Taphonomic analysis of gnawing and tooth markings shows alterations consistent with a canid predator, and the overall pattern suggests full-heavy utilization and possible scavenging activity. A likely candidate for this modification is the dire wolf, Canis dirus, and the cave appears to have served as a den. Isotopic analysis of the community shows that taxa were feeding in a dominantly C3 environment, as all δ13C values are less than -8‰, values of Odocoileus (-13.6‰ to -15.8‰) and Tapirus (-15.0‰ to -15.4‰) also suggest a relatively dense canopyed temperate forest. Even horses have isotopic values (-11.5% and -12.1%) consistent with the consumption of primarily C3 vegetation, potentially C3 trees/shrubs or C3 grasses. Extant Odocoileus from Sullivan County, TN has δ13C values (-13.2‰ to -17.2‰) that are not significantly different from Guy Wilson Cave Odocoileus, suggesting that dietary niches in these deer may have been consistent from the late Pleistocene to today in this region. Although the maintenance of similar dietary niches from glacial to interglacial periods is in contrast to what occurs in Florida, a relatively stable forested environment in the Appalachians may be responsible for similar dietary niches in Odocoileus over time.

Technical Session VIII (Thursday, October 18, 3:00 pm)

**THE PALEOEVIRONMENT AND PALEOECOLOGY OF THE COASTAL MAMMALS SANTA CRUZ FORMATION (LATE EARLY MIocene, ARGENTINA)**

KAY, Richard F., Duke University, Durham, NC, United States; VIZCAINO, Sergio F., Museo de La Plata, La Plata, Argentina; BARGO, M. S., Museo de La Plata, La Plata, Argentina

The paleoenvironment and paleoecology of the Santa Cruz Formation (SCF) is summarized, combining the data from 10 field seasons with a new examination of the community structure of the vertebrate fauna of modern analogs. Emphasis is placed on the SCF outcrops along the coastal Atlantic between about 50°3′ and 51.6°S and their faunas (Sanctacrucian SALMA). SCF Fossil Levels (FL 1-7) south of the Rio Colve range between ~17.4 to 17.5 Ma and are considered analogous to a single modern fauna of limited geographic and temporal scope. As paleolatitude during Sanctacrucian times was the same as that of today, FL 1-7 was extratropical and had highly seasonal daylight lengths. The Andes had not risen to a sufficient altitude to block westerly winds and moisture from reaching the Atlantic coast, nor had the Middle Miocene global climatic cooling begun. Several taxa recovered at FL 1-7 or in nearby penecontemporaneous levels (e.g. palm trees, the frog Calyptocheophalidae, the lizard Tantamias, the anteater Procanthias, and the primate Homunculus) strongly indicate that the climate of FL 1-7 was much warmer and wetter than today. The overall mammalian species richness and niche composition, expressed as percentages of arbooreal or scansorial, frugivorous, and grazing, suggest that overall rainfall was in the range of 1000 to 1500 mm per annum. Occurrence of trees and forest-dwelling birds and mammals (porcupines, spiny rats, sloths, scansional marsupials, and monkeys) supports this conclusion. The occurrence of calcareous root casts in paleosols indicates high seasonality in rainfall with cool wet winters and dry warm summers. Grasses were also present, and a number of vertebrate taxa (giant terrestrial birds, many nongutangulans, glyptodonts, and armadillos) appear to have been adapted to open environments. Stable isotopic, ichnology, floral, and faunal elements taken together suggest a landscape for FL 1-7 consisting of a mosaic of open temperate humid and semi-arid forests, with ponds in some areas and seasonal flooding in others, no doubt promoting the formation of marshlands with a mixture of grasses and forbes.

**Stylus Sharpening Instrument for Fossil Preparation**

KAZUMI, Wada, Museum of Nature and Human Activities, Sand, Hyogo, Japan, Sanda, Japan; IKEDA, Tadahiro, Museum of Nature and Human Activities, Sanda, Hyogo, Japan, Sanda; SAEGUSA, Haruo, Museum of Nature and Human Activities, Sanda, Hyogo, Japan, Sanda, Japan; SHINYAI, Akiko, The Field Museum, Chicago, IL, United States

Air scribes and pin vises fitted with carbide needles are commonly used to prepare vertebrate fossils but the stylus-point becomes dull or breaks over time. Stylus are traditionally sharpened manually with a hand-held or a desk top rotary tool fitted with a diamond grinding disk. These manual sharpening processes are imprecise and the result of the newly sharpened stylus is off-center. This can cause inaccuracy and inefficiency in the preparation of fossils. To overcome the imprecision of manual sharpening processes, a stylus sharpening instrument can be custom built from locally available and inexpensive parts. The instrument is composed of two assemblies each with a variable speed hand-drill motor mounted on a base board. Three stylus shaft holders that are aligned and fixed to the base board hold a stylus in a stable position. The positions of holders are adjustable depending on the length of styl. The first motor rotates the stylus through an O-ring belt connecting the motor’s main shaft to a rubber pulley which is attached to the stylus. Different sized pulleys are used according to the stylus’ diameter. The second motor powers a grinding disc, and this grinding assembly is attached to the base board with a swivel mount that allows the operator to pivot the assembly freely. The grinding assembly has two operator handles to enable the operator to sharpen the stylus to a desired angle. Preparators in the Dinosaur Laboratory of Museum of Nature and Human Activities use a 3/8 inch 400 grit double-sided diamond cut-off wheel.
for sharpening styli, but grinding discs of various grit size and diameter can also be mounted on this assembly. The motors are powered by rechargeable batteries so that the instrument is portable in the laboratory and at excavation sites. A plexiglass cover is mounted over the grinding parts for safety. This instrument allows preparators to easily and safely sharpen styli with precise, centered points.

Preparators’ Session (Thursday, October 18, 8:00 am)

FEATHERING DINOSAURS
KEILLOR, Tyler, University of Chicago, Chicago, IL, United States

Recent fossil discoveries have amplified our knowledge of varied dinosaur integument. Preserved scales, filaments and feathers have supplied a wealth of reference that artists endeavor to incorporate into reconstructions of new specimens. A variety of techniques have been employed to create sculptural flesh-models with unusual integumentary coverings. Coats of feathers and feathers can be sculpted in relief, creating hard models of these soft features. Alternatively, feathers, flocking and other delicate mixed media, such as acetate sheets and nylon monofilament can be used to create the coverings for a life reconstruction. A survey of the methods and materials currently used by a variety of artists and technicians will be presented.

Technical Session XIV (Saturday, October 20, 11:30 am)

A NEW LOWER TRIASSIC ICHTHYOPTERYGIAN FAUNA FROM FOSSIL HILL, NEVADA
KELLEY, Neil P., University of California, Davis, Davis, CA, United States; MOTANI, Ryosuke, University of California, Davis, Davis, CA, United States; EMBREE, Patrick G., Orangevaie, CA, United States

Beginning with discoveries in the 19th Century, Nevada has been an important source of Triassic ichthyopterygian fossils. However, to date it was not known whether ichthyopterygians were present in the region in the Early Triassic, during the earliest phase of ichthyopterygian evolution. We investigated Lower Triassic rocks at the famous Fossil Hill locality in Pershing County, Nevada and identified a previously unrecognized ichthyopterygian fauna. The Anisian (Middle Triassic) Fossil Hill Member of the Prida Formation in the Humboldt Mountain Range, and stratigraphically equivalent horizons in the Favret Formation in the adjacent Augusta Mountain Range, are characterized by a rich marine reptile fauna comprising the ichthyosaur genera Cymbospondylus, Mixosaurus and Phylacodon together with the sauropterygian Augustasaurus and the enigmatic reptile Ongolosaurus as well as ammonites and other ammonoid cephalopods. Recent fragmentary ichthyopterygian fossils have been discovered in the lowest levels of the Prida Formation at the historic Fossil Hill locality. These levels are Spatihan (Lower Triassic) in age based on invertebrate index fossils and sit stratigraphically below the diverse Anisian assemblage of the Fossil Hill Member and above microfossil dominated facies typical of the “delayed recovery interval” that characterizes the earliest Triassic. Although all specimens collected to date are fragmentary, distinctive tooth morphologies indicate that multiple species of ichthyosaur were present and permit comparison to known Lower Triassic ichthyopterygian taxa. The presence of an Utatassaurus-like form, and a Chaoshusaurus/Grippia-like form suggests faunal similarity with Lower Triassic assemblages from Canada and to a lesser extent, Spitsbergen, Japan and China. Taken together, these comparably aged localities indicate biotic dispersal of relatively small-bodied ichthyopterygians across northern Panthalassa during the earliest known phase of their evolution, shortly after the recovery of marine ecosystems from the end-Permian mass extinction. Further work in this and other Lower Triassic localities will provide important opportunities to better understand early ichthyopterygian evolution and potentially pinpoint the stratigraphic, paleogeographic and paleoecological context of their origin.

Technical Session IV (Wednesday, October 17, 2:15 pm)

NEW EVIDENCE ON THE PTEROID ARTICULATION AND ORIENTATION IN PTEROsaurs
KELLNER, Alexander W., Laboratory of Systematics and Taphonomy of Fossil Vertebrates, Museu Nacional/UFRRJ, Rio de Janeiro, Brazil; COSTA, Fabiana R., Laboratory of Systematics and Taphonomy of Fossil Vertebrates, Museu Nacional/UFRRJ, Rio de Janeiro, Brazil; RODRIGUES, Taissa, Departamento de Medicina Veterinária; Universidade Federal do Espírito Santo, Alegre, Brazil

The pteroid is a long, rod-like element whose position, function and orientation have been much debated without reaching a consensus. These debates are focused mostly on whether or not this bone supports the propatagium by being directed forward during flight in an anterior orientation or being medially oriented in a more parallel position to the edge of the wing. These hypotheses are mainly based on indirect anatomical evidence and aerodynamic models of performance. The first hypothesis leads to a broad forewing acting aerodynamic models of performance. The first hypothesis leads to a broad forewing acting and the second one implies a narrower forewing. Paramount to this question is the articulation of the pteroid to the carpus that has been the subject of debate. A long-held view suggests that this bone articulates with the distal fovea of the preaxial carpal. An opposing interpretation argues that the pteroid was articulated to the lateral side of the preaxial carpal, with a small sesamoid filling out the fovea carpal. An alternative proposal followed, in which the pteroid would actually articulate with the proximal syncarpals, but this remained controversial and was not universally accepted. The main problem is that this bone is normally found disarticulated and displaced from its natural anatomical position. New exquisitely preserved specimens from the Romualdo Formation (Albian) of Brazil can settle this question. Some show a distinct articulation surface on the dorsal region of the proximal synarpel, close to the articular facet for the radius. This feature is observed in both anhanguerids and tapejaries and is the strongest candidate for the articulation of the pteroid. Among the most interesting material is a specimen that represents the almost complete wings of an anhanguerid individual and possesses the pteroid directly in articulation with the proximal synarpel. As the proximal carpals are fused into a proximal synarpel in osteologically mature specimens, this position constrains the pteroid to a more medial orientation regarding the edge of the wing, avoiding subjecting this bone to heavy loads if it would have been projected anteriorly.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

IS MODAL BODY SIZE AN EVOLUTIONARY ATTRACTOR? ANOLIS AS A CASE STUDY
KEMP, Melissa E., Stanford University, Stanford, CA, United States; HADLEY, Elizabeth A., Stanford University, Stanford, CA, United States

Many explanations for patterns of body size diversification exist; principal among them is the idea of modal body size acting as an evolutionary attractor. The species lizard genus Anolis serves as an exemplary system to test this hypothesis and investigate whether the biotic environment affects the ability of taxa to converge on modal body size. We focus on anoles restricted to the Lesser Antilles that have a modal body size corresponding to the purportedly optimal solitary status, in addition to two other size classes that are found when species co-occur. We use phylogenetic independent contrasts to reconstruct body size for ancestral lineages and infer directionality of size evolution. While the distributions of these three size classes are significantly different from one another, we find that the Lesser Antillean anoles are not evolving towards the modal body size even when we account for competition. However, body size appears to be constrained by the modal size even though large lineages get larger and small lineages get smaller. These data suggest an important role for competition in driving macroevolutionary trends in body size, in addition to other forces operating at higher taxonomic levels.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A GEOMETRIC AND KINETIC BACKBONE MODEL OF THE Cheetah, ACINONYX JUBATUS, AND ITS APPLICATION TO UNDERSTANDING THE SPINAL KINETICS OF MIRACINOYX TRUMANI
KENNEDY, Natalia K., University of California, Los Angeles, Los Angeles, CA, United States; BHATT, Roopak, University of California, Los Angeles, Los Angeles, CA, United States

Cheetahs are the fastest land animals, partly due to their spinal flexibility. Surprisingly, there has never been a detailed study of the musculoskeletal anatomy and function of its vertebral column despite the obvious contributions it makes to cheetah speed through extreme flexion and extension. Using anatomical data, radiographs, and 3-D laser scanning, a geometric and kinematic computer model of the vertebral column of the cheetah was produced. This model allows a clearer understanding of the spinal flexibility of the cheetah, as well as which specific areas are fundamental in providing the vertebral column flexibility necessary for fast running.

Based on 3-D scans of fossils, the model will be modified to investigate the flexibility of the spine of an extinct North American cheetah-like cat, Miracinonyx trumani. It will demonstrate whether there are short, specific areas of the vertebral column that serve as indicators of overall spinal flexibility. If so, this would allow paleontologists to infer the spinal flexibility, and by extension speed and paleoecology, of extinct felines with only a few vertebrae. This technique will allow for more information to be gleaned from these incomplete specimens than was previously possible.

Technical Session XVI (Saturday, October 20, 11:30 am)

ISOTOPIC DIETARY SIGNALS IN MURINE RODENTS FROM THE NEOGENE SIWALIK GROUP LAGS LARGE MAMMALS BY ONE MILLION YEARS
KEMP, A. Yuri, Southern Methodist University, Dallas, TX, United States; UNO, Kevin T., University of Utah, Salt Lake City, UT, United States; CERLING, Thure E., University of Utah, Salt Lake City, UT, United States; PATNAIK, Rajeev, Panjab University, Panjab, India

The Neogene Siwalik formations of northern Pakistan and India comprise a long depositional sequence of fluvial deposits and contain vertebrate fossils ranging in age from 18 to less than 1 Ma. Carbon isotopes of soil carbonates and large mammal teeth from this interval document an ecological shift from C3-dominated woodlands to C4-dominated grasslands between 8.5 and 6.0 Ma. Here we compile carbon isotope data of true mice and rat (Murinae) teeth, using laser ablation GC-IRMS, from northern Pakistan (13.8 Ma to 6.5 Ma), northern India (2.5 to 2 Ma), and Recent species of both regions. This study relates carbon isotope ratios with morphological traits in murine molars. Because Siwalik murine diversity primarily resulted from in-situ evolution in northern Pakistan rather than immigration, we tested the hypothesis that murines shifted dietary niche in response to a change in food source in a pattern similar to that of large mammals. Alternatively, the small home range of mice may have enabled them to persist in fragmented patches of desirable vegetation during the transition from a C3 to a C4 ecosystem. In this case, an expected dietary shift indicated by isotopes would be delayed in comparison to large mammals.

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Carbon isotope data obtained from more than 70 lower first molars were associated with dental measurements. Preliminary results show: (1) the carbon isotope curve of murines differs from that of large mammals in that the carbon isotope values become abruptly more positive with a broader range at 7.4 Ma, whereas large mammals began the shift at 8.5 Ma, (2) larger murine species generally have more positive carbon isotope values than smaller species between 9.2 and 6.5 Ma, (3) the difference in isotopic means of pre-defined taxa at a given locality are statistically significant at 8.2 Ma and increase in value at 7.4 Ma. They indicate that differences in diet in Siwalik murines can be recognized by 9.2 Ma, but that the major shift attributed to C4 vegetation occurs later in murines than in large mammals. In addition, the pattern of isotopic change in murines is more similar to that seen in Siwalik paleosols than in large mammals, suggesting that like paleosols, which reflect overlying vegetation, the small home range of murines results in more precise resolution of past ecological conditions than large mammals.

**Poster Session III (Friday, October 19, 4:15 - 6:15 pm)**

**PHYLOGENETIC PLACEMENT OF PANTHERA ATROX BASED ON CRANIAL MANDIBULAR CHARACTERS**

KING, Leigh M., East Tennessee State University, Johnson City, TN, United States; WALLACE, Steven C., East Tennessee State University, Johnson City, TN, United States

Over the past twenty years both morphological and molecular phylogenies have been proposed for extant and extinct members of the family Felidae. However, there remain several discrepancies, particularly within the genus Panthera, likely due to the very recent diversification within the family. One example that has received recent attention is the phylogenetic placement of P. atrox. These inconsistencies suggest the need for further analysis and perhaps even different methodology to truly understand pantherine evolution. Consequently, morphologic characters from the skull and dentition were assessed within Panthera (including all extant, and one extinct, taxa) to gain a better understanding of pantherine phylogeny. To increase confidence in the results, multiple specimens of each taxon were analyzed and scored. Extant taxa included: P. leo (African lion), P. tigris (tiger), P. onca (jaguar), P. pardus (leopard), Uncia uncia (snow leopard), and Neofelis nebulosa (clouded leopard). The latter two taxa are considered pantherine, though not in the genus Panthera, due to their consistent placement in various phylogenetic trees as falling just outside the Panthera group. Four outgroups were used: Crocuta crocuta, Metalurus sp., Proailurus lanensis, and Pseudaelurus validus. From each phylogeny created, despite the outgroup, apparent grouping between Panthera leo, P. tigris, and P. atrox was present. Therefore, P. atrox is likely more closely related to the African lion and the tiger than the jaguar, in contrast to what has been recently suggested. Moreover, gross morphological similarities between P. atrox and P. onca are likely the result of convergent hunting styles and/or prey selection, rather than phylogenetic affinity.

**Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)**

**A COMPARISON OF THE MICROVERTEBRATE FOSSILS FROM THE GARDEN PARK FOSSIL AREA IN COLORADO AND THE LITTLE HOUSTON QUARRY NEAR SUNDANCE, WYOMING (BOTH LATE JURASSIC, MORRISON FORMATION)**

KING, Lorin R., Western Nebraska Community College, Scottsbluff, NE, United States; FOSTER, John R., Museum of Western Colorado, Grand Junction, CO, United States; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States

The Garden Park Fossil Area and the Little Houston Quarry have yielded abundant large dinosaurs, including a relatively “typical” Morrison Formation fauna consisting of the theropod Allosaurus and sauropods such as Camarasaurus, Apatosaurus and Diplodocus. The Garden Park quarries (Jennings and Johnson Localities, Cleveland Quarry, Small Quarry and Green Acres Locality) have also produced some identifiable, albeit fragmented, small vertebrate remains. The rare, smaller non-dinosaurian vertebrates include pterosaurs, turtles, crocodyliforms, and lungfish fossils, as well as specimens of the mammals Docodon and Amblytherium, plus the sphenodontian Eilenodon. These are represented mainly by disarticulated to fragmentary limb bones, vertebrae, osteoderms, and teeth. There is a scarcity of fish in the Garden Park Fossil Area (except at the Small Quarry) which could suggest that standing water was sometimes infrequent, but the abundance of plant material and invertebrate material suggests an often wet substrate and likely a high local water table. The small vertebrates preserved at the Little Houston Quarry include actinopterygian fish, lungfish, frogs, salamanders, turtles, sphenodontians, lizards, Ctenioyens, crocodilians, and the mammals Docodon, Psalodon, and an indeterminate dryolestid. At Garden Park, like most Morrison Formation fossil quarries in the western United States, small vertebrate specimens are not as common as the larger dinosaurian material, but at the Little Houston Quarry the total number of bones and minimum numbers individuals of small vertebrates is higher than that of dinosaurs. Importantly, even at Garden Park, the microvertebrate fossils, while not frequently recovered and relatively non-diagnostic, still record a greater diversity of taxa (at higher taxonomic levels) than do the more frequently collected large dinosaur elements.

**Poster Session III (Friday, October 19, 4:15 - 6:15 pm)**

**INFERRING LOCOMOTOR CAPABILITIES OF THE EXTINCT TERROR BIRD GASTORIUS USING GEOMETRIC MORPHOMETRICS**

KIRCHNER-SMITH, Mackenzie E., Indiana University Bloomington, Bloomington, IN, United States

Gastornis was a large flightless bird that lived in the lush Eocene forests of North America and Europe, a member of the family Gastornithidae. These so-called “terror birds” are part of the order Anseriformes, whose living members include ducks, geese and swans. Terrestrial locomotion was an important part of their survival, and estimating their locomotor capabilities is an important part of understanding their ecology because of their terrestrial adaptations. Using geometric morphometric analysis I compared the shape of the distal end of the tarsometatarsus of 11 species of modern day birds ranging from flightless and terrestrial to aerial. Landmarks were taken, three each, around the metatarsal trochlea II, III and IV, one at the point where the metatarsal trochlea III ends, and one on either side of the peak of curvature towards the proximal end. I Procrustes superimposed the landmarks and subjected them to a principle components analysis. The results illustrate differences in shape between the functional groups, with distinct groupings found in the shape of this bone for truly aerial, truly terrestrial, and birds that are often aerial but spend a considerable amount of time wading or walking. The more flat and fused distal ends indicate birds relying on flight, and the more wide spread and separated indicates it is likely terrestrially adapted; this change in shape is what describes the principle component 1. When the data set for Gastornis was added to this plot, it fell close to the large terrestrial birds such as emu and rhea. Based on these data an estimated running speed may be obtained by regressing the principal component scores against the known maximum running speeds of the modern large flightless birds.

**Technical Session XIII (Friday, October 19, 3:45-5:45 pm)**

**MORPHOLOGY OF THE PETROLIAN AND BONY Labyrinth in Afradapis Longicerca ST (PRIMATES, ADAPIFORMES)**

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Afradapis is a large (2-3 kg) adapiform primate known from the early late Eocene BQ-2 locality in the Fayum Depression, Egypt. Here we report the discovery of two isolated petrosals from BQ-2 that are referable to Afradapis based on size and morphology. Both petrosals preserve portions of the canals for the facial nerve and branches of the internal carotid artery. The position of the posterior carotid foramen is indicated by the presence of a lemur-like posterior septum that shields the fenestra cochleae and cochlear fossula in ventral view. As in other adapiforms, the internal carotid enters the middle ear posterolaterally near the stylomastoid foramen, and the stapedial and promontory canals divide on the promontorium in close proximity to the fenestra cochleae. The stapedial and promontory canals are nearly equal in diameter and the promontory canal follows the “transpromontorial” route that is probably plesiomorphic for crown primates. In these features, Afradapis is similar to many adapiforms and omomyiforms but differs from crown haplorhines. The preserved portions of the facial canal are unremarkable except in one respect: the hiatus Falsoopi (intracranial exit for greater petrosal nerve) is very large, exceeding the diameter of the facial canal by 30-50%. It is likely that the gnatecule ganglion was lodged in this large opening, as occurs in 5% of humans. This peculiar morphology is not exclusively typical for Afradapis because it is preserved in both known specimens, but is not seen in other adapiforms. Both specimens also demonstrate that the mastoid was heavily pneumatized, as in adapines and Maharagota. Mean semicircular canal radius of curvature is small relative to estimated body mass, suggesting comparatively low sensitivity to angular accelerations. This finding is consistent with astragalodial morphology indicative of slow, cautious arboreal locomotion. Mean cochlear volume is 17.5 mm³, similar to other mammals of comparable body mass with specialized hearing abilities. Comparative data linking cochlear volume with both the high and low frequency limits of hearing suggest that Afradapis had a range of hearing (~80 Hz to 43 kHz) similar to that measured for Eulemur fulvus (72 Hz to 43 kHz; thresholds at 60 dB SPL). The anatomy of the petrosal and inner ear of Afradapis is consistent with its previous placement as a derived adapiform stem strepsirrhine, and provides no evidence for a phylogenetic link with anthropoids.
theropods Utahraptor and Nodosauria, a basal macronarian sauropod, and the brachiosaur Cetiosaurus characterizes the YC above the calcrete. The discovery of a distinct fauna below a medial Yellow Cat ‘caprock’ near Green River, Utah, characterized by a giant polacanthine, the basal therizinosaur Polacanthus, a primitive tordont Geminiraptor, and the large basal theropod Gigantoraptor suggests the presence of dinosauromorph fauna perhaps older than that of the Gastonia fauna. The correlation of this ‘caprock’ with the calcrete cannot be proven. Forty miles east, a multitaxic, Cretaceous dinosaur fauna is preserved below the calcrete in the Doelling’s Bowl Bonebed (DB). The occurrence of this new dinosaur fauna raises the possibility of testing the hypothesis that the calcrete, although not representing the J/K unconformity, at minimum represents evolutionary time as a dinosauromorph taxan turned over fairly rapidly, on the order of every 1–2 million years. This hypothesis may be tested by examining related species in different dinosauromorph clades occurring above and below the calcrete. At DB, the small dromaeosaur Yurgovuchia has proven to be close to Utahraptor. The polacanthine ankylosaurids at DB represent a new taxan based on comparisons with the braincases of the Jurassic Gargoylesaurus and Myaornis and the 10 known braincases of Gastonia. Still under study, the iguanodont material includes many dentaries that lack the distinct ‘neck of Hypodactylus. Most promising has been the discovery of a juvenile, basal macronarian sauropod skeleton that had been mired in DB and that is associated with parts of a larger adult animal. Much of the skeleton is preserved, including skull material, pelvic elements, limb bones, an articulated pes and lower leg, and most of the vertebrae column including the semi-articulated terminal 10 procoelous vertebrae of the tail. Brigham Young University is researching extensive material from more than a dozen individuals of a closely related basal macronarian sauropod found with Gastonia at the Dalton Wells Quarry near Moab, Utah. Differences between these sauropods provide an additional test of our hypothesis.

Preparers’ Session (Thursday, October 18, 11:00 am)

MAPPING AND LAB PREPARATION OF A CRETACEOUS (CENOMANIAN) TURTLE FROM THE WOODBINE FORMATION OF NORTH TEXAS: THE UNUSUAL CHALLENGES OF THE FLYING TURTLE PROJECT

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In the Fall 2010 field season, a complete turtle carapace and plastron, along with disarticulated postcrania, was discovered by a local student, excavated, and removed. This discovery comes from the Arlington Archosaur Site (AAS) which is a diverse fossil locality from the Late Cretaceous (95 Mya) Woodbine Formation of north Texas. The AAS occurs in an ancient delta plain that was situated along the southeastern interior seaway. The AAS is renowned for recovery of Late Cretaceous crocodyliforms, dinosaurs (ornithopod and theropod), carbonized logs, and turtles. This specimen was embedded in a matrix of hardened, stratified pect with gypsum and carbonized wood integrated throughout. During transport to the fossil lab at the University of Texas at Arlington (UTA), this turtle, wrapped in a plastic jacket but not secured to the truck bed, was ejected (launched) from the bed of the transporting truck landing ‘pancake-style’ on the roadbed below. The turtle was substantially damaged, but recovered and returned to the UTA lab. This incident became known as the ‘Flying Turtle.’ Once safely located in the lab at UTA, the plastic jacket was removed and an assessment of the external damage could be started. Due to the impact, several fissures had been opened on the exposed shell that demonstrated a downward and outward separation. The right side of the specimen, which possessed pre-discovery crushing damage, was further compromised and shattered. It was determined that the criteria for preservation should be systematic, accurately plotted, and completed with a goal of reconstruction of all of the elements of the specimen. Four plans of reference were established: the carapace, internal skeletal, plastron, and surrounding matrix. Lacking sophisticated equipment, the project proceeded using hand tools and dedicated volunteer effort. The resulting grid-coordinate mapping method devised for each plane as well as the fossil sorting and storage using commonly available materials represents a creative approach to preserving smaller complete specimens.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

3D RECONSTRUCTIONS OF THE BRAIN ENDOCAST AND INNER EAR OF A TITANOSAUR (SAUROPODA: TITANOSAURIA) FROM THE LATE CRETAUCEOUS OF SPAIN

KNOLL, Fabien, Museo Nacional de Ciencias Naturales - CSIC, Madrid, Spain; WITMER, Lawrence M., Ohio University, Athens, OH, United States; RIDGELY, Ryan C., Ohio University, Athens, OH, United States; ORTEGA, Francisco, Universidad Nacional de Educación a Distancia, Madrid, Spain; SANZ, Jose Luis, Universidad Autónoma de Madrid, Madrid, Spain

Titanosauras were a flourishing group of sauropod dinosaurs during the Cretaceous. Fossils of titanosauras have been found on all continents (including Antarctica) and their remains are abundant in a number of Late Cretaceous sites. Nonetheless, the cranial anatomy of titanosauras is still very poorly known. We studied an incomplete but relatively well preserved titanosaur braincase from the locality of “Lo Hueso” (Fuentes, Spain) in the Villalba de la Sierra Formation (Late Campanian-Early Maastrichtian). The specimen, which is comparatively more complete than sauropod standards, resembles the braincase of Ampelosaurus atacis from France. Based on CT scanning, digital 3D renderings of the brain endocast and endo-labyrinthine of the inner ear were generated. The endocast has moderate pontine and cerebral flexures (about 40º). In contrast with sauropods for which the endocranial anatomy is well known (such as Spinosauraurus, Diplodocus, and Camarasaurus), the cranial region of the Spanish specimen is not dominated by any remarkable dural expansion. However, we suggest that there remain paired longitudinal dural venous sinuses that, as in some other sauropods, course dorsolaterally through the cranial region. The location of these pronounced venous sinuses is consistent with the hypothesis that most endocranial veins were very little inflated and must have been extremely modest. As in other non-avian archosaurs, the cerebral region is relatively poorly defined in the endocast due to former meningeal coverings and apparently substantial dural venous sinuses, which obscure details of the optic lobes and the cerebellum. The cranial nerves present roughly the general configuation seen in other sauropods although there are derived features that appear to characterize titanosauras. For example, the abducens nerve channels pass lateral to the prefrontal naris in most other titanosauriforms, while in titanosauras they are lateral to the nasal naris. In other sauropods, the ligament is relatively short. Our investigation highlights that, although titanosauras are derived sauropods with a successful evolutionary history, they present a remarkably modest level of paleoneurological organization.

Technical Session I (Wednesday, October 17, 10:30 am)

ORNITHISCHIAN-LIKE DENTAL ARRANGEMENT IN A BASAL THERIZINOSAUR DINOSAUR FROM NORTHEASTERN CHINA

KOBAYASHI, Yoshitsugu, Hokkaido University Museum, Hokkaido University, Sapporo, Hokkaido, Japan; LÜ, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; PU, Hanyong, Henan Geological Museum, Zhengzhou, Henan, China; XU, Li, Henan Geological Museum, Zhengzhou, Henan, China; WU, Yanhua, Henan Geological Museum, Zhengzhou, Henan, China

A basal therizinosaur dinosaur from the Lower Cretaceous Yixian Formation of Jinchang County, western Liaoning Province, was reported previously. It was suggested that it differs from the therizinosaur B. ineptus, for its pharyngothecostal status and its size. Our investigation suggests that this taxon was adapted for herbivory in cranial morphology evolved before changes in the postcrania, as seen in ornithomimosauras and pterosaurs. The most striking feature of this taxon is its dental arrangement in the middle and posterior dentary. Middle and posterior dentary teeth (posterior to the seventh tooth) are offset medially from lateral border of the dentary by a shelf, and these crowns show reversed tooth morphology (concave labial side and convex lingual side), whereas the crowns of all anterior teeth and all anterior teeth show reversed tooth morphology (lingual side concave labial side and concave lingual side). The anterior portion of the upper jaw was covered by a rhamphotheca, and that of the lower jaw is down-turned with normal tooth morphology. The anterior teeth might have functioned to pluck food (e.g., plant material), and the posterior portions, where dentary and maxillary teeth have an opposite arrangement (where the tips of the upper and lower teeth about one another to maximize biting stress) to cut plant fibers, which is an arrangement similar to ornithopods and ceratopsians. This line of evidence suggests that this taxon was adapted for herbivory in a different way from any other therizinosaur.

Technical Session XIII (Friday, October 19, 3:30 pm)

HYPOTHETICAL MODEL FOR THE EVOLUTION AND DIFFERENTIATION IN PEDAL DISTAL PHALANGES OF PRIMATES

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Pedal distal phalanges are more morphologically diverse in primates than in most other mammals. The occurrence of claws or even grooming claws in various groups has prompted discussions about the primitive condition. The question of whether the Eocene aeglidino Darwinius had a grooming claw or not, initiated an extensive survey of pedal distal phalanges among primates. The morphology of the modified distal phalanx as well as its specific position among the five digits must be considered. The grooming claws and claws of the various groups differ in morphology and position indicating occurrence of parallel evolution. Accepting this, a fairly simple hypothetical model can be advanced for the evolutionary modifications of the pedal distal phalanges, fully independent from that of the hands. Starting with laterally compressed claws as in Tupaiidae and Pleuraspididae, the first step was the differentiation of the first toe as an opposable hallux. The bone is scaphoid and has a flat nail. This structure of the halluc was retained throughout most of the primates. As a second step the remaining distal phalanges, most probably, evolved a columniform shape with a small nail, as is preserved in several anthropoids. From such a structure a....
further modifications can easily be deduced. In lemursoids the second toe was separated as a grooming claw, while the lateral distal phalanges became scutiform. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders". The presence of this bone has been often overlooked because of bone fusion around birth. In the haplophine clade, this bone is involved in a functional pattern, but it is significantly different in shape and position, thus not homologous. Among anthropoids, claviform distal phalanges with flat nails on the lateral toes are widespread. This has to be regarded as the primitive condition for ceboids and cercopithecids. In ceboids the callicritichines evolved claws but the halluc retained its scutiform shape. Auxis has a grooming claw like structure. In the cercopithecine and hominid clades the cllominform distal phalanges were mostly preserved as in, e.g., Cercopithecus, Macaca, and Pan. Only in humans the distal phalanges were modified to have very irregular distal tubercles. This hypothesis postulates several cases of parallel evolution, but no evolutionary reversals and loss of specialized structures are required.

Technical Session XII (Friday, October 19, 2:30 pm)

A NEW RECONSTRUCTION OF THE HIP IN HYDROPEDAL MOSASAURS (SQUAMATA, MOSASAURIDAE): FROM ATTACHED TO DETACHED KONISHI, Takuya, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada A pelvic girdle maintaining the symphaline articulation between ischi is preserved on the recently described specimen of *Prognathodon overtoni* (Mosasauridae, Mosasaurinae), TMP 2007.034.0001. This, along with comparison of the specimen to other aquatic tetrapods allows the position of the pelvis in this animal to be re-evaluated. Using the articulated ischi, the maximum distance between the acetabula of this specimen is 24.5 cm. If the ilia are distally connected with the vertebra, the circumference of the space surrounded by the pelvic girdle and the vertebral column is estimated to be 85 cm, or only 15% of the estimated total body length of this mosasaur at 6 m. With respect to the posteriorly tapering (i.e., streamlined) torso hypothesized for hydropedal (derived) mosasaurs, this suggests at least three possibilities: (1) given that mosasaurs utilized their muscular tails as a main means of underwater propulsion, only the base of the tail of this mosasaur was abruptly constricted to become 15% of the body length in circumference; (2) the maximum girth of the tail was not significantly greater than 15% of the body length, showing an abrupt decrease in circumference at the posterior end of the animal’s trunk; and (3) the tail attained its maximum girth at the base at a much greater dimension than 15% of the total body length, more or less continuous with the posterior trunk region in dimensions. The third scenario is preferred, as the first two imply a hydrodynamically less efficient body outline by creating turbulence at the tail-body interface. The second scenario also indicates that the total tail muscle mass would be insufficient to provide and maintain propulsion strong enough for a 6-m animal. At the same time, in order to achieve the third condition, the pelvic girdle in mosasaurs must be free of ilio-vertebral articulation so as to position it further ventrally, a view contrary to the long-standing hypothesis that the hibpene in these large seagoing lizards contacted distal ends of the transverse processes on the first caudal vertebra. Further osteological support for the new hypothesis constitutes: (1) the notable absence of articular facets at distal ends of any transverse processes in the caudal series; (2) the lack of changes in orientation of the transverse processes near the base of the tail unlike in sauropterygians, where a group of transverse processes on each side of the sacral vertebrae converge distally to meet at a point of ilio-vertebral articulation; and (3) the simple rod-like morphology of the ilium. These features found in hydropedal mosasaurs are shared with derived ichthyosaurs, which are reconstructed to show separation between the pelvis and the vertebral column. Based on those lines of evidence and comparison, I conclude that pelvic girdles in hydropedal mosasaurs most likely lacked direct contact with the axial skeleton.

Technical Session VII (Thursday, October 18, 3:15 pm)

RESOLVING THE HOMOLOGY AND MIXED EMBRYONIC ORIGIN OF A MAMMALIAN SKULL BONE: THE IDENTITY OF THE INTERPARietAL BASED ON PALEONTOLOGICAL AND DEVELOPMENTAL DATA KOYABU, Daisuke, University of Zurich, Zurich, Switzerland; MAIER, Wolfgang, University of Tubingen, Tubingen, Germany; SANCHEZ-VILLAGRA, Marcelo R., University of Zurich, Zurich, Switzerland The mammalian interparietal is a dermal bone situated between the parietal and supraoccipital. Its presence, development, terminology and homology across living and fossil synapsids are yet poorly known and largely undocumented, with contradictory statements in literature. Furthermore, the interparietal is a critical and problematic element in embryonic studies of the head because of its reported mixed embryonic tissue origin. To solve these issues, we conducted a comprehensive taxonomic and ontogenetic sampling of extant and extinct mammalian taxa, integrating embryonic evidence and fossil records. There is reportedly no interparietal in monotremes, marsupials, xenarthrans, moles and soricids, and phocids. However, we confirmed its presence in all extant mammalian “orders”. The presence of this bone has been often overlooked because of bone fusion around birth. Our investigation of mammalian embryos demonstrates that the interparietal consists of four elements and not by two as in Goodrich’s paradigm and textbook knowledge. Since the lateral interparietal pair quickly fuses to the medial interparietal at embryonic stage in many taxa, this makes it critically difficult to identify the lateral interparietal pair. Although it is generally assumed that the tabular bone is lost in modern mammals, given the presence of the lateral interparietal element in extant taxa, we hypothesize that the postparietal of basal tetrapods is homologous to the medial interparietal elements of mammals and that tabulares are retained within the mammalian interparietal rather than being lost. If the medial and lateral extrascapulars of osteolepiform fishes are respectively homologous to the postparietal and tabular of basal tetrapods, the medial and lateral extrascapulars of osteolepiform fishes are presumably still conserved as the four elements constituting the interparietal of mammals. Our four-element view for the interparietal provides a synthetic understanding of the dermatocranium, its possible bridges and hints at an evolutionary pattern between tetrapods and mammals. This hypothesis postulates several cases of parallel evolution, but no evolutionary reversals and loss of specialized structures are required.
A. However, SQ values derived from lower second molars did not change significantly in this interval. The pattern in body mass and SQ in upper second molars is consistent with that observed in the lower ones, although the relationship between SQ and diet is more ambiguous in the upper dentition. Collectively, SQ values from the upper and lower second molars suggest that microsopic diet did not change in Biohorizon A despite changes in body mass. This suggests that with the increase in MAT more insect resources might have been available for exploitation by insectivorous stem pteraninds, allowing for body mass increase.

Technical Session XVII (Saturday, October 20, 3:15 pm)

FLYING ROCKS AND FLYING CLOCKS: EXPLAINING DISCREPANCIES BETWEEN FOSSIL AGES AND MOLECULAR DATES IN BIRDS

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Major disparities have been recognized between molecular divergence dating estimates and ages provided by the fossil record for critical nodes in the Tree of Life, but broad scale patterns and underlying drivers remain elusive. We harvested 268 recently published molecular divergence estimates for 67 major clades within Aves using the online database TimeTree. We also collected the ages of the oldest fossil occurrence for each of these clades, taking into account the age of fossils from sister taxa where relevant. Molecular dates were on average more than 1.5 times as old as the age of the oldest fossil record in these 67 clades, extending the estimates for targeted divergences by an average of approximately 25 million years per terminal branch. This resulted in molecular divergence estimates for 40 avian clades with earliest fossil records restricted to the Cenozoic being pushed into the Mesozoic by molecular estimates, implying a wave of mass survival across the K-Pg mass extinction for which fossil evidence is currently lacking.

Several pervasive patterns were observed. Mitochondrial genes yielded older dates than nuclear genes for an overwhelming proportion of targeted divergencies. Disparity between molecular divergence estimates and the fossil record was substantially higher for divergences within major clades (crown divergencies) than for divergences between major clades (stem divergencies). The first pattern may be attributed to higher rates of substitution, compositional bias, and site saturation in mitochondrial versus nuclear genes. However, the second pattern is less easily explained and may be the result of higher quality of the fossil record in expected to increase towards the present. The basal crown divergences within a given clade by definition must have occurred more recently than stem divergence between that clade and its sister clade, so an explanation of the bias towards relatively older crown dates versus stem dates must be sought elsewhere. We identify some proposed effects of calibration strategy that may explain the patterns observed in birds, and more broadly result in systematic overestimates in molecular divergence estimates for other clades such as insects.
Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleocology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:45 am)

VEGETATION AND CLIMATE RECONSTRUCTION OF DINOSAUR-BEARING LATE SANTONIAN, EARLY CAMPANIAN UNITS IN ALABAMA AND MISSISSIPPI

LAMB, JR., James P.; University West Alabama, Livingston, AL, United States

Pollen, leaves and charcoal from the near-shore marine Late Cretaceous (L. Cret.) (Late Santonian – Early Campanian) Eutaw Sand and Mooreville Chalk Formations in Alabama and Mississippi indicate a unique taphonomic bias for each plant part. Previous reconstructions of L. Cret. flora from the Southeastern United States (SeUS) indicated a dominance of angiosperms in both leaf and pollen data. Wood data have been lacking. Leaf data are skewed towards foliage resistant to physical degradation in the high-energy environment of deposition. Pollen is the best indicator of diversity in the overall flora, but for many angiosperm taxa, stature of the plant is unknown, and diversity does not necessarily equal total biomass. Pollen taphonomy is affected by varying degrees of aqueous flotation; some taxa may not be particularly relevant for floral reconstructions unless complimented by other plant parts. Data from charcoal (n=125) indicates that conifers comprised 95% of tree-sized flora. A smaller sample (n=12) of petrified wood indicates conifers comprised 92% of the tree-sized flora. Although charcoal taphonomy can be affected by differential flotation among taxa, similar results from charcoal and petrified wood indicate the dominance of conifers is not an artifact. Six new dicotyledonous taxa have been identified from charcoal. Growth rings in trees vary considerably among taxa, and the identity of taxa must be known for growth ring analysis to be relevant. Growth ring morphology in conifers and dicots and carbon isotopes from a single conifer indicate seasonal variation in rainfall, and suggest a monsoon climate regime. Pollen indicates dicots comprised 46%, pteridophytes 27%, gymnosperms 24%, and monocots 5% of the flora, and a warm, humid climate. Angiosperm diaspor size indicates a closed forest canopy. Conifer dominance of the tree-sized component of the flora differs from other contemporaneous sites in the SeUS. This may reflect the lack of wood data in most floral reconstructions. Climate simulations, the presence of hummingbird-beded sands, and localized sand lenses entrained within the Mooreville Chalk Formation indicate the occurrence of paleo-hurricanes. A hurricane/fire disturbance regime may explain the prevalence of conifers, although data reflect knowledge only of coastal areas. Flooding, drowning and flotation may explain the presence of a high concentration of associated dinosaur carcases in the study area. Dinosaur carcases are concentrated near barrier island inlets, and storm runoff may explain how dinosaur carcases and eggs are transported across the high-energy shore-face to be deposited in shallow marine chalks. Dinosaur bone preservation is strongly controlled by bottom water oxygenation.

Technical Session V (Wednesday, October 17, 3:30 pm)

THE ARCHIC BEAKED WHALE NINOZIPHIUS PLATYROSTRIS: CLUES ON THE EVOLUTIONARY HISTORY OF THE FAMILY ZIPHIIDAE (CETACEA, ODONTOCETI)

LAMBERT, Olivier, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; BIANNUCI, Giovanni, Università di Pisa, Pisa, Italy; DE MUIZON, Christian, Muséum national d’Histoire naturelle, Paris, France

Beaked whales (Family Ziphiidae) are a species-rich clade of medium to large size odontocetes (toothed whales). In most extant species the dentition is drastically reduced, a feature interpreted as related to suction feeding. Only one or two pairs of mandibular teeth are usually retained, transformed in tusks in adult males. Shared with sperm whales, the habitat of ziphiids can be described as extreme; several species have been recorded performing feeding dives at depths greater than 1000 m, locating their prey in the darkness using their sonar. Ninoziphius platyrostris has long been considered as the best-known fossil ziphiid, based on the holotype, a skull from the early Pliocene of Peru with associated ear bones, mandible, and several postcranial elements. However, the poor preservation of the dorsal surface of the skull, including the diagnostic vertebra and rostrum base, proved to be an obstacle for the analysis of the phylogenetic relationships of this key archaic species, displaying a full set of functional upper and lower teeth on its elongated snout, as well as several other plesiomorphic characters. The addition to the sample of two newly prepared specimens of the dromaeosaurid Bambiraptor Atrociraptor marshalli to illustrate variation in the teeth of an extant xiphodont faunivore. Fifteen skulls of adult Varanus komodoensis were measured in order to quantify morphological variation of the dentition present in the species. Three gross tooth measurements, as well as molar and distal tooth denticle size, were measured for each of ten teeth across the tooth row. The number of tooth positions varies little between specimens; maxillary and premaxillary tooth counts remain identical in all specimens, but the smallest specimens have one fewer dentary tooth position than the largest skulls. Denticle size and tooth width in regionally equivalent teeth also remain essentially constant (negative allometry) across the size ranges even though tooth length and height increase isometrically with respect to skull size. These findings suggest that orthomorphic aspects of tooth morphology are remarkably consistent between individuals and robust to differences in body size. Data from multiple individuals and comparison to other varanids indicate the potential of diagnostic characters in teeth. These results have implications for understanding the diversity of small theropods, as extensive information on their abundance and diversity is derived from isolated teeth. Comparison with specimens of the dromaeosaurids Atrociraptor marshalli, Bambiraptor feinbergi, and Dromaeosaurus albertensis indicates that the standard deviation of denticle size is similar (~0.2–0.4) to that of individual specimens of Varanus komodoensis, showing that within-individual denticle size is consistent. However, comparison to the large number of isolated teeth referred to these same species shows much greater disparity than would be expected from intraspecific variation in F. komodoensis. This suggests that hidden ontogenetic or taxonomic factors are likely contributing to fossil tooth disparity. Although ontogenetic variation of teeth is not well understood in theropod dinosaurs, these results are consistent with a growing body of evidence that alpha diversity of small theropods is underestimated.

Technical Session VII (Thursday, October 18, 2:00 pm)

TOWARD A QUANTITATIVE WAY TO IDENTIFY ANCESTORS IN THE FOSSIL RECORD: A BAYESIAN APPROACH

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The only direct evidence of the diversity of life through geologic time is contained in the fossil record, and this record is biased and incomplete. Fossils provide information that cannot be obtained from studying living organisms alone, but they bring with them unique methodological challenges. When a fossil lineage is densely sampled through time and sufficiently accessible to morphological change, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time.

When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time. When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time. When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time. When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time. When an unbroken transition in morphology is observed between older and younger forms, it can be argued that the stratigraphically older fossils represent ancestors and the younger fossils their descendants. However, the fossil record rarely provides the kind of evidence needed to make a strong argument for an ancestor-descendant relationship. Moreover, fossils must be treated as terminal taxa in order to be included in phylogenetic analyses. For this reason, they are considered to represent extinct species with no morphological change through time.
endemisms. However, the paucity of vertebrate fossils has made the inclusion of this clade difficult. A new marine and terrestrial vertebrate fauna from the upper Valanginian (ca. 138 Ma) is presented. The age is constrained by the presence of the small ammonite Saynoceras verrucosum. The fauna is composed of chondrichthyan, actinopterygian, testudines, a pleiosaur, a crocodyloform, a possible pterosaur, and a dinosaur. These are interpreted in the context of the biogeographic interchange that would have dominated faunal dynamics in the region during this time.

Technical Session I (Wednesday, October 17, 10:45 am)

A BIOMECHANICAL MODEL OF ERLIKOSAURUS ANDREWSI (DINOSAURIA: THERIZINOSAURIA) WITH IMPLICATIONS FOR CRANIAL FUNCTION AND DIETARY PREFERENCES
LAUTENSCHLAGER, Stephan, University of Bristol, School of Earth Sciences, Bristol, United Kingdom; RAYFIELD, Emily J., University of Bristol, School of Earth Sciences, Bristol, United Kingdom; WITMER, Lawrence M., Ohio University, Department of Biomedical Sciences, College of Osteopathic Medicine, Athens, OH, United States; ALTANGEREI, Perle, National University of Mongolia, Ulaanbaatar, Mongolia

Theropod dinosaurs have historically been regarded as an exclusively carnivorous and predatory group. However, recent analyses have suggested that herbivory may have been more widespread among the theropod clades than previously thought, leading to far-reaching ramifications for the evolution of dietary specialisations in theropods. Therizinosaurus represents one such herbivorous clade and their highly unusual anatomy has led to a variety of dietary assumptions. These range from piscivory and insectivory to various forms of herbivory, whereas the edentulous tip of the snout has been regarded as evidence for the presence of a keratinous beak. However, these assumptions have not been subjected to a more rigorous, biomechanical analysis.

We analysed the biomechanical behaviour of the skull and lower jaws of *Erlikosaurus andrewsi* – the only therizinosaur preserving a nearly complete and articulated skull. Using information derived from computed tomography (CT) scanning, the complete skull of *Erlikosaurus* was digitally reconstructed. The three-dimensional model subsequently served as a foundation for the detailed reconstruction of the adductor musculature, thus allowing for the estimation of individual muscle and bite forces. The latter were calculated for different positions in the skull and lower jaws: the edentulous tip of the snout, the first tooth position and the posteriormost tooth position. The estimated bite forces for *Erlikosaurus* are relatively low, both in actual numbers as well as in comparison to other theropods or in relation to its body size. With this result in mind, a different finite element (FE) model was created, incorporating muscle and bite force estimates, to test the mechanical capabilities of *Erlikosaurus*. Two hypothetical models were further tested, which contained a keratinous sheath or beak, covering the edentulous premaxilla and partly the maxilla.

The results of the finite element analysis demonstrate that even the comparably low bite forces would cause increased stress values in the skull of *Erlikosaurus*, in particular when applied to the posterior teeth. The addition of a keratinous beak on the skull and lower jaws considerably reduces the generated stresses for the anterior bite scenarios. The lack of wear facets, tooth occlusion and the possible presence of a large gut to process plant material, further suggest that the available bite force would not have been used for extensive mastication and chewing processes. This supports a hypothesis that *Erlikosaurus* would use the edentulous snout (potentially covered by a keratinous sheath) and anterior teeth to procure plant matter by branch-stripping and cropping of soft vegetation.

Technical Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE BRAINCASE AND ENDOCRANIAL SPACE OF THE IGUANODONTIAN LURDUSAURUS ARENATUS
LAUTERS, Pascaline, IRSNB, Brussels, Belgium; TAQUET, Philippe, MNHN, Paris, France; VERCAUTEREN, Martine, ULB, Brussels, Belgium; GODEFROIT, Pascal, IRSNB, Brussels, Belgium

*Lurdusaurus arenatus* is a heavily built iguanodontian discovered in the Aptian (Early Cretaceous) of Gadoufoua, Niger. Since its first descriptions in 1988 and 1999, *L. arenatus* remained poorly known and its endocranial region was not studied. Information on the structure of its brain is presented based on a silicone endocranial cast. The endocranial cast of *L. arenatus* shows several peculiar features not observed on the endocasts of other iguanodontians. The olfactory lobes are comparatively small, suggesting that the sense of smell was less developed than in the other ornithopods observed by the authors. The cerebral hemispheres are narrow and oval in shape. Despite the large size attained by *L. arenatus*, the pituitary body, responsible of the production of the growth hormone, was small. The position of the inner ear is marked by a profound constriction, contrary to what is observed in other ornithopods. With its straight endocast, *L. arenatus* preserves the derived condition observed in *Iguanodon bernissartensis* and in hadrosaurids. The most likely causes of variation in the angles of the primitive flexure pattern are absolute skull size and position of the inner ear. This result further supports the phylogenetic position of *Lurdusaurus arenatus* as a transitional form between these two clades.

Postersession II (Thursday, October 18, 4:15 - 6:15 pm)

FOSSIL AND MODERN TURTLE EGGSHells: TESTING THE VALIDITY OF EGGShell CHARACTERS IN CLADISTIC ANALYSES
LAWVER, Daniel R., Montana State University, Bozeman, MT, United States

Several studies demonstrate the usefulness of egg and eggshell characters in determining phylogenetic relationships among extinct non-avian taxa as well as extant avian taxa. However, such analyses based solely on egg and eggshell characters have not been adequately tested with eggs of extant species outside of Aves. Therefore, a cladistics analysis was conducted to determine whether egg and eggshell characters are phylogenetically significant within Chelonia. Ingroup taxa include 24 extant turtle species from multiple clades (e.g., Chelidae, Kinosternidae, Dermatemydidae, Trionychidae, Bataguridae, and Testudinidae) and one fossil specimen.

Eggshell from each taxa was freshly broken and half of each fragment prepared as a standard thin section (30 μm thick) and examined under a Nikon Eclipse LV100POL light microscope. The other half of each fragment was mounted on an aluminum stub, coated with gold, and imaged under a JEOL JSM-6100 scanning electron microscope at 15 kV. Images included the inner and outer surfaces and radial views of each eggshell. This analysis allowed for identification of features used in the cladistic analysis, including mineral composition and structural features (e.g., shell unit height/width, shell unit spacing, pore length/width, shell shape and number of shell layers). Features, such as eggshell size and shape are also included in the analysis. Additional characters obtained from the literature permit a more comprehensive cladistic analysis of eggshell. Four outgroup taxa were included in this analysis in order to polarize the characters (i.e., two crocodilian and two avian taxa). Characters and character states were analyzed using PAUP/MacClade software in order to determine the most parsimonious trees. The trees were then be compared to previously published phylogenies of extant and extinct turtles.

Resulting consensus tree shows a large polytomy comprised of chelonian taxa. Within this polytomy, an archosaurian clade is resolved containing both a crocodilian clade as well as an avian clade. This suggests that egg and eggshell characters are not phylogenetically adequate for distinguishing among chelonian taxa; however, these characters are phylogenetically significant and sufficient for differentiating Chelonia from non-turtle taxa.

Technical Session XI (Friday, October 19, 2:00 pm)

PEDAL DIGIT IV PROPORTIONS REVEAL BODY-SIZE ASSOCIATED CONSTRAINT ON DINOSAUR FOOT MORPHOLOGY
LEARY, Brian, University of Massachusetts Dartmouth, North Dartmouth, MA, United States; KAVANAGH, Kathryn, University of Massachusetts Dartmouth, North Dartmouth, MA, United States

The proportions of the pedal phalanges of tetrapods have been found to correlate with foot function. Plotting the phalangeal proportions of birds in morphospace not only allows us to discriminate functional groups, but also reveals a restricted range of variation in which many potential morphologies are unrepresented. Additionally, we observed some striking examples of convergent evolution. In previous studies, digit III of the foot was used to infer function as it was hypothesized to be the most functionally significant. However, we found that digit IV is more effective in discriminating functional groups in birds. We applied this insight to the pedal phalanges of 30 non-avian theropods and bipedal ornithischians to identify functional groups and compare the range of variation in the ancestors of modern birds. Using Principal Component Analysis and Generalized Linear Modeling, we have shown that the phalangeal proportions of all dinosaurs sampled fall within a subset of the range of variation observed in birds, (2) ornithischian dinosaurs fall exclusively within the range of terrestrial, non-perching birds (e.g., running, walking, swimming), exhibiting in most cases, extreme proximodistal gradient patterning, (3) non-avian theropods fall within a range spanning from terrestrial birds to highly arboreal taxa, but extreme raptorial morphologies are conspicuously absent, and (4) the phalax proportions of non-avian theropods are strongly correlated with body length. Extreme distal elongation does exist in the forelimbs, but not hind limbs, of some non-avian theropods. Since body length is not predictive of digit proportion variation in birds, this apparent constraint on hind limb proportions may only exist at the extreme body sizes found in large dinosaurs. The evolution of flight and reduction of body size are thus correlated with the expansion of variation in the distal phalanges of the avian lineage.

Technical Session XIV (Saturday, October 20, 8:00 am)

DENTAL HISTOLOGY OF DIAPECTOMORPHA AND THE EVOLUTION OF CEMENTUM AND ALVEOLAR BONE WITHIN AMNIOTA
LEBLANC, Aaron R., University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada

Recent studies of tooth implantation using histological methods in squamates and other diapsid reptiles have led to a novel hypothesis for the homology of amniote tooth tissues. These studies have demonstrated the presence of alveolar bone, cellular and acellular cementum, and periodontal ligaments in squamates, ichthyosaurs, and crocodilians, which is similar to the condition in mammals. The presence of these tissues in distantly related
reptiles suggests that this characterizes tooth implantation for Amniota instead of being unique to mammals. To test this hypothesis, thin sections were made of the marginal dentition of diadectids from the Lower Permian of Texas. Diadectids are suggested to have been the first high fiber herbivores in terrestrial communities, and also occupy an important position in the amniote phylogeny as stem amniotes. In this study, diadectids are important subjects for the identification of primitive conditions of tooth implantation in Amniota.

Historical examination of the marginal dentition of Diadectes shows for the first time that plicidentine (dentine infolded towards the pulp cavity) was present in Diadectidae, but does not significantly contribute to an increase in surface area for attachment of the teeth to the jaws. Instead, the teeth are set in deep sockets lined with alveolar bone that was shed with each tooth replacement event. Although no periodontal ligament is preserved, the teeth appear to be ankylosed to the alveolar bone via a network of thick Sharpey’s fibers that insert into cellular and acellular cementum coating the root of the tooth. The carnivorous basal diadectomorph Limplosicus also possesses deep roots lined with alveolar bone and roots coated with cementum, suggesting that these features are not associated with high fiber herbivory in this clade. The presence of these tissues indicates that the potential to produce thecodont periodontal tissues is present in these stem amniotes and may be primitive for Amniota.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

NATIONAL PARK SERVICE VERTEBRATE COLLECTIONS AT THE SMITHSONIAN: COLLABORATION TO SUPPORT SCIENCE AND STEWARDSHIP

LESSER, Samantha, Geological Society of America, Rochester, NY, United States; SMITHSONIAN: COLLABORATION TO SUPPORT SCIENCE AND NATIONAL PARK SERVICE VERTEBRATE COLLECTIONS AT THE

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A LARGE-BODIED BASAL ENANTHIORMITE BIRD FROM THE EARLY CRETAEOUS OF CHINA WITH A PROPOSED RAPTORIAL FEEDING ECOLOGY

LI, Zhiheng, The University of Texas at Austin, Austin, TX, United States; ZHOU, Zhongbe, Institute of Vertebrate Paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; CLARKE, Julia A., The University of Texas at Austin, Austin, TX, United States

Enantiornithes are proposed to comprise the most significant radiation of Mesozoic birds in terms of species richness and ecological diversity. Their earliest records are Early Cretaceous in age. Although fossils relevant for understanding this radiation are globally distributed, Early Cretaceous Enantiornithes are best represented in the Yixian and Jiufotang Formations of northeastern China. In the fauna known from these Formations, the Jehol Biota, the diversity of Enantiornithes greatly exceeds that of other groups of birds (e.g., Ornithurae, or more basal avians). However, only a handful of Jehol taxa have been proposed as basal parts of Enantiornithes (e.g., Protopteryx, Pengornis, and Eoenantiornis). Globally this early part of the lineage is poorly sampled, and early arising synapomorphies for the group are still not fully understood. Here, we describe a new large-bodied species of basal enantiornithine bird from the Early Cretaceous of China that sheds light on both morphological variation and ecological specialization in the clade. The new specimen, a complete skeleton with a well-preserved skull, shows a unique combination of characters for basal avians: reduced maxillary and dentary denticulation with smaller, peg-like premolar teeth; sternum with the posterior sternal midline and lateral trabeculae approximately equal in posterior extent; a flat to sub-concave lateral margin of the coracoid with a small lateral process; abbreviated rod-like hypochondium on the furcula, an extremely robust sub-rectangular arcomion process on the scapula; a small metacarpal I with a weakly-bowed anterior margin; and, markedly elongate, recurved pedal unguals. The body size of the new species is only slightly smaller than Pengornis, the largest described enantiornithine taxon, and is larger than all other Early Cretaceous Enantiornithes. Based on the novel combination of both cranial and pedal attributes we propose the new species may have had a raptor-like ecology. By providing new insight into character evolution and ecological range in basal Enantiornithes, the reported taxon improves our understanding of the early part of a key Mesozoic radiation.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

USING STABLE ISOTOPE ANALYSIS OF COPROLITES TO DETERMINE PALEODIET OF LATE PLEISTOCENE MAMMALS

LIGHTNER, Erik, University of Wyoming, Laramie, WY, United States; CLEMENTZ, Mark T., University of Wyoming, Laramie, WY, United States; FOX-DODBS, Kena, University of Puget Sound, Tacoma, WA, United States; MINKLEY, Thomas, University of Wyoming, Laramie, WY, United States; KORNFIELD, Marcel, University of Wyoming, Laramie, WY, United States

Stable isotope analysis has contributed to reconstructions of paleoenvironment and paleodiet of fossil taxa across glacial intervals during the Late Pleistocene-Holocene. Yet, few Pleistocene studies have examined δ13C and δ15N values in coprolites. Stable isotopic analysis of coprolites can aid in dietary reconstruction of fossil consumers, but only after diet-fece discrimination, taphonomic effects, and past environmental conditions (e.g., variation in the δ13C of atmospheric CO2) have been taken into account. To test the degree of influence of these factors on δ13C and δ15N values, we analyzed rodent (Neotoma sp.) and sheep (Ovis aries) coprolites from the Last Canyon Cave rockshelter in southern Montana. These coprolites form a continuous record spanning the last 40 ka, and occur in association with well-preserved pollen and mammal fossils, which provide an independent record of paleoenvironmental information for this deposit.

Coprolite δ13C and δ15N values varied with depth and age within the measured section. δ15N values of coprolites were higher in both Neotoma sp. and Ovis aries than would be anticipated for terrestrial consumers, with some values exceeding 20‰. This reflects the combined effects of 1) enrichment due to microbial activity, 2) possible evaporative enrichment prior to burial, and 3) an assumed diet-fece discrimination of 2.1‰ for Neotoma sp. and 3.1‰ for Ovis aries. Mean (± 1 s.d.) δ13C values for Neotoma sp. (-25.7 ± 1.0‰) and Ovis aries (-26.5 ± 0.8‰) were not as enriched in 13C as compared to δ15N values, which is consistent with results from modern soils. This suggests that δ13C values in coprolites are a more reliable indicator of paleodiet. Thus, the seemingly stochastic variations through time in our results could be explained by changes in individual foraging preferences, possibly by switching between gymnosperm and angiosperm plant types, or by variation in cactus consumption over time.

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used to derive estimated ages for the individuals. All three processes produced congruent results, with the rank order of species derived from cranial elements tallying with the order of the postcranially-based size estimates (ranging from 8.0-16.5 metres), which in turn agreed with the estimated ages derived from annular counts of the meristic elements (ranging from 21-45 years). All these examinations of fossil material is necessary for the detailed resolution of growth rate, in particular in the first years of life, this technique has importantly demonstrated a consistent pattern of size and age among different specimens of *Leedsichthys* from three differing areas of their skeletal remains. The size and age estimates are compatible with what is known of the growth of large modern-day oceanic suspension-feeding chondrichthyans.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

**BODY SHAPE DIFFERENCES BETWEEN NORTH AMERICAN AND ASIAN FOSSIL CATOSTOMIDS AND ONTOGENETIC CHANGE IN EARLY CYPRINIFORMS**

LIU, Juan, University of Alberta, Edmonton, AB, Canada; TSENG, Zhijie J., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; WILSON, Mark V., University of Alberta, Edmonton, AB, Canada; MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada

The most studied early fossil catostomid *Amzyon aggregatum* (Cypriniformes, Catostomidae), recorded from the early Eocene of Canada, was highly variable in its meristic and metric characters. Measurements and meristics of two other well-known species of *Amzyon* overlap with this species. One of these, *A. gosiutense* from the Green River Formation, has been considered by some to be a junior synonym of *A. aggregatum*. The other, *A. huanense*, from southern China, is difficult to distinguish from *A. aggregatum* based solely on meristic and metric characters. To examine body shape differences of early catostomids and shape changes through ontogeny of early cypriniforms, geometric morphometric analyses were performed on three early catostomid species, as well as on the Eocene *Jianghanichthys hubeiensis*, a putative basal cypriniform. Anatomical landmarks were digitized in two dimensions on complete fossil specimens preserved on slabs. First, principal component analysis (PCA) shows that the body shape of *Jianghanichthys* differs from that of all included species of *Amzyon*, and that a difference between North American and Asian catostomids is also apparent within the body shape morphospace. The Asian species possess a comparatively shorter head, caudal peduncle, and dorsal fin base, a more caudally placed anal fin, and a deeper body. Second, regression analysis of shape changes with size shows a parallel pattern of body shape change through ontogeny in all tested taxa. General shape changes with growth include: skull, caudal peduncle, and anal fin base shorter, body deeper, dorsal fin base extended further anteriorly and posteriorly, and pectoral fin originating more anteroventrally. Interestingly, PCA performed on the residuals of the body size and shape regression analysis (to remove size effects) showed that the body shapes of tested taxa were less distinct from one another when compared with the results of analysis prior to size correction; this holds true even between *Amzyon* and *Jianghanichthys*. This indicates that comparisons among species should concentrate on individuals of similar body size. The size-corrected morphospace nevertheless shows *Amzyon* having a shallower body and longer head than *Jianghanichthys*. Discriminant function analysis of both datasets returned negligible errors in correct identification of species based on body shape, but these results were statistically significant (p < 0.0001) only between genera. In conclusion, body shape changes indicated by geometric morphometrics analysis has the potential to improve diagnosis of closely related fossil catostomids, as well as to illuminate interspecific differences in morphological shape that become more pronounced after ontogeny (as measured by body size) has been taken into account.
occurrences alone, Campanian baenid assemblages display distinct northern and southern provinces with no taxonomic overlap. To investigate the evolutionary patterns of this biogeographic signal, I applied a dispersal-extinction-cladogenesis model to the strict consensus tree and three randomly selected most parsimonious trees (out of a total of 18) from my phylogeographic analysis. For each tree, I computed both smoothed and strict temporal calibrations. My analysis reveals that the ancestral ranges for basal baenid branches were cosmopolitan across either Laramidia or all of North America. More derived baenids (i.e., sub-clade Baenodda) possessed ancestral ranges in the area of Montana, Wyoming, and the Dakotas; the analysis reconstructs multiple individual lineages then dispersing to southern Laramidia and Alberta.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macromutation (Friday, October 19, 9:00 am)

CONFIDENCE INTERVALS ON NODE AGE ESTIMATES IN VERTEBRATE PHYLOGENY

LLOYD, Graeme T., University of Oxford, Oxford, United Kingdom; FRIEDMAN, Matt, University of Oxford, Oxford, United Kingdom; BELL, Mark A., University of Glasgow, Glasgow, United Kingdom

Palaeontology and biology are increasingly converging on common goals and methods, particularly in regards to phylogenetics. However, the recent adoption of Phylogenetic Comparative Methods (PCM) by palaeontologists has exposed a hitherto unrecognized problem in how fossil trees are dated. Specifically, the approach of dating each node using its oldest descendant means at least of half of all branches have a duration of zero -- an untenable and unrealistic result. Previous solutions to this problem have been somewhat arbitrary in nature, for example: adding a million years to each node. Here we use a novel approach that takes as its input the topology, tip ages and, critically, outgroup ages for a given clade. All internal nodes are then dated by either a probabilistic (where specific requirements are met) or randomisation-approach. The method then returns a distribution of ages for each node, allowing for median and 95% confidence estimates.

Explanatory application of this approach to a 554-taxon phylogeny of placental mammals gives a median age for the origin of the clade as 84.28 Ma with 95% confidence intervals of 71.32-106.04 Ma. Comparison with a recent molecular clock analysis shows that for all comparable nodes (Carnivora, Ceratomorpha, Perissodactyla and Placentalia) the 95% confidence intervals comfortably overlap. Thus, explicitly taking into account the uncertainty implied in the fossil record indicates a greater congruence between fossil and molecular data than previously supposed.

Beyond cross-correlation between dating methods future applications of this approach include: 1) leveraging more fossil data than merely the oldest crown-group occurrence for a clade to provide better calibration dates for molecular clock approaches, 2) providing improved calibration points for molecular clock approaches, 3) providing a clade to provide better calibration dates for molecular clock approaches, 4) providing improved calibration points for molecular clock approaches. My analysis reveals that the ancestral ranges for basal baenid branches were cosmopolitan across either Laramidia or all of North America. More derived baenids (i.e., sub-clade Baenodda) possessed ancestral ranges in the area of Montana, Wyoming, and the Dakotas; the analysis reconstructs multiple individual lineages then dispersing to southern Laramidia and Alberta.

POSTER SESSION I (Wednesday, October 17, 4:15 - 6:15 pm)

HIGH OBSERVER VARIABILITY IN DENTAL MESOWEAR ANALYSIS OF AN EXTREME GENERALIST CORMOHIPPARION EMLIESI FROM FLORIDA: CAUTIONARY LESSONS LEARNED FROM INTEGRATING GEOCHEMICAL AND DENTAL MESOWEAR DATA

LOFFREDO, Lucas F., Vanderbilt University, Nashville, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

Dental mesowear is an inexpensive and quick method used to assess the average diet of herbivorous mammals. In contrast, most dental microwear that captures dietary information produced via abrasive food material during the last few weeks of an animal’s life, mesowear captures wear produced over the lifetime of the animal by both attrition and abrasion. Most mesowear methods focus on qualitatively categorizing cusp shapes as high, round, or blunt (also noting high or low relief), or categorizing teeth into numerical categories (typically 0 to 6, from sharp to blunt) that integrate these variables. As mesowear requires an observer to make subjective judgments as to tooth categories, we aim to assess observer variability similar to what has been done with other observer reliant methods such as dental microwear. Additionally, we integrate carbon isotope geochemistry with mesowear data in a generalist herbivore Cormohipparium emliesi to assess if mesowear similarly records average dietary information. Stable carbon isotope samples from C. emliesi from the Bone Valley of Florida (~5 Ma) were analyzed and added to previously published data, yielding a δ13C range of 13.7‰ (-12.9 to 0.8‰). These geochemical data suggest extremely generalized dietary behavior ranging from primarily browsers to grazers. Mesowear data collected by experienced individuals and minimally trained individuals are significantly different from one another, with experienced individuals assigning lower average shape categories (e.g., assigning blunt over round; p<0.001) and lower relief categories (e.g., assigning low over high relief; p<0.024), while assigning higher numerical categories (p<0.01). Furthermore, multiple linear regression models of shape and relief categories significantly predict assignments of 0-6, while experienced individuals have higher R2 values than novices (R2=0.95, R2=0.81, respectively). All shape and relief categories were assigned to 83% and 100% of teeth sampled (n=23), respectively. Despite these differences, average mesowear values of all teeth sampled are ~4.0 (on a 0-6 scale) for both groups of observers and consistent with a mixed diet. However, stable carbon isotope and mesowear data for identical specimens are not significantly related, with δ13C extremes (-12.9 and 0.8‰)yielding mesowear values only 0.7 apart (4.9 and 4.2), based on experienced classifications. Collectively, these data demonstrate that mesowear data is highly variable and should not be interpreted as similar to geochemical data.

THE EARLY EVOLUTION OF TYRANNOSAURID DINOSAURS: NEW ANATOMICAL, PHYLLOGENETIC AND BIOGEOGRAPHIC EVIDENCE

LOEWEN, Mark A., University of Utah, Salt Lake City, UT, United States; SERTICH, Joseph J., Denver Museum of Nature and Science, Denver, CO, United States; IRMIS, Randall B., University of Utah, Salt Lake City, UT, United States

Recent descriptive and phylogenetic work over the past decade has identified an increasing origination and extinction. Recent descriptive and phylogenetic work over the past decade has identified an increasing recent descriptive and phylogenetic work over the past decade has identified an increasing

A PECULIAR TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF FLORIDA

LOMAX, Dean R., Doncaster Museum and Art Gallery, Doncaster, United Kingdom; MASSARE, Judy A., Earth Sciences Dept, SUNY College at Brockport, Brockport, NY, United States

A new species of Ichthyosaurus from the Lower Jurassic (Pliensbachian) of west Dorset, England

LOW, Barbara M., Royal Scottish Museum, Edinburgh, United Kingdom; LONG, John A., Natural History Museum of LA Co., Los Angeles, CA, United States; AUSTRALIA SUPPORTS GONDWANA ENDEMISM IN THE STEM TETRAPOD RADIATION

LONG, John A., Natural History Museum of LA Co., Los Angeles, CA, United States; HOLLAND, Timothy, Museum Victoria, Melbourne, Australia; YOUNG, Gavin C., Australian National University, Canberra, Australia

A new tetrapodomorph fish (Osteichthyes; Sarcopterygii) from the late Middle Devonian (late Givetian) Harjupa Sandstone member of the Amadeus Basin, central Australia, is represented by several near complete skulls and much of the body and postcranial skeleton. It has been studied from latex casts made from detailed sandstone impressions. It had a long parietal shield relative to its postparietal, a posteriorly broad postparietal shield, very small orbits and broad, triangular extratemporal bones, allowing confident phylogenetic placement within the caninwondruid clade, as shown by a new PAUP analysis of tetrapodomorph fishes. Our analysis also questions the long held position of Rhizodontida at the base of the

Technical Session I (Wednesday, October 17, 9:00 am)

A NEW SPECIES OF ICHTYSOaurus FROM THE LOWER JURASSIC (PLIENSCHBACHIAN) OF WEST DORSET, ENGLAND

LOMAX, Dean R., Doncaster Museum and Art Gallery, Doncaster, United Kingdom; MASSARE, Judy A., Earth Sciences Dept, SUNY College at Brockport, Brockport, NY, United States

A new species of Plenosichichthys ichthyosaur from the Stone Barrow Marls Member (Charmouth Mudstone Formation) of Dorset, England is recognized. The species is assigned to Ichthyosaurus on the basis of humerus, forefin, and pectoral girdle morphologies. Diagnostic features of the new species include a long, fairly robust snout, moderate to small orbit, short stout humerus, and very small femur (and hindfin) relative to the humerus (and forefin). Two specimens are known, the proposed holotype and a nearly complete skeleton of a juvenile, possibly from Lyme Regis (stratigraphy unknown). According to current criteria for assessing the maturity of ichthyosaurs, it appears that the holotype is at least a sub-adult. The new species brings the diversity of Pliensbachian ichthyosaurs to at least three and possibly as many as five species, representing three genera: Ichthyosaurus, Leptonectes, and Tennomdosaurus.

Technical Session II (Wednesday, October 17, 9:15 am)

A PECULIAR TETRAPODOMORPH FISH FROM THE MIDDLE DEVONIAN OF AUSTRALIA SUPPORTS GONDWANA ENDEMISM IN THE STEM TETRAPOD RADIATION

LONG, John A., Natural History Museum of LA Co., Los Angeles, CA, United States; HOLLAND, Timothy, Museum Victoria, Melbourne, Australia; YOUNG, Gavin C., Australian National University, Canberra, Australia

A new tetrapodomorph fish (Osteichthyes; Sarcopterygii) from the late Middle Devonian (late Givetian) Harjupa Sandstone member of the Amadeus Basin, central Australia, is represented by several near complete skulls and much of the body and postcranial skeleton. It has been studied from latex casts made from detailed sandstone impressions. It had a long parietal shield relative to its postparietal, a posteriorly broad postparietal shield, very small orbits and broad, triangular extratemporal bones, allowing confident phylogenetic placement within the caninwondruid clade, as shown by a new PAUP analysis of tetrapodomorph fishes. Our analysis also questions the long held position of Rhizodontida at the base of the
clade containing total group Tetrapodomorpha minus Kenichthys. Caninoidrnioids are an endemic clade of tetrapodomorph fishes only known from the Middle-Late Devonian of Australia and Antarctica. This new form shows greater morphological disparity and reveals new patterns of anatomy not previously known for the group, such as the structure of the palate and parasphenoid, which is v-shaped posteriorly. It is also unusual in having large open spiracles on top of the head, cheek plates tightly integrated anteriorly to the skull roof, and large lateral extracapsulars that almost meet mesially. The significance of the large spiracles, also seen in the late Devonian Gogonasus andrewsae, hinges on the fact that the new genus is older than Gogonasus, well before the period of anoxia in the Devonian reef previously thought to be a possible explanation for these structures being developed for accessory air-breathing. The new find suggests that large spiracles appear at different times and at widely differing nodes in the stem tetrapod radiation so were most likely a convergent feature that did not become phylogenetically significant until established as a robust character in the more derived elpistostegiids, and later transformed in early tetrapods into the tympanum.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

MULTIPLE INTERCONTINENTAL DISPERALS OF THE RHIZOMYINAE (SPLACIDAE, RODENTIA)

LÓPEZ-ANTOÑANZAS, Raquel, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain; FLYNN, Lawrence J., Peabody Museum of Archaeology and Ethnology, Harvard University, Cambridge, MA, United States; KNOŁ, Fabien, Museo Nacional de Ciencias Naturales-CSIC, Madrid, Spain

The Subfamily Rhizomyinae is known from the late Oligocene to the present. Today, this group comprises only six species, which live in southern Asia and eastern Africa: Rhizomys sinusipes, R. prainorum, R. numidicus, Cannomys badaxis, Tachyoryctes splendens, and T. macrocephalus. However, the rhizomyines were more diverse and had a much wider distribution in Asia and Africa in the past. Thus far, 33 fossil species can be referred to this group: Rhizomyx (Brachyhyrizomyx) shensianus, R. (Brachyhyrizomyx) shajas, Miochizomyx nigrei, M. micrus, M. blaci, M. pilgrimi, M. harri, M. tetracharax, M. choristos, Protachyoryctes tato, P. mokoza, T. plicacenticus, T. konjii, Rhizomydes sivalensis, R. punjabensis, R. carthoronti, R. platytoemus, Kanasimys indicus, R. nagri, K. sivalensis, K. potvarenisi, Eiotherium koulaudense, Emprihizomyx opykei, A. pinjoricas, Pronokalimys andrewsii, Nakalimys wacovati, Prokanisamyx wokalalek, P. arifj, P. benjavuni, P. major, and P. sp. from Libya. A cladistic analysis involving fossil and living species has been carried out. The most basal representative of the subfamily Rhizomyinae belongs to Prokanisamyx and the crown-group is formed of two clades: Tachyoryctini and Rhizomyini. This analysis provides information about the origin of the African rhizomyines and allows inference of multiple dispersal phenomena from their Asian center of radiation to Africa at different times during the Miocene. Thus, a first geodispersal of Prokanisamyx from Pakistan to East Africa would have taken place at the beginning of the early Miocene. From this first event Prokanisamyx sp. from Jebel Zelten would have originated. The second and third geodispersal events took place probably not earlier than 18 Ma and would have given rise to the middle Miocene Pronokalimys and to the late Miocene Nakalimys. With respect to the late Miocene Protachyoryctes makooka and the African Tachyoryctini, two unidirectional dispersal events from southern Asia to Africa took place in the late Miocene (not earlier that 8.2 Ma). The first involved the origin of Protachyoryctes makooka, whereas the derivation of the African Tachyoryctini (Tachyoryctes sp.) would have come from an independent entry into this continent.

Poster Session I (Tuesday, October 18, 4:15 - 6:15 pm)

PATTERNS OF ENCEPHALIZATION IN THE EARLY EVOLUTION OF PRIMATES

LOPEZ-TORRES, Sergio, University of Toronto, Toronto, ON, Canada; SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

Ancestral state reconstruction techniques are widely used to estimate character states for traits such as brain size in basal nodes of phylogenetic analyses. Previous attempts to infer ancestral brain size for the basal euapimates did not include data from stem primates (Plesiadapisiformes) or their closest relatives. This study presents ancestral state reconstructions of absolute and relative brain size (encephalization quotient; EQ) on key nodes related to Primates, including Euarhonta, Primates sensu lato (including “Plesiadapiformes”), Euprimatiformes (Plesiadapidae + Euprimates), Euprimates, Strepsirrhini, and Haplorhini. Two ancestral state reconstruction methods were used: Bayesian analysis matched this pattern. This suggests a significant brain size increase at the euprimates node, consistent with hypotheses that link cerebral expansion to improvements in visual processing. Including fossils and relevant outgroups proved critical to refining ancestral state reconstructions.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A DIVERSE WOMBAT FAUNA FROM THE PLIOCENE CHINCHILLA SAND FORMATION, SOUTHEASTERN QUEENSLAND, AUSTRALIA

LOUYS, Julien, The University of Queensland, Brisbane, Australia

The Chinchilla Sand Formation is a Pleistocene fluvial system of interbedded clays, sands and conglomerates representing several episodes of deposition. It is one of Australia’s few vertebrate Pliocene sites, and one of the richest with 14 new species described and a total of 57 species represented at the site. Despite well over 100 years of research on the Chinchilla local Fauna, the wonbs have never before been systematically described, and the taxonomic identity of the Vombatidae preserved in the deposit remains unknown. Here, I describe the wombat material from Chinchilla. At least four species of wombat can be identified in the deposit, making this Australia’s richest wombat assemblage. Identified species include Vombatus ursinus, Phascolonus gigas, Ramsayia lemayi and “Phascolomys” medius. Most of the identifiable material is represented by mandibular fragments, although some identifiable cranial fragments are also preserved. Isolated teeth are relatively common, however they can only be assigned to Vombatidae gen. et sp. indet. The most abundant wombats recovered are of the large-bodied forms such as Phascolomys, “Phascolomys” and Ramsayia, with Vombatus-sized elements relatively less common. Both adult and juvenile wombats are preserved. The incredible richness of Chinchilla’s wombat fauna suggests a considerable grassland component to southeast Queensland’s Pleistocene palaeoenvironments, and supports a mid to late Pliocene age for this site.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW ALVAREZSAURID (DINOSAURIA, THEROPODA) FROM UPPERMOST CRETACEOUS OF LUANCHUAN, HENAN PROVINCE OF CHINA

LU, Junchang, Institute of Geology, Chinese Academy of Geological Sciences, Beijing, China; XI, Li, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliang, Henan Geological Museum, Zhengzhou, China; CHANG, Huali, Henan Geological Museum, Zhengzhou, China; XU, Li, Henan Geological Museum, Zhengzhou, China; HUANG, Han, Henan Geological Museum, Zhengzhou, China; CHANG, Huali, Henan Geological Museum, Zhengzhou, China; XU, Li, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, China; XU, Li, Henan Geological Museum, Zhengzhou, China; ZHANG, Xingliao, Henan Geological Museum, Zhengzhou, China

Herein reported is a new alvarezsaurid dinosaur discovered from the uppermost Cretaceous deposits of the Qupa Formation, Tantou Basin, Henan Province of central China. The Qupa Formation (late Maatrichitan) is dominated by brownish red thick-bedded siltstone, calcareous mudstone, interbedded with thin fine conglomerates, and parallel and cross laminations which indicate shallow lacustrine and braided river delta facies. The new taxon is assigned to Parvicursorinae based upon: supractubular crest on ilium extending only to the cranial half of the acetabulum; and proximal end of metatarsals III reduced, not reaching the tarsals. It represents the youngest alvarezsaurid dinosaur from China.

A preliminary phylogenetic analysis was performed using 77 characters and 15 taxa (including two taxa: Tyrannosauridae and Dromaeosauridae as outgroups and 13 taxa as ingroups). The analysis produced two most parsimonious trees of length 109 steps (consistency index of 0.78, rescaled consistency index of 0.67, and a retention index of 0.67). The strict consensus of the two most parsimonious trees shows that the new alvarezsaurid dinosaur is basal to the Mongolian parvicursorines (Mononykus plus Shuvuuia). It shares one character with Mongolian parvicursorines: metatarsals II and IV subequal in length. The apomorphies of the new taxon are: cervical centra with flat sides, dorsal vertebrae amphiplatyan and proximal end of grooves on manual ungual I partially enclosed by notches.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FOSIL CAMELS FROM THE LATE OOLIGOCENE EASTLAKE LOCAL FAUNA, OTAY FORMATION, SAN DIEGO COUNTY, CALIFORNIA

LUBAR, Candace A., Occidental College, Los Angeles, CA, United States; PROTHERO, Donald R., Natural History Museum of Los Angeles County, Los Angeles, CA, United States

Fossil camel skulls and jaws recovered from the upper Oligocene Otay Formation (Eastlake local fauna) in southern San Diego County has never been fully described or identified. Re-examination of this material and comparison with previously described camel shows that the San Diego camel is referable to Mioptolopus leonardi, the smallest of three species of the paracamelid / stereonylme camel Mioptolopus previously known only from the early to middle Arikareean deposits (Gering-Monroe Creek equivalents) from eastern Wyoming. Both the small and medium-sized morphs from Wyoming include clear examples of male and female jaws with their distinctive canines, running out a size difference due to sexual dimorphism. The larger camel Dysseolopus migrans from the upper Oligocene Sespe Formation in Ventura County is a junior synonym of the medium-sized stereonylme Mioptolopus gibbi.
from the same Arikareean beds in Wyoming. These identifications extend the geographic range of these previously rare and badly misunderstood canals from a limited area of eastern Wyoming to the Pacific Coast.

NEW SPECIES OF THE ENIGMATIC ARCHOSAUROMORPH DOSWELLIA FROM THE UPPER TRIASSIC BLUEWATER CREEK FORMATION, NEW MEXICO, USA

LUCAS, Spencer G., New Mexico Museum of Natural History, Albuquerque, NM, United States; HECKERT, Andrew B., Dept. Geology, Appalachian State University, Boone, NC, United States; SPIELMANN, Justin A., New Mexico Museum of Natural History, Albuquerque, NM, United States

The occurrences of doswelliid archosauriforms from the Upper Triassic Chinle Group of the American Southwest are based on incomplete material, principally osteoderms. Here, we document the first new species of the doswelliid archosauriform genus Doswellia based on an incomplete, but associated, skeleton from NMMNH (New Mexico Museum of Natural History and Science) locality 5700 in the Upper Triassic Bluewater Creek Formation of the Chinle Group in west-central New Mexico, U.S.A. The new specimen, NMMNH P-61909, differs from D. kaltenbachi Weems, the type and only known species of Doswellia, in its larger size, higher tooth count and greater heterodony, possession of keels on the cervical centra, and the presence of discrete knobs or spikes on some osteoderms. Our reconstruction thus shows a more complex snout shape, with terminal nares, but also multiple lateral bulges reminiscent of phytosaurs, albeit with greater heterodony in that the teeth in the bulges are much larger than those between them. Other preserved elements, such as the quadrate and surangular, are extremely similar to the type of D. kaltenbachi, so we do not consider the Sixmile Canyon material a distinct genus. The cervical centra are particularly distinctive, being strongly laterally compressed such that they are nearly x-shaped in cross-section with prominent keels on the central keels. Most of the osteoderms are indistinguishable from those of D. kaltenbachi, but some posses a distinct spike projecting from the dorsal surface.

NEW CENTROSAURINE CERATOPSID MATERIAL FROM THE MIDDLE CAMPAIGN WAHWEAP FORMATION OF SOUTHERN UTAH

LUND, Eric K., Department of Biomedical Sciences, Ohio University Heritage College of Osteopathic Medicine, Athens, OH, United States; O’CONNOR, Patrick M., Department of Biomedical Sciences, Ohio University Heritage College of Osteopathic Medicine, Athens, OH, United States; LOEWEN, Mark A., Department of Geology and Geophysics, University of Utah, and Natural History Museum of Utah, Salt Lake City, UT, United States; JINNAH, Zubair A., School of Geosciences, University of the Witwatersrand Johannesburg, Johannesburg, South Africa

The Upper Cretaceous (middle–late Campanian) Wahweap Formation of southern Utah contains the oldest diagnostic evidence of ceratopsids (all centrosaurines) in North America, with a number of specimens recovered from throughout a unit that spans between 81 and 77 Ma. To date only a single specimen has been named, Diabloceratops eatoni, from the middle member of the formation. The phylogenetic affinities of other Wahweap Formation ceratopsids remain ambiguous, due in part to the recovery of incomplete specimens. The new centrosaurine material (Utah Museum of Natural History VP 20550) reported herein derives from the upper member of the Wahweap Formation and lends insight into ceratopsian diversity in the formation. UMNH VP 20550 represents a single individual recovered from a calcareous mudstone and consists of: two curved and elongate orbital hornscores, a left jugal, a nearly complete, slightly deformed braincase, the left squamosal, and a parietal from the upper member of the Wahweap Formation and lends insight into ceratopsian ceratopsids remain ambiguous, due in part to the recovery of incomplete specimens. The new case UMNH VP 20550 contributes to the known diagnostic centrosaurine record of the late Campanian of Laramidia.

NEW INSIGHT INTO THE Locomotor BEHAVIOR OF THE GIANT SHORT-FACED BEAR, ARCTODUS SIMUS, REVEALED BY 3D LANDMARK MORPHOMETRIC ANALYSIS OF THE FORELUMB

LYNCH, Eric R., East Tennessee State University, Johnson City, TN, United States; SCHUBERT, Blaine W., East Tennessee State University, Johnson City, TN, United States

Researchers have long been aware of the characteristic skeletal morphology displayed by the Pleistocene giant short-faced bear, Arctodus simus (Ursidae, Tremarctinae), but none have confidently interpreted the functional implications of those features that set it apart from the rest of the Ursidae. One hypothesis is that A. simus filled a similar niche to the extant African lion, Panthera leo, using its shortened rostrum for a more powerful bite and its relatively long legs for more cursorial locomotion, but more recent studies have proposed alternative interpretations. A. simus is reconstructed as a high-speed predator, long-distance scavenger, specialist herbivore, or omnivore depending on the researcher asked. Most comparative studies aimed at recreating the paleobiology of this species have focused on craniodental features or basic postcranial indices, and none have studied the finer details of shape between elements and muscle attachment sites within the appendicular skeleton of A. simus. This hypothesis was here pursued using traditional and three-dimensional landmark morphometrics and represents one of the first 3D landmark analyses of whole postcranial elements. Previous observations of the scapula, humerus, radius, ulna, scapholunar, magnum, and third metacarpal are confirmed, and while overall gross morphology and proportions are quite bear-like, a trend of reduced abductor-adductor/supinator-pronator musculature, more restricted parasagittal joint motion, increased stride length, and lighter, more packed distal elements is suggested. These trends agree with the hypothesis that A. simus represents a bear in the early stages of cursorial evolution and was likely capable of efficient, high-speed, straight-line, long-distance locomotion.

EVOLUTIONARY DEVELOPMENTAL MODEL FOR THE ORIGIN OF THE TURTLE SHELL AND A NOVEL FUNCTIONAL HYPOTHESIS FOR THE ORIGIN OF THE CHELONIAN LUNG VENTILATION MECHANISM

LYSON, Tyler R., Yale University, New Haven, CT, United States

The origin of the turtle shell and the constraints it places on how turtles breathe are interdependent problems that have fascinated scientists for the past three centuries. The discovery of the stem turtle Odontochelys semitestacea supports the developmental de novo hypothesis, because it is the only known stem turtle whose fossil remains overlap in time with the outgrowth of (sub)dermal bone from the perichondral collar of the dorsal ribs and vertebral centra. Such an endeavor was here pursued using traditional and three-dimensional landmark morphometrics and represents one of the first 3D landmark analyses of whole postcranial elements. Previous observations of the scapula, humerus, radius, ulna, scapholunar, magnum, and third metacarpal are confirmed, and while overall gross morphology and proportions are quite bear-like, a trend of reduced abductor-adductor/supinator-pronator musculature, more restricted parasagittal joint motion, increased stride length, and lighter, more packed distal elements is suggested. These trends agree with the hypothesis that A. simus represents a bear in the early stages of cursorial evolution and was likely capable of efficient, high-speed, straight-line, long-distance locomotion.

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Romer Prize Session (Thursday, October 18, 10:45 am)

EVOLUTIONARY DEVELOPMENTAL MODEL FOR THE ORIGIN OF THE TURTLE SHELL AND A NOVEL FUNCTIONAL HYPOTHESIS FOR THE ORIGIN OF THE CHELONIAN LUNG VENTILATION MECHANISM

LYSON, Tyler R., Yale University, New Haven, CT, United States

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RECONSTRUCTION OF INACCESSIBLE ANATOMY FROM AN EARLY PERMIAN LANTHANOSUCHOID (AMNIOTA: PARAREPTILIA), AND A NEW PHYLOGENIC ANALYSIS OF THE PARAREPTILIA

MACDOUGALL, Mark J., University of Toronto Mississauga, Mississauga, ON, Canada; REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada

One of the newest parareptiles to be described from the Richards Spur locality of Oklahoma consists of an exquisitely preserved small, triangular skull (total skull length ca. 25mm) with both rami of the mandible in perfect articulation. Some important areas of the holotype and only known specimen are inaccessible to detailed anatomical study, and cannot be observed through direct visual examination. These areas include the tooth bearing surfaces of the dentaries, portions of the palate that are covered by supportive matrix and other elements, and parts of the braincase that are covered by the skull roof. The skull has been scanned using computed tomography (CT) because these regions of the skull are critical for detailed phylogenetic analyses of parareptile interrelationships. This method has been used in conjunction with imaging software to produce three-dimensional models of the obscured elements of the skull. Reconstruction of the dentaries reveals that the dentition of the mandibles is very similar to that of the maxillae, with the presence of recurved, unicuspid teeth. Each dentary also exhibits the presence of two large caniniform teeth, much larger than the other marginal teeth of the dentaries. Reconstruction of the palate allows for the lateral portions of the palatal surface, obscured in this specimen by supportive matrix and the mandibular ramus, to be seen in 3-d. A new phylogenetic analysis including this new taxon revealed that it was a member of the parareptilian clade Lanthanosuchoidae. A new analysis incorporating the anatomical data revealed by this study, together with the addition of other recently recovered Richards Spur parareptiles further solidified the position of the new taxon as a Lanthanosuchoid and revealed that the newly added parareptiles were also members of the Lanthanosuchidae.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 10:30 am)

THE NEW WORLD TROPICS AS A CRADLE OF BIODIVERSITY DURING THE EARLY MIocene: Calibration of the Centenario Fauna from Panama

MACADDEN, Bruce J., University of Florida, Gainesville, FL, United States; FOSTER, David A., University of Florida, Gainesville, FL, United States; RINCON, Aldo F., University of Florida, Gainesville, FL, United States; MORGAN, Gary S., New Mexico Museum of Natural History, Albuquerque, NM, United States; JARAMILLO, Carlos A., Smithsonian Tropical Research Institute, Panama City, Panama

New excavations along the Panama Canal have yielded a growing Miocene vertebrate assemblage referred to as the Centenario Fauna. Despite its proximity to South America, the mammals of the Centenario Fauna have entirely North American affinities. The Centenario Fauna, which is distributed throughout a ~115 m stratigraphic interval encompassing the uppermost Culebra and Cucaracha formations, mixes taxa diagnostic, or characteristic, of three successive North American Land Mammal Ages (NALMAS) as these are defined from temperate North America, i.e., the Arikareean, Hemingfordian, and Barstovian. This sympathy may not be explained by superpositional biostatigraphy (because taxa of different NALMAS exist at the same horizons), nor by reworking (REE analyses refute this explanation), and thus we assert that these associations are biologically meaningful. Previously published age determinations using Sr-ratio and U-Pb methods constrain the age of the lower limit of the Centenario Fauna to no younger than ~19 Ma, but the upper limit has remained problematical. A fresh exposure of the Cucaracha tuff, which is demonstrably interbedded within the principal reference section measured at Centenario Bridge, has yielded two new radiogenic ages: (1) a Ar/Ar weighted plateau age of 18.94 +/- 0.83 Ma; and (2) a U-Pb zircon age of 18.81 +/- 0.30 Ma. Given these geochronological and paleomagnetic constraints, the age of Centenario Fauna from the Bridge section occurs within the 0.27 myr interval of chron C5Er. This essentially correlates to the late Arikareean NALMA (Ar4) interval during the early Miocene. These results have significant ramifications for biogeographic heterochrony of Barstovian, and possibly Hemingfordian, mammals. The ancient New World tropics during the early Miocene apparently supported a cradle of biodiversity from which numerous taxa subsequently dispersed northward, accounting for their better-known distributions in temperate North America.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

THE GEOLOGY AND PALEONTOLOGY OF COGLAN BUTTES, OREGON: THE FIRST DISCOVERED ARIKAREAN VERTEBRATE FOSSIL LOCALITY IN THE NORTHWESTERN GREAT BASIN

MACKENZIE, Kristen A., University of Oregon, Eugene, OR, United States; WHISTLER, David P., John Day Fossil Beds National Monument, Pendleton, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

The John Day fauna of North-central Oregon is famous for its diverse assemblage of Late Oligocene and Early Miocene terrestrial mammals; however, few sites of similar age are known from the Northwest. The sedimentary beds found in the vicinity of Coglan Buttes, Oregon, contain a little-known vertebrate mega fauna and microfauna. While a few publications refer to the existence of the fauna, it has in the past been regarded as likely Hemingfordian in age. Our more extensive collection reveals that this is the first Arikareean site to be found in the Northwestern Great Basin, though parts of the fauna seem also to represent the Hemingfordian. The closest localities that are age-correlative with the Arikareean part of the fauna are almost 200 miles away to the north in the Crooked River Basin of eastern Oregon. The fauna initially collected shares some similarities with the Upper John Day Formation, Oregon, and the Wounded Knee Fauna of South Dakota. The stratigraphy at Coglan Buttes consists of multiple layers of highly tufaceous paleosols with little discernable interbedding inter-bedded with tuff breccias, welded tuffs, airfall volcanic tephras and volcanic flows (andesites, dacites and basalts). Hence, the rocks may be of similar age to the John Day Formation, but are lithologically quite different. To date, cranial and postcranial material from at least 1.5 mammalian taxa, and some unidentified plant material, have been recovered from the fossiliferous horizons. Most abundant in the fauna are a diversity of camels, most likely miolabidines and larger, ?aepycameline forms with elongate, partially fused metapodials. Oreodonts are the next most abundant, represented by both cranial and postcranial material. Hypertragulid is also well represented. The microfauna, screened both from anhills and in situ sediment, includes teeth of aepodontids (Allomy and a meniscoyrmne), crecids (leidyms), geomyids, heteromyids, mylagaulids, lagomorphs, and hystricidae. Additional specimens of taphonics and tomboceros and equal material tentatively assigned to Archaeohippus have also been found. Fragmentary specimens add three size classes of canids, a felid, a chalicotherium, and some possible paleomerycids to the fauna. Many of the best-preserved taxa are represented by partial skeletons. While our work is at an early stage, we are already finding some important differences (e.g. the dominance of camels) from the John Day region at the same time. Understanding the Coglan Buttes fauna will contribute to our overall picture of the early Miocene landscape of the West by filling an important gap in the terrestrial fossil record.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9:30)

WHEN AND HOW DID LAND Vertebrates REACH THE GREATER ANtilles?

MACPHEE, Ross D., American Museum of Natural History, New York, NY, United States; ITURALDE-VINCENT, Manuel A., Museo Nacional de Historia Natural, Habana, Cuba

When and how (and how often) land vertebrates reached the Greater Antilles has been a contentious question in historical biogeography since the early 20th century. Although a number of new discoveries have been made in recent years, the axes of interpretation—and disagreement—remain the same: Can most propagule introductions be explained by sweepstakes-style, over-water transport? Some? None? How do you know? Do fossils provide a good time-stamp for dating dispersals? Fair? Irrelevant? How do you know? Is there good evidence for ancient continent-island connections that may have it have provided dry-land routes for immigrating species? Marginal evidence? No evidence? How do you know? In recent years, debate has taken a new turn with the appearance of molecular clock models for computing age-of-divergence (AOD) estimates for a number of Antillean taxa whose closest relatives live (or lived) in circumjacent continental areas. However, different models using different genes give different results; at present, AOD estimates for various groups with Antillean representation (e.g., solenodontid insectivores, platyrrhine primates, various bat families, Peltophyne frogs) form a crazy-quilt of possibilities, with no particular time for latest Mesozoic/Cenozoic immigration events being apparently more likely than any other. This seems improbable. At least for Cenozoic invasions, one alternative is the GAARlandia hypothesis, which utilizes tectonic, stratigraphic, and regional uplift history to posit that northernmost South America and the Greater Antilles Arc were briefly connected by the once-subaerial Aves Rise, ca. 35-33 Ma. This notion provides a single event horizon for Antillean radiation and supports, although uncertain, the AOD estimates. It is not clear how the GAARlandia hypothesis could be reconciled with the AOD estimates, which are robust across a variety of both biogeographical and molecular sources of information.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:30)
vertebrate taxa from the type Laventan are widespread across northern equatorial South America, Amazonia and along the Andes from Ecuador and Bolivia to as far south as Chubut in Patagonia. Older and younger faunas are known from both the Miocene lowland and highlands of equatorial South America. The faunal sequence in southern Ecuador includes the Arikareean, Hemingfordian and Clarendonian in concordance with the mid-Miocene (p<0.05), fossiliferous (p<0.01), and terrestrial (p<0.001) mammals. Applying these results to the paleofaunas of southern Ecuador, pre- and post-uplift faunas have fossiliferous taxa indicating annual rainfall <2000 millimeters (consistent with results from leaf morphology), and higher crowned rodents and toxodontids appear in the post-uplift fauna. Shared mammal taxa suggest ophiurophonogenic continuity southward at least to Bolivia. The post-uplift mammal assemblages differ in characteristics of ecological morphology that suggest dryer, more open or mosaic habitat. By analogy with modern vegetation, such environments at the equator would require an ophiurophonogenic rainshadow. However, leaf morphology shows no significant change in valley bottom vegetation during the interval of uplift. Neither canopy continuity nor upland vegetation are yet sampled, although a pilot study confirms the presence of well-preserved phytoliths in the San Cayetano and Letrero formations (pre- and post-uplift). Forest indicator phytoliths (palms and bamboo) dominate the assemblages and indicate mostly closed habitats.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

USING PALEOSOLS TO IDENTIFY NICHE PARTITIONING IN MICOCENE EQUIDS OF CENTRAL OREGON

MAGUIRE, Katie C., UC Berkeley, Berkeley, CA, United States

In Miocene deposits throughout North America, several genera of equids are frequently found co-occurring. Here I test whether these co-occurrences are consistent with niche partitioning as detected through environmental proxy data. Although equal niches traditionally are inferred based on morphology, the sedimentary record, especially that of paleosols, provides an independent second line of evidence to characterize the niche occupied by a given taxon. I used information from paleosols to characterize niche-space of equids at the level of genus, focusing on Barstovian deposits that commonly contain equid fossils in Central and Eastern Oregon. There the three dominant genera are Archaeohippus, Desmatippus, and Merychippus. The genera differ in characteristics of ecological morphology that suggest dryer, more open or mosaic habitat. I tested this hypothesis by using the paleosol record to reconstruct precipitation values for the environment with which each genus is associated. Paleosol samples were taken from Bw and Bt horizons in which specimens of each genus were found: these span the Barstovian deposits of the study area both spatially and temporally. The bulk geochemistry was analyzed using X-ray fluorescence (XRF). Paleoprecipitation was calculated using a published relationship between the chemical index of alteration without potassium (CIA-K). Preliminary results indicate the early Barstovian was wetter than the Arikareean, Hemingfordian and Clarendonian in concordance with the mid-Miocene climatic optimum. Archaeohippus specimens are associated with deposits that have the highest calculated precipitation values, consistent with their low crowned molars that suggest it was most likely a browser in densely vegetated areas. Merychippus specimens, in contrast, are associated with the lowest precipitation values, consistent with their high-crowned molars that suggest a full grazing diet in grasslands. Precipitation results are less clear for Desmatippus, which is inferred to have had a diet consisting of more grassy vegetation than Archaeohippus based on its more complex and hypsodont tooth morphology. These results are the first to provide paleoprecipitation data for Barstovian deposits in Oregon, and demonstrate how the sedimentary record can be utilized as a second line of evidence in reconstructing ecological niches.

SYMPOSIUM: Cretaceous Faunas of Appalachia: Systematics, Paleobiogeography and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 11:15 am)

WILDFIRE PALEOECOLOGY FROM THE CRETACEOUS COAST OF SOUTHWEST APPLAUCHIA AT THE ARCHINTON ARCHEOSASIR SITE, TEXAS

MAIN, Derek J., University of Texas, Arlington, TX, United States; NOTO, Christopher R., University of Wisconsin-Parkside, Kenosha, WI, United States; SCOTESE, Christopher R., University of Texas, Arlington, TX, United States; WEISHAMPEL, David W., Johns Hopkins University School of Medicine, Baltimore, MD, United States

The Arlington Archeosaur Site (AAS) is a diverse fossil locality from the Cretaceous (Cenomanian; 95 Mya) Woodbine Formation that occurs within the Dallas-Ft. Worth Metropole of North Texas. The paleogeographic setting is a coastal plain that stretched across a peninsula along the southern interior sea of southwest Appalachia. The climate in this part of Appalachia during the Cenomanian was moist, with a distinct dry season. The beginning of the wet season may have begun with intense tropical storms that are associated with the lowest precipitation values, consistent with their high-crowned molars that suggest a full grazing diet in grasslands. Precipitation results are less clear for Desmatippus, which is inferred to have had a diet consisting of more grassy vegetation than Archaeohippus based on its more complex and hypsodont tooth morphology. The AAS offers a unique chance to study southern Appalachian paleoecology and the effect of seasonal disturbance on an ancient coastal ecosystem.

The AAS fossil exposures occur within a 2 m section of peat and paleosol. The peat is fossil rich and contains numerous, well preserved vertebrates including fish, amphibian, mammal, turtle, crocodyliform and dinosaur (thoropod and ornithopod), as well as the remains of numerous trees. The crocodyliform recovery from this bed consists of remains from an interesting new taxon. Overlying the peat, is a paleosol sequence containing dinosaur, crocodyliform, and lungfish. The dinosaur material recovered to date consists of remains from a new taxon of basal hadrosauroid. The paleosol contains two distinct horizons. The upper is mottled and well-rooted with numerous calcareous concretions, within which are preserved charcoal, from individual fragments to large stumps and root systems. The lower horizon is a gray mudstone lacking root traces and preserving the majority of the fossils. Concretions formed during the dry season, where the water table dropped to the level of the lower horizon, which remained waterlogged year round. Alternating seasons brought the threat of wildfires, as shown through abundant charcoal found throughout the site. Charcoal conglomerate beds and numerous fragments are visible throughout the outcrop, occurring below, within, and above the vertebrate fossil horizons. The presence of charcoal conglomerates is typical of coastal, deltaic systems where burned materials were transported by river channels. We suggest that periodic wildfires were influential in driving the high diversity preserved at the AAS and provide a unique opportunity to study the Intermediate Disturbance Hypothesis (IDH) in a coastal Cretaceous ecosystem. The IDH states that diversity is highest in environments experiencing moderate levels of disturbance, such as those experiencing seasonal storms. Wildfires are not geographically random, but occur within specific paleoclimatic zones that are predisposed to fires. Continued study of wildfires may elucidate links between paleoclimate and biodiversity in coastal Cretaceous ecosystems.

Technical Session XV (Saturday, October 20, 11:15 am)

EVALUATION TRENDS IN THE SHAPE OF THE SQUAMOSAL IN CERATOPSID DINOSAURS

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The well documented Late Cretaceous Ceratopsidae had one of the highest rates of dinosaur speciation, as documented by the rapid variation in their diagnostic cranial ornamentation, including that on the nasal, postorbital, and parietosquamosal frill. To investigate shape change across the two main ceratopsid clades, Chasmosaurinae and Centrosaurinae, we applied geometric morphometrics (GM) using a 22 landmark configuration for 74 squamosals, including juveniles, subadults, and adults (juveniles only in centrosaurine sample), of 25 ceratopsid species (11 Centrosaurinae and 14 Chasmosaurinae). Principal Component Analysis indicates that centrosaurines have a uniform squamosal shape, with the exceptions of the basal centrosaurs Diabloceratops eatoni and Avaceratops lamersi, and the more derived Spinops sternbergorum. A Mantel test between a phylogenetic covariance matrix and a Procrustes distance matrix demonstrates that disparity in the ceratopsid squamosals is highly constrained by phylogeny. An evolutionarily significant allometric signal exists between the two clades (Chasmosaurinae and Centrosaurinae), but not within clades. Even when accounting for phylogeny (Phylogenetic Generalized Least Squares), the relationship between squamosal shape and size is significant. Phenotypic evolutionary rate analysis revealed a significant phenotypic shift in shape at the node for Diabloceratops and a phenotypic shift at the node for Chasmosaurus. Mapping shape change onto a ceratopsid phylogeny, we estimated ancestral states at nodes using squared change parsimony. From root to tips, centrosaurine squamosals were found to be conservative, but exhibit a slight dorsoventral expansion and a narrow angle between the infratemporal process and the caudoventral margin in more derived taxa. Chasmosaurines, compared to centrosaurines, show a derived morphology with a trend towards being strongly expanded dorsoventrally and a narrower angle between the infratemporal process and the caudoventral margin. In this study GM allowed us to analyze quantitatively squamosal shape across different ceratopsid clades and to reveal previously unquantified phenotypic shifts and different shape patterns between clades through time.

Technical Session XV (Saturday, October 20, 11:30 am)

CERATOPSID DINOSAURS DIDN'T JUST GET BIGGER: EVIDENCE FOR DWARFISM IN PSITTACOSAURUS

MAKOVICKY, Peter J., Field Museum of Natural History, Chicago, IL, United States; ERICKSON, Gregory M., Florida State University, Tallahassee, FL, United States; GAO, Ke-Qin, Peking University, Beijing, China; ZHOU, Cheng-Fu, Paleontological Museum of China, Beijing, China

Over large evolutionary and temporal scales, Dinosauria and its major constituent clades exhibit an increase in average body mass, although this may reflect passive rather than active processes. Ceratopsians follow this general pattern and increase in body size through both time and evolutionary history. Proposed instances of evolutionary size reduction, such as the small ceratopsid Brachyceratops, likely represent juvenile specimens and are thus inconclusive evidence for shifts in life history strategy.

Joint expeditions to Laiyang, Shandong Province, China by Peking University and the Field Museum of Natural History in 2005 and 2007 resulted in the collection of over a dozen specimens of the small ceratopsian Psittacosaurus sinensis. Histological analysis of hind
limb bones of three of these individuals reveals that they attained adulthood at a significantly smaller body size than in either P. mongoliensis or P. lufengensis, which have statistically indistinguishable growth patterns. Specifically, 11 year old, mature individuals of P. sinensis match the size of four year old juveniles of the other two species, which are still in the lag phase of growth. Because P. sinensis is more closely related to P. lufengensis than to P. mongoliensis, its unique growth pattern is most parsimoniously interpreted as dwarfism, and thus represents the first histologically confirmed instance of evolutionary body size reduction in ceratopsian evolutionary history.

P. gobiensis represents another dwarf taxon, but results are equivocal as to whether it is closely related to P. sinensis, or whether these species evolved small body size independently. Whereas P. sinensis is not sympatric with other species of Psittacosaurus, P. gobiensis does co-occur alongside a larger species of Psittacosaurus, suggesting niche partitioning between closely related and morphologically similar species. P. sinensis is only definitively known from the Shandong Peninsula, which is traversed by a major fault at its base, and the peninsula would have been positioned up to several hundred miles north of its current position during the Early Cretaceous. It would have formed an island during part of its Mesozoic tectonic history, substantiating the possibility that P. sinensis represents an instance of island dwarfism. Thus dwarfism in Psittacosaurus may represent a common strategy in the face of increased competition, whether intraspecific or interspecific in nature.

Technical Session XV (Saturday, October 20, 8:30 am)

DIETARY Niche Partitioning as a Means for the Coexistence of Megaherbivorous Dinosaurs from the Dinosaur Park Formation (Upper Cretaceous) of Alberta, Canada

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During the Late Cretaceous, megaherbivorous dinosaurs flourished in the western interior of North America (Laramidia). At any one time, there were typically two ankylosaurs (one ankylosaurid plus one nodosaurid), two ceratopsids (one centrosaurine plus one chasmosaurine), and one nodosaurid (Psittacosaurus). This diversity exceeds that of living megaherbivorous mammal communities, which are only rarely observed in the mammalian fossil record. Opinions differ about how this diversity was achieved. Some have argued that megaherbivorous dinosaurs thrived because of their low metabolic rates, or because of high primary productivity during the Late Cretaceous, implying that food resources were not limiting. It is also possible that predation pressure kept megaherbivore populations from fully exploiting the available resources. Others have argued that dietary niche partitioning played an important role in the coexistence of these animals, with each species consuming a different plant resource than the next, thereby minimizing interspecific competition.

This study uses the megaherbivorous dinosaur assemblage from the upper Cretaceous Dinosaur Park Formation (DPF) of Alberta, Canada as a model to test the dietary niche partitioning hypothesis by examining several aspects of ecomorphology known to relate to the procurement and mastication of food. These include feeding height, skull and beak morphology, jaw mechanics, and tooth morphology and wear. Evidence is sought for taxonomic separation in ecomorphospace between coexisting species, which is known to reflect niche relationships with reasonable fidelity. Although sympatric taxa are better discriminated by some features than others, consideration of the total evidence supports the dietary niche partitioning hypothesis, as even the most closely related taxa are sympatric and have been partitioned according to ecomorphology. Whether these dietary niche relationships arose as a result of long-term competition, or whether they evolved allopatrically is not clear. However, the fact that conspecific species coexistence was uncommon—and when it did occur, was either short-lived or involved only rare species—implies that the structure of the megaherbivorous dinosaur assemblage from the DPF was at least partly influenced by competitive interactions.

Technical Session VI (Thursday, October 18, 3:15 pm)

THE EVOLUTIONARY HISTORY OF TITANOSAURIFORM SAUROPODS

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Titanosauriforms represent the most diverse clade of sauropod dinosaurs, with over 90 distinct species, a global distribution and a temporal range extending from the Middle or Late Jurassic through to the end-Cretaceous. However, the interrelationships of this clade are poorly understood, and most previous work has focused on the less inclusive clade of derived titanosaurs. Here we present a new species-level phylogenetic analysis focused on elucidating the evolutionary relationships of basal titanosauriforms. We analyzed a new dataset of over 260 characters for 7 outgroups and 56 putative ingroup titanosauriforms. Many of these characters are heavily revised or novel to our study, and a number of ingroup taxa have never previously been incorporated into a phylogenetic analysis. In addition, we treat quantitative characters as discrete and continuous data in two parallel analyses. Although we recover monophyletic brachiosaurid and somphosphodanid sister clades within Titanosauriformes, their compositions are strongly affected by our differing treatment of quantitative data, suggesting that the decision to draw arbitrary boundaries between character states is problematic and may lead to incorrect tree topologies. Several characters traditionally considered titanosauriform synapomorphies (e.g. the lateral budge and medially deflected proximal femur) instead characterize the less exclusive macronarian clade. A number of taxa are recovered outside of Titanosauriformes, with the putative earliest titanosaur Janenschia positioned as a basal macronarian. This removes any unambiguous pre-Cretaceous body fossil record for Titanosauria, although ghost lineages, trackways and paleoecological analyses suggest that their Jurassic absence can be accounted for by a combination of low diversity and abundance, coupled with a rarity in preservation of suitable environments. Phylogenetic diversity estimates suggest that titanosauriforms were diverse by at least the late Oxfordian, which indicates that this was not a depauperate time interval as proposed by previous analyses, but instead suggests that it is extremely poorly sampled and/or that many Late Jurassic outcrops might be inaccurately dated. Diversity increased throughout the Late Jurassic, and titanosauriforms did not undergo a severe extinction across the Jurassic/Cretaceous boundary, in contrast to diplodocids and non-neosauropods. Titanosauriforms of low diversity remained relatively constant throughout the Early Cretaceous, but here was a severe drop (~60%) in species numbers at the Alban/Cenomanian boundary, representing a faunal turnover whereby basal titanosauriforms were replaced by derived titanosaurs, although this transition occurred in a spatiotemporally staggered fashion.

Technical Session XVIII (Saturday, October 20, 2:30 pm)

BASICRANIAL MORPHOLOGY OF PALEOGENE NUCYRTHERIIDAE (MAMMALIA, EULIPOTYPhLA?) AND EVIDENCE FOR EULIPOTYPhLAN AFFINITIES

MANZ, Carly L., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; BROWN, Ocean S., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; SILOCOX, Mary T., Department of Social Sciences, University of Toronto Scarborough, Scarborough, ON, Canada

Nucytheriid is a small, insectivorous, scannorial mammals that have been linked with Eulipotyphla (shrews, moles, hedgehogs, solenodons) and Chiroptera (bats) based on dental morphology and Eulipotyphlans (primates, tree shrews, dermopterans) using postcranial traits. Due to this range of suggested affinities, nucytheriids may be critical taxa to unraveling boreoeutherian ( Laurasiatheria + Euchiroptera) relationships. Other than a basicranial fragment (UM 85176) first attributed to a plesiadapiform primate and later tentatively assigned to Nucytheria, cranial morphology has been unknown for the group. Dentally associated nucytheriid basicrania have been recovered from late Cretaceous freshwater littoritostone deposits from the Willwood Formation, Big Horn Basin, WY. Comparison of these specimens to UM 85176 confirms its attribution to Nucytheriidae and their morphology closely resembles that of fossorial and living Eulipotyphla in having: 1) a moderately expanded ectotympanic ring; 2) a evidence of a fully ossified auditory bulla; 3) a transpromontorial groove on the ventral petrosal associated with the medial entrance of the internal carotid artery (ICA) to the middle ear; 4) transpromontorial grooves for the stapedia and posterior branch of the ICA; 5) small caudal and ventral tympanic petrosal processes; 6) an open canal for the facial nerve; 7) a laterally positioned euryptyon petrosal wing; and 8) a narial sulcus on the ectotympanic. Some of these similarities (2, 3, 4, 6, 8) may be retained primitive features. Nucytheriid basicrania differ from those of bats in lacking fusion of entotympanic elements to the ectotympanic. Nucytheriids are unlike some primitive eutherians in having an ectotympanic wing of the petrosal and further differ from most eutherians (excluding microsyopsids) in having no evidence of entotympanic elements and an open pathway for the facial nerve. Nucytheriid basicrania closely resembles those of fossil and modern Eulipotyphla but many of these similarities are likely primitive and may reflect a retained boreoeutherian cranial morphology, rather than a derived eulipotyphlan relationship.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:45 am)

A PHYLOGENETIC APPROACH TO DETERMINE THE CONTRIBUTION OF LINEAGE EVOLUTION TO PALEOECOLOGICAL CHANGE: AN EXAMPLE USING MAMMALIAN UNGULATES OF NORTH AMERICA

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Ecological communities can be characterized by distributions of the functional roles among their constituent taxa. Changes in the functional distributions reflect reorganizations of ecological communities and ecosystem functioning. Such changes are driven by both ecological and evolutionary processes. Ecological processes change communities through differential sorting of taxa with stable functional roles. Examples of ecological processes include the addition or subtraction of taxa from a community due to either migration or interspecies interactions (e.g., predation and competition). On the other hand, even when the taxonomic composition of the community is relatively stable, community change can occur if the constituent taxa themselves evolve and their functional roles change. While numerous studies have documented ecological change due to both ecological and evolutionary processes, the relative role of each in long-term paleoecological change is not clear.

In this study, we use phylogenetic comparative methods to estimate the rates of character change over time, and compare these changes in the distribution of the same characters among coeval members of the herbivorous mammalian ungulate guild. If lineage evolution contributes strongly to community change, we expect rates of character evolution to be highly correlated with changes in functional distributions. We characterize species within the North American ungulate guild using ecologically relevant measurements of their dentitions. We compiled published measurements of cheek teeth from the literature, and supplemented these with novel data from museum specimens. The final data set includes more than...
3799 specimens of 802 artiodactyl and perissodactyl species. We determine major axes of variation of dental measurements with principle components analysis (PCA). We estimate body mass for each species using published regression equations. We then determine the distributions of PC scores and taxon body size within 1.5My time intervals between 55 and 5Ma. We estimate changes between distributions in subsequent intervals using the Bray-Curtis distance. We reconstruct ancestral states of the same PC scores and body mass on a composite phylogeny, then calculate the rate of change along branches within each of the 1.5My intervals. Finally, we determine the correlation of these rates with interval-to-interval changes in the distributions.

We find no significant correlation between the dissimilarity between distributions in subsequent intervals and the rate of evolution for either the PC scores or body mass. These results suggest a relatively minor contribution of within-lineage evolution to paleocoeological change among ungulates, and that ecological sorting is a dominant influence.

Technical Session XIX (Saturday, October 20, 2:00 pm)

AT THE BEST ANGLE: INCREASED INCISOR PROCUency ALLOWed POCKET GPHerS (THOMOMYS BOTTae) TO CLAIM CLIMATE-HARDENED SOILS

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Morphology, changing environmental factors, and competition mediate the unique allopatriotic distribution of northern Californian pocket gophers (Thomomys spp.). While all gophers in the genus use claw-digging, subgenus Megacrasphus gophers display a range of additional tooth-digging adaptations. GIS analysis of specimen localities mapped on NRCs physical soil maps demonstrates that percent soil clay, bulk density, and shrink-swell capacity separate species with different digging strategies. Clay and bulk density stay constant for 1000s of years, however, low precipitation and high temperatures can rapidly produce shrink-swell behaviors in reactive soils. These climate-hardened soils favor Megacrasphus, suggesting a mechanism for a gradual replacement event during the Pleistocene-Holocene transition. During this period of increasing aridity, T. Megacrasphus bottae gophers expanded northward and displaced an exclusive claw-digging species. Geometric morphometric data from 450 adult female crania demonstrate that Megacrasphus gophers with the largest angle of procumbency tend to occupy the hardest soils. We hypothesize that the expanding populations of T. bottae increased incisor procumbency through rostra remodeling as they encountered hardening soils. The strong yet underappreciated interaction between soil and moisture on this major vertebrate group is rarely considered when projecting species responses to climatic change. Understanding how the environment impacts gopher digging efficacy has pinpointed key climatic and associated morphological changes most likely to have influenced past populations of gophers. Given current climate trends and California’s abundant shrink-swell soils, these findings could inform distribution predictions for any organism that is dependent on a stable soil structure.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

WHAT DOES THE LIFE HISTORY OF A FOSSIL BOVID TELLS US ABOUT PALEOENVIRONMENT?

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Life history traits are shaped by environmental conditions, specifically by extrinsic mortality and resource availability, and may shift in one or the other direction when these conditions change, leading to a complex adaptation of an organism’s life cycle termed its ‘life history strategy.”

Here, we aim to draw inferences on life history and paleoenvironment of Tragoparotis gaudryi, an Upper Miocene small to medium sized bovid from Torrent de Traginers (Vallès-Penedès Basin, NE Iberian Peninsula). This bovid has been suggested to have dwelled in habitats with humid wood and very soft ground. We compared the life history traits, specifically age at sexual maturity, of this fossil bovid with that of two extant bovids of similar body size and habitat preferences, Tragelaphus scriptus and Tragelaphus speki, that live in bush savannas and dense woodlands in south and central Africa. We counted of Lines of Arrested Growth (LAGs) in thin sections from long bones of these fossil and extant species to determine age at sexual maturity.

T. gaudryi attained sexual maturity earlier than both species of Tragelaphus, indicating a faster life history strategy for this fossil species. In continental ecosystems, the main factor of extrinsic mortality is predation. In Tragelaphus ecosystems, the vegetal coverage has been suggested to act as an important burrow role that fends off attacks by top predators such as leopards and lions. However, a faster life history in T. gaudryi may indicate a higher predation pressure in the Vallès-Penedès Basin in the Upper Miocene than in extant Tragelaphus ecosystems. Our results agree with previous demographic studies on T. gaudryi population of Torrent de Traginers that indicate a L-shaped attritional mortality (juvenile predominance) typical of highly predated populations. We therefore suggest a more open habitat with a stronger predation pressure for Torrent de Traginers. This would agree with the presence of top predators such as Stenailurus (Felidae) at this site. A higher mortality through higher levels of predation pressure would have led to compensatory changes in the timing of life-history events such as age at sexual maturity, and concomitantly cause a shift towards the fast end of the slow-fast life-history continuum.

Technical Session XIV (Saturday, October 20, 8:30 am)

FINALLY GROWN UP: IS THIS WHAT A MORPHOLOGICALLY ADULT LISSAMPHIBIAN LOOKS LIKE? NEW DATA FOR ONTOGENETICS AND PHYLOGENETICS FROM AN OLIGOCENE NEWT (SALAMANDRIDAe: PERELODElINAE)

MARJANOVIć, David, Museum für Naturkunde, Berlin, Germany; WITZMANN, Florian, Museum für Naturkunde, Berlin, Germany

Lissamphibians, especially caudates, share features with immature and neotenic temnospondyls and seymouriamorphs (lepospondyl ontogeny being largely unknown). This fact features prominently in the discussion about the origin of Lissamphibia. Paedomorphosis has also been a common mechanism of evolution within Caudata. Pelorudine salamandrids (newts), particularly the extant Tylototriton and Echinotriton and the Eocene to Pliocene Chelotriton and Brachycormus, show parameorphic features: sculpture on the skull, long ribs, presacral neural spines ending dorsally in flat sculptured surfaces that articulate with each other, and contacts of the maxilla to pterygoid and quadrate. In some pleurodines, the jaw joints lie level with the occiput (slightly caudal in some Chelotriton species), farther caudal than in any other caudates or even some temnospondyls. Yet, unlike the terrestrial Tylototriton and Echinotriton, Chelotriton and Brachycormus were aquatic as shown by their hyobranchium and their ribbon-like tails.

MB.Am 45.1 (Museum für Naturkunde) is a late Oligocene natural mold of an articulated presacral skeleton in dorsal view. While likely referable to Chelotriton, it is more parameorphic and larger than all previously known specimens. The jaw joints lie so far caudal to the occiput that the squamosals are inclined rostromedially to caudolaterally, unlike in any other caudate. The ribs are longer than three vertebrae, and at least some of them are curved ventrally; both features are unique among lissamphibians. Carpus and hyobranchium are at least partly ossified. Most of the skull (like the neural spine tables) bears posterior talo-tibial ligament. Although some of these features may be found in several groups of temnospondyls, this combination better matches that observed in Cebinae (Cebidae). MUSM-2024 would thus document a Saimiri-like cebine, with the body size of a marmoset. Functionally, the features and proportions of MUSM-2024 indicate that this small primate was an arboreal quadruped capable to cling on vertical support, leap and climb, although not particularly specialized for either of these activities. This small talus is the first lissamphibian fossil from Peru and the earliest primate remain from northern South America. Besides, it is likely to document the earliest known crown primate, as most early Miocene Patagonian lissamphibians seem not to be closely related to modern clades.
Morphometric methods allow quantitative assessment of variability, but are not frequently used. Although phylogenetic methods are undeniably useful for exploring evolutionary signals that are not available to palaeontologists, shifting from a morphological species concept to definitions using amino acids or genomics will become ‘fixed’ in later ones and extract a genuine evolutionary signal. It is hoped further understanding of what a morphological species ‘is’ from a biological perspective and understand the constraints imposed by taphonomy on these samples, we need to study them as Operational Taxonomic Units before coming to any conclusions about their taxonomic structure. By using populations as the OTU we can compare groups through time and use the changes between these to understand which features that are variable in early populations) have become ‘fixed’ in later ones and extract a genuine evolutionary signal. It is hoped further advances in developmental plasticity research will give us a far better understanding of what phenotype is and what mechanisms allow it to vary.

Preparators’ Session (Thursday, October 18, 9:30 am)

COMBINING MECHANICAL PREPARATION AND X-RAY COMPUTED TOMOGRAPHY TECHNIQUES TO VISUALIZE OBSCURED MORPHOLOGY IN A BASAL SAUROPODOMORPH DINOSAUR

MARSH, Adam D., The University of Texas at Austin, Austin, TX, United States; BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States; COLBERT, Matthew W., The University of Texas at Austin, Austin, TX, United States; ROWE, Timothy B., The University of Texas at Austin, Austin, TX, United States

The use of X-ray computed tomography (CT) in the study of fossil material has increased significantly in the last decade, and has augmented or even supplanted conventional mechanical preparation techniques in vertebrate palaeontology laboratories. CT is dependent upon X-ray contrast between matrix and fossil material, and allows palaeontologists to study otherwise unobservable morphological features in specimens. The articulated left forelimb and manus of the basal sauropodomorph dinosaur Sarahsaurus aurifontanalensis presents a unique opportunity to combine CT and standard laboratory techniques. This specimen, found in the Kayenta Formation of Arizona, represents the third described basal sauropodomorph taxon from North America. Standard mechanical preparation was performed until further preparation would have required the disarticulation of the specimen. This left several phylogenetically informative characters obscured by matrix on the palmar surface of the manus, including the presence of collateral ligament fossae, the angular offset of distal condyles, and phalangeal formulae. Because the specimen was left in articulation, articular surfaces of the carpus, metacarpus, and phalanges were also obscured. The specimen was scanned at the University of Texas High Resolution X-ray Computed Tomography Facility (UTCT) and volumetric CT data was processed by digitally removing the mudstone matrix from each individual bone surface. Digital surface files were then generated for each element and printed in acrylic and water-soluble wax by a 3D prototyper at Innovation Park at The University of Notre Dame. These high-quality 3D replicas of the individual bones of Sarahsaurus reveal detailed articular surfaces of the elements in the manus, allowing thorough description of the entire specimen and aiding interpretations of the extent of ossification and interosseous compression of the carpus. Finally, the individual replicated elements were molded and cast using standard techniques, a process that could have been impossible with the original articulated specimen. Although pouring plastic casts is currently less expensive than digitally prototyping replicas, the cost of this technology is decreasing, and it is possible that future fossil preparation laboratories may have the capability to generate wax, plastic, or even bronze replicas of important fossils. Most importantly, the complementary nature of CT and mechanical preparation techniques may increase specimen longevity and aid destructive sampling of fossils, without the loss of valuable morphological and contextual information. Similarly, these methods allow an opportunity to verify interpretations of previously ambiguous or unobservable character data.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DENS OF THE AMERICAN-ALLIGATOR (ALLIGATOR MISSISSIPPIENSIS) AS TRACES AND THEIR PREDICTIVE VALUE FOR FINDING LARGE ARCHAOSAUR BURROWS IN THE GEOLOGIC RECORD

MARTIN, Anthony J., Emory University, Atlanta, GA, United States; PAGE, Michael, Emory University, Atlanta, GA, United States; SKAGGS, Sheldon, Georgia Southern University, Statesboro, GA, United States; VANCE, Robert K., Georgia Southern University, Statesboro, GA, United States

Large arachosaur burrows are rarely interpreted from the geologic record, a circumstance that may be attributable to a lack of search images based on modern examples, rather than actual rarity. To test this idea, we measured, imaged, and mapped den structures of the American alligator (Alligator mississippiensis) on St. Catherines Island (Georgia, USA). St. Catherines is an undeveloped barrier island on the Georgia coast, consisting of Pleistocene and Holocene sediments. Alligators dug most dens along the edges of freshwater ponds in loosely consolidated Holocene or Pleistocene sand. Adult female alligators use dens to protect offspring, but burrows also aid in thermoregulation or serve as refugia for alligators during droughts and fires. Some dens are evidently reused and modified by different alligators after initial construction. Drought conditions along the Georgia coast have exposed many abandoned dens, thus better allowing for their study while increasing researcher safety. Den entrances have half-moon cross sections, and based on one sample (n = 20), these range from 22-115 cm wide (mean = 63 +/- 23 cm) and 14-55 cm high (23 +/- 9 cm). In addition to field descriptions, we applied geographic information systems (GIS) and ground-penetrating radar (GPR) to help define the ecological context and subsurface geometry of these structures, respectively. GPR gave spatial data relatable to alligators and their territories, substrate conditions, and proximity to potential sites. GPR produced subsurface images of active dens, which were compared to abandoned dens for a sense of taphonomic history. Most den entrances are southerly facing, with tunnels dipping to the northwest or northeast. From entrances, tunnels slope at about 10-15°, turn right or left within a meter, and lead to enlarged turn-around chambers. Collapsed dens in formerly ponded areas (secondary-succession maritime forests) provided further insights into subsurface forms of these structures. These features are: 3:1.4-6 m long; 30-40 cm deep, relatively narrow at either end (35-60 cm), and 1.2-1.6 m wide in their middles. Expansive areas were probable turn-around chambers, and total volumes of collapsed dens accordingly reflect maximum body sizes of their former occupants. One sampled area (8,100 m²), an almost dry former pond, had 30 abandoned dens, showing how multiple generations of alligators and fluctuating water levels can result in dense concentrations of alligator burrows over time. In summary, the sheer abundance, distinctive traits, and sizes of these structures on St. Catherines Island and elsewhere in the Georgia barrier islands give palaeontologists excellent search images for seeking similar trace fossils made by large semi-aquatic arachosaurs.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

DIVERSITY AND PALEEOECOLOGY OF THE AMIDAE OF THE DINOSAUR PARK FORMATION AND OLDMAN FORMATION (CAMPAIGNIAN) OF ALBERTA, CANADA

MARTIN-ABAD, Iago, Universidad Autónoma de Madrid, Madrid, Spain; NEWBIE, Michael G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; BRINKMAN, Donald B., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; NEUMAN, Andrew G., Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; POYATO-ARIZA, Francisco J., Universidad Autónoma de Madrid, Madrid, Spain

Amidans are important members of fish assemblages and aquatic ecosystems throughout the Cretaceous, but there is still much to be understood about their diversity, distribution, and relationships. We examine amid material from the Oldman and Dinosaur Park formations (Campanian) from Alberta and Saskatchewan, to identify diversity and growth patterns. Amid specimens were collected from 31 vertebrate microfossil localities at 12 stratigraphic intervals within Dinosaur Provincial Park. Diversity of amidans was addressed using morphology of skull elements and vertebral centra, as well as data on age and growth, and relative abundance. We identified two taxa based on two different morphotypes of maxillae, dentaries, upper postinfraorbitals, opercula, and cleithra. Two morphotypes of preaural vertebrae were also recognized, both included in the subfamily Aniinae. They differed from each other in the shape and relative length of the ventral pits (narrow and elongated vs. subovate to D-shaped), as well as in the general contour (ventrally flattened vs. rounded), and the length of the centra (longer towards the posterior region of the column vs. approximately constant length). Each centrum morphotype had similar age distributions.
and growth profiles, with no statistical difference, but Morphotype I grew to significantly smaller sizes at age three in stratigraphically higher localities, whereas Morphotype II showed no change in size through the section. The relative abundance of each morphotype was different at numerous localities falling outside the 99% confidence intervals to indicate that Morphotype I was found at stratigraphic levels or local populations compared to Morphotype II. It was initially hypothesized that the morphotypes would be attributable to the genera Cyclurus and Amia. However, we reject that hypothesis as centro of Morphotype I are present in both Mesozoic and Cenozoic Cyclurus and extinct and extant species of Amia. Morphotype II is not present in these genera, and thus represents a poorly known lineage currently represented by isolated elements that extends at least to the K-P boundary. The presence of two amines in the mid-Campanian of Alberta suggests that arguing had a more complex evolutionary history in the Cretaceous of North America than had been previously recognized.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

PALEOHISTOLOGICAL ANALYSIS OF METAPODIAL BONES OF MIOCENE HIPPARION CONCUDENSCUS FROM SPAIN

MARTINEZ-MAZA, Cayetana, Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain; ALBERDI, Maria T., Department of Paleobiology, Museo Nacional de Ciencias Naturales (CSIC), Madrid, Spain; PRADO, Jose L., Universidad Nacional del Centro, Olavarría, Argentina

The life history of extinct animals may be assessed through the study of their hard tissues. During life, bone microstructure is influenced by internal and external factors such as developmental processes, environmental or seasonal factors, life style adaptations, and biomechanical function. Several works have shown the relationship between these aspects of life history and bone histology. In this work, we analyzed the microstructure of metapodial bones of the extinct tridactyl Hipparion to provide data about its development, biomechanics, and palaeoecology. The genus Hipparion is recorded in Eurasia from the Upper Miocene to the Plio-Pleistocene boundary. These fossil horses represent an intermediate stage in horse evolution towards higher crowned molars, larger size, and reduced autopodials. Hipparion horses present an autopod composed of a major central toe and two reduced lateral ones. Previous analyses from a systematic, evolutionary and palaeoecological point of view have suggested that body size and morphological variability are related to environmental conditions and ground characteristics. However, no histological studies have been performed on these skeletal elements. Here, we studied the Hipparion concudense species from two basins of the Late Miocene of Spain with different environmental conditions: the Turonian site (Concud, Teruel) and the Vallesian site (Valles de Fuentidueña, Segovia). Transverse ground sections from the middle of central and lateral metapodial bones were stained with safranin and quinone alkaline fast green. Histological data show changes throughout the development that allowed identification of ontogenetical stages and biomechanical changes. Secondary osteons in the central metapodial bones of young individuals occur in the area associated with lateral metapodials, which show remodeled bone in the region close to central metapodial. These histological data confirm that lateral metapodials are involved together with the central metapodial bone in the biomechanical processes of these three-toed horses. We compared these histological data between the two Hipparion samples to analyze how these changes in the bone microstructure are related to different environmental conditions.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PRELIMINARY DATA ON THE NEW PARTIAL CARCASS OF THE WOOLLY MAMMOTH, MAMMUTHUS PRIMIGENIUS, FROM YAKUTIA, RUSSIA

MASCHELN, Eugene, Borkowski Paleontological Institute, Russian Academy of the Sciences, Moscow, Russian Federation; POTAPOV, Olga, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; BOESKOROV, Gennady, Diamond and Precious Metals Geology Institute, Siberian Branch of Russian Academy of Sciences, Yakutsk, Russian Federation; PLOTNIKOV, Valery, Sakha Republic (Yakutia) Academy Sciences, Yakutsk, Russian Federation; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

A partially frozen and mummified carcass of Woolly Mammoth, Mammuthus primigenius, was found in the lower part of the Aktit Flight Straight, the Yana River, Yakutsk region (72°40’ N 142°50’ E) in 2009. The carcass (72°40´ N 142°50´ E) was discovered in the rich bone-bearing Late Pleistocene sediments located within the Aktit Flight Straight, the Yana River, Yakutsk region (72°40’ N 142°50’ E). The carcass was discovered during the field work of the expedition to the Yana region in 2009. The Yana mammoth age could be lowered down to approximately 6-8 years. The bone length was about 265 cm and shoulder height was about 160 cm. The morphology of the genitalia allowed identifying the specimen as a female. The ongoing studies of the Yana mammoth are complex evolutionary history in the Cretaceous of North America than had been previously recognized.

Technical Session XI (Friday, October 19, 3:15 pm)

OSTEOLOGY OF THE EMBRYONIC THEROPODS FROM THE LATE JURASSIC OF PAIMOGO, PORTUGAL

MATEUS, Octávio, Universidade Nova de Lisboa, Faculdade de Ciencias e Tecnologia & Museu de Lourinhã, Lourinhã, Portugal; CARRANO, Marilyn T., Department of Paleobiology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; TAQUET, Philippe, Muséum national d’Histoire naturelle, Paris, France

Among the more than one dozen dinosaur egg- and eggshell-bearing localities in the Late Jurassic Lourinhã Formation of Portugal (upper Kimmeridgian–Tithonian), the nest from Paimogo was of the first to be found and remains the largest and most significant. Located within the Amoreira-Porto Novo Member (uppermost Kimmeridgian), this nest has yielded about 300 embryonic bones and bone fragments identified as belonging to a theropod dinosaur. Here we present a detailed anatomical description of the nest and embryos. The Paimogo nest comprised about 100 eggs (or eggshell concentrations that represented individual eggs), but much of the nest had been eroded, indicating that an even greater number of eggs would have been present originally. There is no clear nest structure, but eggs are the highly concentrated in the center, along with the majority of embryonic bones (suggesting a more advanced ontogenetic stage). All the eggs were crushed, but despite this compression, some eggs are complete and retain embryonic bones inside.

The embryonic anatomy is comparable to the holotype of Lourinhanosaurus antunesi from the same stratum and region. However, most Lourinhanosaurus autapomorphies are in the pelvis and vertebral laminae, rarely preserved in the embryos, making their positive identification more difficult. A single autapomorphy is present in both subadult and embryos: a medial condyle of the ischium that is half the transverse width of the fibular condyle. Other contemporary theropods differ from the embryos in specific details: the embryonic maxilla lacks an antorbital fenestra (present in Torvosaurus and Allosaurus), the ilium lacks a vertical ridge (present in Jurassic theropods), the ischium lacks an antorbital fenestra (present in Aviaraynus), and the ilium caudal crest is short (unlike Ceratosaurus). One other nest with embryos from the Lourinhã area, in Porto das Barcas, has been provisionally ascribed to Torvosaurus. These embryonic specimens are much larger in size, and the eggshell structure is entirely different. If this assessment of the Porto das Barcas embryos is correct, then the Paimogo embryos cannot be Torvosaurus.

In general, the embryos are morphological miniatures of the adults, fully equipped for predation of small prey, and thus may have been precocial (i.e. relatively mature and mobile from the moment of birth or hatching). The teeth have large denticles on the distal carina only and bear some resemblance to those of more derived theropods, suggesting a role for pedogenesis in theropod evolution.

Education and Outreach Poster Session (Posters displayed October 17 – 20)

TAKING SCIENCE AND EDUCATION OUTSIDE AT THE BLM MCCASIN MOUNTAIN TRACKSITE, UTAH

MATTHEWS, Nefissa A., DOI-Bureau of Land Management, Denver, CO, United States; CHRISTENSEN, Thomas M., DOI-Bureau of Land Management, Kanab, UT, United States; HAINES, Misti E., DOI-Bureau of Land Management, Kanab, UT, United States; NOBLE, Tommy A., DOI-Bureau of Land Management, Denver, CO, United States; BREITHAUPF, Brent H., DOI-Bureau of Land Management, Cheyenne, WY, United States

America’s Great Outdoors (AGO) and Take It Outside (TIO) are Presidential initiatives put in place to encourage families to spend more time together enjoying their natural surroundings. What better enticement to go outside and get excited about science than to experience paleontological resources found on America’s Public Lands? A relatively new tracksite has been managed and developed for the benefit of the public, establishing an education and outreach platform for the important paleontological resource within the vicinity of the MMT. A brochure containing photographs and descriptions of the diverse ichnofauna (Eubrontes, Otozoum, Batrachopus and Brasilichnium) and growth profiles, with no statistical difference, but Morphotype I grew to significantly smaller sizes at age three in stratigraphically higher localities, whereas Morphotype II showed no change in size through the section. The relative abundance of each morphotype was different at numerous localities falling outside the 99% confidence intervals to indicate that Morphotype I was found at stratigraphic levels or local populations compared to Morphotype II. It was initially hypothesized that the morphotypes would be attributable to the genera Cyclurus and Amia. However, we reject that hypothesis as centro of Morphotype I are present in both Mesozoic and Cenozoic Cyclurus and extinct and extant species of Amia. Morphotype II is not present in these genera, and thus represents a poorly known lineage currently represented by isolated elements that extends at least to the K-P boundary. The presence of two amines in the mid-Campanian of Alberta suggests that arguing had a more complex evolutionary history in the Cretaceous of North America than had been previously recognized.

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In general, the embryos are morphological miniatures of the adults, fully equipped for predation of small prey, and thus may have been precocial (i.e. relatively mature and mobile from the moment of birth or hatching). The teeth have large denticles on the distal carina only and bear some resemblance to those of more derived theropods, suggesting a role for pedogenesis in theropod evolution.

Education and Outreach Poster Session (Posters displayed October 17 – 20)
footprints, encouraging the discovery and documentation of other tracks at the site. Signs to be installed on site will follow the theme of exploration, providing basic information on the MMT and complementing the brochure. As this tracksite is surrounded by prime OHV recreational areas, signage will not only help interpret the area to outdoor enthusiasts, but will also discuss the conservation and management of the MMT, as well as encourage local stewardship of these valuable paleontological resources. The podcast (available for download) briefly discusses track and trackway formation, as well as highlighting technology used at the site. In 2008, close-range photogrammetric documentation of the MMT was conducted using both ground-based and low-altitude aerial imagery. Digital terrain data and ortho-imagery (at a variety of scales) were integrated into a real-world coordinate system. These images and 3D data not only form the basis for maps of the site, but also enhance the interpretation by providing virtual renderings of footprints and trackways in the podcast. This cadre of educational and interpretive materials provides an effective tool for presenting the uniqueness of the MMT to the public and encourages children of all ages to explore the palaeontological wonders of America’s Great Outdoors.

Technical Session XIV (Saturday, October 20, 12:00 pm)

CHANGES IN ICHTHYOSAUR BODY SIZE DURING THE EARLY TOARCIAN EXTINCTION EVENT

MAXWELL, Erin E., Staatliches Museum für Naturkunde, Stuttgart, Germany; VINCENT, Peggy, Staatliches Museum für Naturkunde, Stuttgart, Germany

Extinction events have a characteristic effect on the taxonomic composition, species diversity, and abundance in both marine and terrestrial ecosystems. Body size, both within species and within a fauna, is thought to decrease following an extinction event. Taxonomic diversity is also assumed to decrease, but the abundance of opportunistic species increases. In this study, we examined body size changes in the Lower Jurassic ichthyosaur Stenopterygius quadriscissus in a marine environment of the Posidonia Shale ichthyosaur fauna, to test if the early Toarcian extinction event had an ecological effect on large marine vertebrates.

Six elements, two from the skull and four from the postcranium, were measured for adults of S. quadriscissus (N=26). The individual score on the first axis of a principal component analysis was used to condense these measurements into a single multivariate size metric. This metric was then plotted against stratigraphic occurrence, based on regional zonation of the Posidonia Shale in the Southwest German Basin. A resampling analysis was designed to examine whether the largest individual for a stratigraphic interval was smaller than expected based on the data and the sample size for that interval. We also divided the ichthyosaur fauna into small (adult body length equal to or less than 4 m; Stenopterygius, Hauffiopteryx) and large genera (Tennodontosaurus, Euhelopteryx, Suesovleitanii), and examined the stratigraphic abundance of specimens in each size class. We report a significant increase in size in S. quadriscissus following the extinction interval, but size remained constant during the survival interval. Following a similar pattern, the ichthyosaur fauna during the extinction interval showed high abundance of S. quadriscissus, but low taxonomic diversity (80% of all recovered specimens belonged to the aforementioned species). Large genera were absent from the fauna. Immediately following the extinction interval, large genera gradually became proportionately more abundant, and S. quadriscissus steadily declined.

The intraspecific body size, abundance, and generic size distribution of early Toarcian ichthyosaurs follows the classic pattern for a fauna suffering from post-event syndrome. However, this pattern occurred during the extinction interval, not following the interval as in benthic marine invertebrates. These observations suggest that large ichthyosaurs may have been more strongly affected by adverse environmental conditions from the onset of the extinction event, rather than by the final extinction pulse related to global warming and oceanic anoxia, and that conditions in the nektic realm rapidly ameliorated at the end of the extinction interval.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

TRACKS IN THE ARCTIC: A DINOSAUR ICHNOFOSSIL ASSEMBLAGE FROM THE UPPER CRETACEOUS PRINCE CREEK FORMATION, NORTHERN ALASKA

MAY, Kevin C., University of Alaska Museum, Fairbanks, AK, United States; DRUCKENMILLER, Patrick S., University of Alaska Museum, Fairbanks, AK, United States

Globally, only a small number of formations provide information on the diversity and distribution of dinosaurs from high paleolatitudes. One of the most prolific units known is the Upper Cretaceous Prince Creek Formation of northern Alaska. The Prince Creek Formation (Campanian-Maastrichtian) consists predominantly of siliciclastic sediments shed off of the growing Brooks Range to the south. The formation is a tidally influenced continental succession deposited at polar latitudes (approximately 82 degrees North) on a low-gradient, coastal/alluvial plain. The Prince Creek Formation is well known for its dinosaur fauna, including a taxonomically wide range of both ornithischian and saurischian taxa represented exclusively by body fossils. However, these skeletal remains are not evenly distributed through the unit; the majority of remains are restricted to a small number of productive bone beds deposited in the upper portion of the formation. Field investigations conducted by the University of Alaska Museum between 1997 and 2010 reveal a diverse assemblage of dinosaur tracks and trackways documented in numerous exposures of the Prince Creek Formation along an 80-kilometer leg of the lower Colville River, between Ulukhak Bluff and Ocean Point. At least five track morphotypes are recognized, which are preserved as true tracks, natural casts and underprints. Trampled surfaces have been noted at several localities and tracks can be seen in cross-section throughout the unit. A preliminary analysis of the ichnocoenaseal assemblage reveals a medium to large ornithopod and a possible ceratopsid. Also present are a medium sized theropod and at least two morphotypes of small theropods, including a probable avian track referable to Magnorporis sp. The tracks are significant in that they occur throughout the entire Cretaceous portion of the unit, are relatively common, and are more evenly distributed within the succession than skeletal remains. The ichnofauna compliments the skeletal record and reveals additional diversity not currently recognized in the formation based on body fossils alone.

Preparators’ Session (Thursday, October 18, 9:15 am)

DIGITAL DEVELOPMENT AND MOUNTING OF AN ALAMOSAURUS SKELETON FOR THE PEROT MUSEUM OF NATURE AND SCIENCE

MAY, Peter, Research Casting International, Trenton, ON, Canada; FAIR, Matt, Research Casting International, Trenton, ON, Canada; CRAWFORD, Brett, Research Casting International, Trenton, ON, Canada; MAY, Amelia, Research Casting International, Trenton, ON, Canada; MACLEOD, Mike, Research Casting International, Trenton, ON, Canada

Three different specimens were used to develop the first skeletal mount of the giant titanosaur from the late Cretaceous of North America, *Alamosaurus*. The individual elements of all three skeletons were laser scanned, creating digital files of all of the bones necessary to develop a complete skeleton. The individual bones were then manipulated by scaling for size, and if the opposite side was missing a mirror image was made. Once the complete skeleton was digitally developed, it was physically created using 3D printers and a 5 axis router. The specimen from University of Texas, Austin was originally collected in 1973 and consisted of the bones of a single specimen, including femur, humerus, hip and articulated dorsal series through to the first cervical. It had been only partially prepared. In all, 13 unprepared blocks consisting mainly of the hip and dorsal series were prepared for this project. The specimen from the Smithsonian was collected in Utah in 1946. It consists of approximately 30 articulated caudal vertebrae and a front forelimb. The Perot Museum specimen was collected in 1997, and consists of nine articulated cervical vertebrae. Each specimen preserves elements that overlap with the other specimens, and that could be scaled for the reconstruction of the skeleton. The sheer size of the skeleton ruled out 3D printing of the entire skeleton from the original scanned data, due to the restrictive size of the 3D print envelope. The point cloud data generated by laser scanning had to be transferred to 3D files so tool paths could be created for a 5 axis router to carve out the replicated bones from two-pound density polystyrene blocks.

Technical Session XII (Friday, October 19, 3:45 pm)

A NEW OPHIDIOFAUNA FROM THE LATE oliGCoeNE NSungwe FORMATION OF TANZANIA AND THE RISE OF COLUMBROID SNAKES (REPITILIA, SERPENTES)

MCCARTNEY, Jacob A., Stony Brook University, Stony Brook, NY, United States; STEVENS, Nancy J., HCOM and Center for Ecology and Evolutionary Studies, Ohio University, Athens, OH, United States

An active field program in the late Oligocene Nsungwe Formation in the Ruwuka Rift Basin of southwestern Tanzania has begun to shed light on faunal dynamics during the Oligo-Miocene transition on continental Africa. Groups recovered to date include a rich assemblage of mammals, birds, crocodylians, lepidosauromorphs, anurans, and fishes as well as multiple invertebrate clades. Among the Nsungwe Formation discoveries is a diverse collection of snake vertebrae. The sample (n = 23) can be sorted among four primary morphotypes: a booid of uncertain affinities, a boiid, and two columbroid snakes. All of the snake specimens are small, likely representing individuals that did not exceed a meter in total length. The booid morphotype reveals important ecological insights, preserving vertebral features typical of burrowing snakes. The columbroid material strikingly dominates the ophidiofauna, comprising almost 70% of the snake specimens collected to date. This stands in stark contrast to contemporaneous faunas known from Europe and North America, both of which are dominated by booid snakes. In these regions columbroids diversified in the early Miocene, likely as a result of aridification and a spread of grasslands that favored more active predators. Sedimentological interpretations from fossiliferous Nsungwe Formation localities indicate a seasonal environment with perennial availability of water in the form of muddy floodplain and shallow lacustrine settings. The early dominance of columboids in the Nsungwe Formation may reflect seasonally drier habitats and a general emergence of more open environments in the region. Because of the lack of diverse contemporaneous African faunas for comparison, it is unclear whether this fauna reflects local conditions or a continent-level pattern. Regardless, the Nsungwe Formation fauna illustrates that the pattern of ophidiofaunal turnover in Africa may be more complex than that characterizing the northern continents, either occurring earlier or in a patchier manner than has been documented for Europe and North America.
caution when using domestic horses in evolutionarily-informed studies, as artificial selection has led to distinct breeds, each with slightly different morphologies. These results show the need for morphological studies and their use in performance studies. Higher performance is correlated with a specific set of conformational traits; however, predicting performance even in all-around disciplines is challenging. The relationship between conformational measures and competition scores is significant but complicated. The results of this study support the importance of morphological traits in performance studies.

FUNCTIONAL MORPHOLOGY IN MODERN HORSES: NATURAL VS. ARTIFICIAL SELECTION

MCHORSE, Brianna K., University of Oregon, Eugene, OR, United States; DA VIZ, Edward B., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

Functional morphology plays an important role in modern sport horse purchase and breeding decisions. Conformation, or the proportional relation of the body, is a reliable indicator of athletic ability and long-term resistance to injury. Genetic selection for desirable traits has led to variations in conformational ideals. Despite the importance of conformational assessments on equine breeding and trade, few studies have used analytical methods to establish quantitative relationships between conformational performance and artificial or naturally-selected competition horses, and none have examined the differences between domestic breeds and the feral mustang. Existing work suggests a significant relationship between conformational traits and athletic performance, as well as the reach and timing of the horse’s stride. We investigated the conformation-performance relationship in modern horses, using data from tamers and questionnaires. The results show the need for caution when using domestic horses in evolutionarily-informed studies, as artificial selection for desirable traits predicts evolutionary history and patterns of horses.

 Ontogeny and Phylogeny of Temnospondyl Amphibians, a Window into Terrestrial Ecosystems during the Permo-Triassic Mass Extinction

MCHUGH, Julia, University of Iowa, Iowa City, IA, United States

Temnospondyls are an abundant fossil group across the Permo-Triassic boundary (PTB), the point of the largest mass extinction in the Phanerozoa. Temnospondyls are a long-lived lineage, spanning the Middle Mississippian to Early Cretaceous, across the PTB and into the Cenozoic. The evolutionary history of temnospondyls is complex; their diversity and evolution during this interval have been limited by the incompleteness of available phylogenetic hypotheses. To alleviate this and provide better understanding of evolution in this widespread group, a comprehensive species-level phylogenetic dataset was constructed for 99 ingroup taxa and 297 morphological characters with GREEREPTON. The resulting phylogeny was used to estimate ghost lineages and range extensions, and to calculate speciation and extinction rates, using raw occurrence data and incorporating ghost species. This analysis shows that the PTB is predominantly the result of the basal radiation of a major clade (Stereospondyli), and it is unclear how large of an effect can be ascribed to selective pressures during the massive extinction event, or to what degree this radiation is simply coincidental with the PTB. Regardless, this data indicate a Permo-Triassic world favorable to rapidly speciating lineages, as well as individual growth in amphibians, who long-lived and cyclical or sustained. Temnospondyls may have behaved as disaster taxa, quickly evolving to fill vacant niches in the Early Triassic. This suggests that flexibility in growth and rapid evolution may be key characteristics to not only surviving, but also proliferating through a mass extinction event.

Posters Session I (Wednesday, October 17, 4:15 - 6:15 pm)

FUNCTIONAL MORPHOLOGY IN MODERN HORSES: NATURAL VS. ARTIFICIAL SELECTION

MCHORSE, Brianna K., University of Oregon, Eugene, OR, United States; DA VIZ, Edward B., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States

The phylogeny also provided the framework to test changes in body microstructure across the PTB. Phases were taken from multiple postcranial elements of five temnospondyl taxa, spanning the Middle Permian to Early Triassic of the Karoo Basin. Permian specimens show slow, zonal growth in large, medium-to-large aquatic stereospondyls; earliest Triassic temnospondyls show axonal, sustained growth in small-to-medium terrestrial forms. Global extinction and speciation rates for temnospondyl lineages are elevated across the PTB; however, extinction and speciation rates derived from only occurrence data are highly correlated with the number of sampled localities, both per geologic stage and normalized per million years. Thus, extinction rate and speciation rate (from only occurrence data) cannot be differentiated from rock record bias at the PTB. Conversely, speciation rate derived from occurrence data and inferred ghost lineages is not strongly correlated with the number of sampled localities; however, it is significant. The PTB is predominantly the result of the basal radiation of a major clade (Stereospondyli), and it is unclear how large of an effect can be ascribed to selective pressures during the massive extinction event, or to what degree this radiation is simply coincidental with the PTB. Regardless, this data indicate a Permo-Triassic world favorable to rapidly speciating lineages, as well as individual growth in amphibians, who long-lived and cyclical or sustained. Temnospondyls may have behaved as disaster taxa, quickly evolving to fills vacant niches in the Early Triassic. This suggests that flexibility in growth and rapid evolution may be key characteristics to not only surviving, but also proliferating through a mass extinction event.

Poster Session VIII (Thursday, October 18, 11:00 am)

ONTogeny AND PHYLOGeny OF TEMNOSPondYLI AMPHIbians, a WIndow INTO TERRESTRIAL ECOSYSTEMS DURING THE PERM-O-TRiASSIC MASS EXTINCTION

MCHUGH, Julia, University of Iowa, Iowa City, IA, United States

Temnospondyls are an abundant fossil group across the Permo-Triassic boundary (PTB), the point of the largest mass extinction in the Phanerozoa. Temnospondyls is a long-lived lineage, spanning the Middle Mississippian to Early Cretaceous, across the PTB and into the Cenozoic. The evolutionary history of temnospondyls is complex; their diversity and evolution during this interval have been limited by the incompleteness of available phylogenetic hypotheses. To alleviate this and provide better understanding of evolution in this widespread group, a comprehensive species-level phylogenetic dataset was constructed for 99 ingroup taxa and 297 morphological characters with GREEREPTON. The resulting phylogeny was used to estimate ghost lineages and range extensions, and to calculate speciation and extinction rates, using raw occurrence data and incorporating ghost species. This analysis shows that the PTB is predominantly the result of the basal radiation of a major clade (Stereospondyli), and it is unclear how large of an effect can be ascribed to selective pressures during the massive extinction event, or to what degree this radiation is simply coincidental with the PTB. Regardless, this data indicate a Permo-Triassic world favorable to rapidly speciating lineages, as well as individual growth in amphibians, who long-lived and cyclical or sustained. Temnospondyls may have behaved as disaster taxa, quickly evolving to fills vacant niches in the Early Triassic. This suggests that flexibility in growth and rapid evolution may be key characteristics to not only surviving, but also proliferating through a mass extinction event.
The sawfish Ischyrorhiza mira, is a very common element of Late Cretaceous marine faunas from all over North America. Both its rostral denticles and oral teeth are frequently encountered, especially in lag deposits. Even though the rostral denticles are very brittle, and are often found broken, they are very distinct in many of their features and can usually be readily recognized even in a very fragmentary condition. The oral teeth are very abundant in some deposits but are often overlooked because of their small size.

The systematic placement of *Ischyrorhiza* is uncertain but has traditionally been placed in the *Sclerorhynchidae*, a lineage long considered convergent with modern sawfishes (*Pristiidae*). Complete *Sclerorhynchidae* specimens are known from Lebanon, sclerorhynchid rostra with teeth have been noted for the Moroccan taxa *Onchopristis* and *Schizorhiza*, and fragments identified as *Ischyrorhiza mira* rostral cartilage and vertebrate have been reported. However, *Ischyrorhiza mira* has only ever been confidently identified from isolated rostral denticles and oral teeth making comparisons with pristids and even other sclerorhynchids difficult.

Recently, a partial *Ischyrorhiza mira* rostrum with associated rostral denticles was recovered from the Maastrichtian Ripley Formation (Selma Group) of Lowndes County, Alabama. Found in situ in the formation, the preserved portion is Stem long, somewhat deformed, and has six rostral denticles still attached. Four more rostral denticles were recovered from matrix near the anterior end. This unique anatomical specimen promises to shed light on this enigmatic group of fishes.

**Technical Session XVII (Saturday, October 20, 4:00 pm)**

**COMPARING LATE PLEISTOCENE WITH PRESENT-DAY AVIAN COMMUNITY STRUCTURE ON FLORES ISLAND, INDONESIA**

**MEIJER, Hanneke J., Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; HOLEN, Steven, Department of Vertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; SUTIKNA, Thomas, The National Research and Development Centre for Archaeology, Jakarta, Indonesia; DUE, Rokhus A., The National Research and Development Centre for Archaeology, Jakarta, Indonesia; TOCHERI, Matthew W., Human Origins Program, Department of Anthropology, National Museum of Natural History, Smithsonian Institution, Washington, DC, United States**

Wedge'd in between the large continental landmasses of Asia and Australia, Wallacea constitutes a transitional biogeographic zone renowned for its unique biotic assemblages. While it is largely undisputed that the Wallacean biota is derived from the two large continental areas enclosing it, the details are poorly understood. Liang Bua, on the Indonesian island of Flores, has yielded a rich late Pleistocene and Holocene faunal sequence that can provide important insights into the evolutionary and ecological history of this Wallacean community. In the late Pleistocene, Flores was home to an endemic vertebrate fauna, including the pygmy elephant *Stegodon florensis insularis*, a small species of hominin *Homo floresiensis*, giant rats including *Papagomyx*, and Komodo dragons *Varanus komodoensis*. The late Pleistocene avifauna of Liang Bua, composed of at least 23 taxa, represents the first Pleistocene record of an avian community in Wallacea. Here, we present a comparison of the non-passerine Pleistocene avifauna of Liang Bua with that reconstructed by the extant bird community on Flores in terms of body size distribution, feeding guild membership, and habitat spectrum. The results indicate that, despite the disappearance and likely extinction of *Homo floresiensis* and *Stegodon florensis insularis* toward the end of the late Pleistocene, the avifauna remained relatively unaffected by extinction and accompanying change in community structure. The loss of the giant stork *Leptoptilos robustus* and the vulture *Trigonocepus* sp. agrees with prehistoric extinctions observed on other islands and continents, which are generally biased towards larger body sizes. Despite the loss of a few large-bodied taxa, the distribution of body size in the late Pleistocene avifauna is not statistically different from the extant one. Also, the feeding guild membership and habitat spectrum of the late Pleistocene do not differ from the extant avifauna. This is in contrast to other fossil avisfaunas, such as those on Hawaii, where prehistoric extinctions significantly altered avian community structure. This suggests that the Pleistocene avifauna on Flores was either less affected by extinctions than was the case on many other islands, or recovered quickly. Additionally, the relatively low extinction rate for birds on Flores suggests that population connectivity with nearby islands protected birds against extinction.

**Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)**

**DESCRIPTION OF A JUVENILE DIPLODOCUS FROM DINOSAUR NATIONAL MONUMENT, UTAH AND ITS ONTOGENETIC IMPLICATIONS**

**MELSTROM, Keegan, University of Michigan, Ann Arbor, MI, United States**

Articulated sauropod sauropod material is exceptionally rare and can give unique insights into morphological changes experienced during ontogeny. I describe the partial skeleton of a juvenile *Diplodocus* individual from the Morrison Formation of Dinosaur National Monument, Utah and examine both serial and ontogenetic variation. Vertebral remains are articulated and include three posterior cervical vertebrae, ten dorsal vertebrae, five sacral vertebrae, and at least three caudal vertebrae. Appendicular remains include fragmentary pelvic fragments, a partial right femur and a left femoral head. Smal scale indicates a lack of fusion of neurocentral sutures in presacral vertebrae, and the absence of lines of arrested growth in the femur indicate the individual is a juvenile. The excellent preservation of the vertebral column allows documentation of both serial and ontogenetic morphological changes in
Diplolocus. Pneumatic fossae are found in the centrum and neural arch in the posterior cervical series of this juvenile specimen. The pleurocentral fossae are shallower and divided by fewer internal laminae than in more mature specimens. The cervical prezygapophyses extend far anteriorly, terminating above the pneumatic cavity of the preceding vertebra. This condition differs from that in which prezygapophyses end above the base of the preceding vertebra. The postzygapophyses of the juvenile are nearly level with the neural spines, whereas the postzygapophyses of adults are more ventrally positioned. Pneumatised in the dorsal vertebrae varies serially. Large pneumatic fossae punctuate the anterior 4 dorsal centra, but these spaces are occupied by extremely reduced, shallow depressions in dorsal vertebrae 5 and 6. Posterior dorsal vertebrae 7-10 have well-developed pneumatic fossae that resemble those in the anterior dorsal centra. This variation in the middle of the dorsal series may represent a pneumatic hiatus. The nearly complete sacrum illustrates patterns of fusion along the interneural, costovertebral, and intercostal junctions. Intervertebral junctions s1/2 and s2/3 are already closed in this individual, but more posterior interneural junctions remain unfused. Costovertebral junctions are nearly completely fused in this specimen, save the final costovertebral junction. Intervertebral junctions were likely the last osteological unit of the sacrum to completely fuse, with no sutures having fused in this specimen. Additionally, well-preserved individuals representing other ontogenetic stages will shed light on the ontogenetic and serial variation in Diplolocus.

Technical Session II (Wednesday, October 17, 8:45 am)

IDENTIFICATION OF THE BONES OF THE SNIOUT IN LOWER ACTINOPTERYGIANS — A NEW NOMENCLATURE SCHEME BASED ON CHARACTERS

MICKLE, Kathryn E., University of Kansas, Lawrence, KS, United States

Currently, there is no standardised nomenclatural scheme for identifying and naming the bones of the snout in lower actinopterygian fishes. This creates a situation where the same bone names are used to identify very different bones. This is problematic because it makes comparing previously described taxa difficult, presents potential pitfalls when building character matrixes for phylogenetic analyses, and impairs our understanding of the diversity of lower actinopterygians. Because of the problems the absence of a standardized nomenclature scheme presents, a new set of rules for the identification of the bones of the snout of lower actinopterygians is proposed. Definitions for what premaxilla, lachrymal, rostral, and postrostral bones constitute are presented. The new definitions are based on the presence of characters that are commonly preserved such as the presence or absence of sensory canal lines, location of bones in relation to other bones, and whether or not the bones contribute to the formation of the nasal openings. When numerous characters are present in a single bone, this bone is considered to be a complex bone and the name reflects this. The snout bones of various Devonian and Carboniferous actinopterygians are then identified using this nomenclature scheme. When this is done, patterns regarding the makeup of the snout in Devonian and Carboniferous fishes emerge. The snouts of Carboniferous fishes show much more diversity than those of Devonian fishes. Devonian fishes are characterized by a more generalized snout. In depth investigations into characters such as the bones of the snout are important for forming a stronger understanding of the morphological diversity of lower actinopterygian fishes and have implications for phylogenetic studies. When the snout characters in a character matrix are recoded using this terminology and phylogenetic analysis is performed, the resultant tree has clades of lower actinopterygian fishes supported by the revised characters. This tree and the clades supported by the newly defined snout characters in a character matrix are recoded using this terminology and phylogenetic analysis is performed. When this is done, patterns regarding the makeup of the snout in Devonian and Carboniferous fishes emerge. The snouts of Carboniferous fishes show much more diversity than those of Devonian fishes. Devonian fishes are characterized by a more generalized snout. In depth investigations into characters such as the bones of the snout are important for forming a stronger understanding of the morphological diversity of lower actinopterygian fishes and have implications for phylogenetic studies. When the snout characters in a character matrix are recoded using this terminology and phylogenetic analysis is performed, the resultant tree has clades of lower actinopterygian fishes supported by the revised characters. This tree and the clades supported by the newly defined snout characters are presented and discussed here. For example, there are clades supported by the presence of different complex premaxillary bones and another clade supported by the presence of a separate and distinct premaxilla. Reinvestigating the snout bones of lower actinopterygians is important for understanding character relationships and evolutionary processes of these fishes. More in depth investigations into specific characters are necessary in the future.

DISTRIBUTIONAL PATTERNS OF MAWSONIIDAE (SARCOPHYGII: ACTINISTIA): A TRACK ANALYSIS

MIGUEL, Raphael D., Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

GALLO, Valêria D., Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

MORRONE, Juan J., Universidad Nacional Autónoma de México, Distrito Federal, Mexico

Mawsoniidae are a fossil family of actinistian fish popularly known as coelacanths, which are found in continental and marine paleoenvironments. The taxon was proposed in the 1990’s and is considered monophyletic according to the most recent reviews. It includes five valid genera (Axelrodichthys, Chinlea, Diplurus, Mawsonia, and Parnabaia) and 11 genera with some taxonomical controversy (Aloicueria, Changxia, Garnbergia, Hepatanes, Indocoeoelacanthus, Libys, Luvabaia, Megalocoeoelacanthus, Moekeongia, Bhigis, and Trachycormorops). Mawsoniidae possess a remarkable biogeographical signature due to their extensive temporal range, from the Late Triassic to the Late Cretaceous, and a widespread geographical distribution in the Americas, Africa, Asia, and Europe. The genera restricted to the Northern Hemisphere (Diplurus and Chinlea) possess the oldest records (Late Triassic), whereas those found in the Southern Hemisphere (Mawsonia, Axelrodichthys, and Parnabaia) extend from Late Jurassic to Late Cretaceous, especially in Brazil and Africa. We analyzed the distribution patterns of Mawsoniidae, including all genera, applying a track analysis, which obtained 12 individual species tracks and three generalized tracks (GTs). GT1 (Northeastern Newark) occurs in strata of the Newark Group (Upper Triassic); GT2 (Midwestern Gondwana) occurs in the Lualaba Formation (Upper Jurassic); and GT3 (Iapetocuru-Alcántara-Santana) occurs in the Iapetocuru-Alcántara-Santana formations (Lower Cretaceous). Individual tracks were also obtained for genera by geological periods, showing congruence with the individual species tracks. The origin of Mawsoniidae can be dated to the Late Triassic of Pangaea. The tectonic events related to the breakup of Pangaea and Gondwana and the evolution of the oceans are suggested as the vicariant events affecting the distribution of this taxon throughout the Mesozoic. The results highlight the potential of the panbiogeographical approach for analyzing distributional patterns of fossil taxa.
LUMBAR MORPHOLOGY OF SUSPENSYORY, GLIDING AND FLYING MAMMALS: IMPLICATIONS FOR THE LOCOMOTOR BEHAVIOR OF SELECT FOSSIL PRIMATES
MILLER, Charlotte E., Duke University, Durham, NC, United States; GRANATOSKY, Michael C., Duke University, Durham, NC, United States; CHESTER, Stephen G., Yale University, New Haven, CT, United States; BOYER, Doug M., Brooklyn College, New York, NY, United States; SCHMITT, Daniel, Duke University, Durham, NC, United States

Lumbar vertebral morphology has been used as an indicator of locomotor behavior in living and fossil mammals. Rigidity within the lumbar region is thought to have importance for increasing overall axial rigidity during various forms of locomotion, including bridging between supports, inverted quadrupedalism, gliding, and flying. But distinguishing between those behaviors using bony features has been challenging. This study used osteological characters of the lumbar spine that appear to limit lumbar mobility in a broad phylogenetic sample of extant taxa, including members of Dermoptera, Chiroptera, Scandentia, Primates, Pilosa, Rodentia, and Marsupalia, representing a wide range of locomotor behaviors. These same lumbar characters were measured in three extinct species for which locomotor behaviors have been debated, the sloth lemurs (Paleopropithecus and Babakotia radofilai) and paromomyid plesiadiforms (Ignaucus graybullianus), in order to further investigate their possible locomotor and positional behaviors.

Results from a principal components analysis of six geometric mean standardized measurements demonstrate that suspensory taxa are characterized by short and cranio-caudally expanded spinous processes and relatively short transverse processes compared to scansorial and gliding mammals. Both dermopterans and chiropterans exhibit these traits and cluster most closely with committed inverted quadrupeds in this sample. The sloth lemurs (Paleopropithecus and Babakotia radofilai) groups closely with primate taxa like the lorises and Pongo, while Paleopropithecus groups with extant sloths. In accordance with previously conducted studies, these finding suggests that Paleopropithecus was engaged in inverted quadrupedalism at a high frequency, while Babakotia radofilai may have engaged in a more diverse array of locomotor and positional behaviors. Corroborating previous studies of the lumbar spine, Ignaucus graybullianus is most similar to taxa: it shares no similarities in these characteristics with extant mitten-gliders. If the lumbar of suspensorial species is less mobile than that of non-suspending taxa, then the osteological characters we have measured appear to reflect those differences well and suggest that axial rigidity is advantageous for suspensory locomotion and possibly flight in bats.

Furthermore, lumbar rigidity, as reflected by our measurements, would appear to have arisen independently among multiple mammalian lineages.

TEMPORAL MEGABIAS: LATITUDINAL CONTROLS ON TIME-AVERAGING OF TERRESTRIAL DEATH ASSEMBLAGES AND THEIR ECOLOGICAL DATA
MILLER, Joshua H., Florida Museum of Natural History, Gainesville, FL, United States

Maximum survival durations of bones on landscape surfaces are primary controls on the ecological data captured by death assemblages. Particularly if time-averaging is significantly different among climatic settings or across latitudes (even among constant sedimentation rates), death assemblages from similar, or even identical communities could capture different ecological data. Paleoecological comparisons among fossil assemblages from strongly different communities, latitudinal settings, and across geologic time must be cognizant of inherent differences in time-averaging. Here, I test for differences in time-averaging of modern large-mammal death assemblages in tropical, temperate and arctic settings. I also test for climatic and ecological controls on the weathering stage frequency distribution of landscape bone accumulations across this latitudinal gradient. To test the survival durations of bones on aquatic landscapes, I radiocarbon-dated 50 antlers, bones, and teeth of adult and neonatal caribou (Rangifer tarandus) recovered from bone surveys of Alaska’s North Slope (Arctic National Wildlife Refuge). To test for differences in time-averaging durations across latitude, these new data are paired with existing data on survival durations of ungulate bones from high arctic, temperate, and tropical landscapes (including radiocarbon dating and observations of carcasses with known postmortal duration). Clear latitudinal controls on bone survival durations are observed, with time-averaging increasing by successive orders of magnitude between latitudinal bins: maximum bone survival reaches decadal time-scales in the tropics, centennial time-scales in temperate regions, and millennial time-scales in the arctic. While over-all time-averaging duration is driven by climate, the frequency distribution of bone weathering stages is strongly influenced by ecological history, particularly species’ population stability (or lack thereof). Ecosystems with significantly different time-averaging durations can produce highly-similar weathering stage frequency distributions, illustrating that such comparisons are not necessarily straightforward. Environmental and ecological settings with faster bone recycling rates (the tropics) may be particularly adept at capturing ecological changes across decadal timescales, without significant blurring by generations from prior centuries or beyond. Colder, more northern ecosystems, including those in temperate and arctic settings, offer extended observational windows, which are particularly insensitive to high-frequent ecological variability. Establishing and evaluating ecological differences in temporal resolution among death assemblages is an important component of any paleoecological comparison.
In 1880, the early Eocene fluvial deposits of the Erquelinnes sand quarry in the southern part of the Mons basin in Belgium yielded their first mammal fossil, a well preserved jaw of a primitive perisodactyl. By 1927, about 40 mammal specimens had been recovered from Erquelinnes and were attributed to Adaptadon, Protomys, Paramys, Plesiadapis, Arctocyonides, Hyaenotherium, Coryphodon and 'Oxyaena or Miacidae'. By that time however, the Erquelinnes fauna had already been eclipsed by the contemporaneous Dornaal fauna from northeastern Belgium, which yielded thousands of specimens rather than only a few dozen. Since then, attention for the Erquelinnes fauna has therefore been limited to the passing mentions of referred specimens in the formal descriptions of the new plesiadapid Phlaenothrops georgii and of the miacid Gracilicyon solei.

Here we present an updated faunal list of the complete Erquelinnes mammal fauna. We show that also hyaenodontids, mesonychids, hyopsodontids, and dichobunid artiodactyls are present in the Erquelinnes fauna, and some of the earlier identifications are corrected. Results from δ13Corg analysis of the mammal-bearing level at Erquelinnes and the strata immediately below it, seem to independently support the faunal correlation. Faunal differences between Erquelinnes and Dormaal are most likely the result of subtle differences in depositional environments and thus in taphonomic bias. Details of the stratigraphic origin of the Erquelinnes pterossoctyl specimens however show that these are derived from two distinct stratigraphic levels, which potentially have significantly different age correlations.

Technical Session XVII (Saturday, October 20, 3:00 pm)

PALEOCOLOGY OF THE JEHOH BIRDS INFERRED FROM MODERN BIRD ECOMORPHOLOGY
MITCHELL, Jonathan S., The University of Chicago, Chicago, IL, United States; MAKOVICKY, Peter J., The Field Museum of Natural History, Chicago, IL, United States; GAO, Ke-Qin, Peking University, Beijing, China

Birds are a major component of modern faunas across the globe, with a staggering amount of ecological diversity. Although the avian fossil record is better than often assumed, it is still sparse enough to make studying the evolution of ecomorphological diversity in birds difficult. Further, all crown and many stem birds lack teeth, obscuring dietary inference in paleoecological settings. To address this problem quantitatively, we scored over 500 genera of living birds for 17 binary ecological variables (e.g., occurrence in lakes, consumption of seeds) and took linear measurements of limb bone lengths of over 1000 specimens of those same genera, representing most modern families. Canonical correlations resulted in six axes with Pearson’s correlation coefficients of 0.825, 0.66, 0.554, 0.51, 0.427, and 0.271. Independent contrasts were computed using a published family-level phylogeny of 119 bird taxa, and further supported the coevolution of morphology and ecology (Pearson’s r = 0.58). These same measurements were made on over 100 fossils from the Jehol Biota, representing over 30 named genera of early avian taxa. We projected the measurements from the fossil taxa into the canonical space defined by the correlations between modern bird ecology and morphology, and then computed the distances between each fossil taxon and all of the modern taxa. We used these distances to establish distributions for each fossil, and then found the modern birds that were more than 1.645 standard deviations (the 90% confidence limit) closer to the fossil taxa than their mean distance. These modern birds were then considered the robust analogues. Concurrent with previous reconstructions, Gansus was found to be closest to the foot-propelled diver Podilymbus in our analysis, and despite not including beak characters, the longipterygids were found to be sister to long-billed taxa such as Colaptes and Galbula. Enantiornithines in general clustered close to cuckoos (especially Cuculus and Chrysococcyx) while more modern birds such as Confuciosaurus tended to cluster by phianisids (especially Coturnix and Lagopus, also the trogonid Phaenocorys). Without including external data on gut contents or beak shape, our method is prone to clustering many ground-dwelling taxa with owls, as they have evolved an exceptionally short tarsometatarsus for the purposes of prey handling, rather than locomotion. On the whole, the avifauna of the Jehol biota was more heavily weighted towards taxa that do the bulk of their foraging on the ground or in forests, with fewer taxa reliant on aerial or aquatic foraging, than modern avifaunas, even when taphonomic biases are taken into account.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

NEW INFORMATION ON BASICRANIA OF TROGOSUS (TILLODONTIA, MAMMALIA) WITH AN EXQUISITELY PRESERVED PETROSAI
MIYATA, Kazunori, Fukui Prefectural Dinosaur Museum, Fukui, Japan; DEMERRI, Thomas A., Department of Paleontology, San Diego Natural History Museum, San Diego, CA, United States

Tillodonts, archaic herbivorous euthamerian mammals with elongated incisors (I2s and i2s), have been described from Upper Paleocene through Middle Eocene deposits in North America and Eurasia (Canada, USA, France, Germany, India, Pakistan, China, and Japan). Many tillodont fossils are represented by only whole or partial dentitions and crania and postcrania are unfortunately rare. Important exceptions to this are Bridgerian age specimens of Trogosus and Tildodon from the Green River Basin, Wyoming, USA and the Huerfano Basin, Colorado, USA. Even more rare are tillodont specimens with well preserved bascrania. Consequently, little is known about functionally and phylogenetically important features such as those associated with the auditory region. The recently prepared skull of Trogosus sp. (SDSNH 40819) from the Delmar Formation (Bridgerian) of coastal San Diego County, California, USA provides the best anatomical information for the tillodont bascranium, with an almost complete petrosal area. Based on this new specimen it is possible to describe for the first time the anatomy of the auditory region in the order Tillodontia. Incomplete but unique stylohyoids are also associated with the skull in SDSNH 40819. The anteroventrally shortened basiscincia of Trogosus sp. has an operculomastoid process with a knobbed lateral head, lateral to the occipital condyle. SDSNH 40819 clearly demonstrates that this process consists of the mastoid process of petrosal (anterolateral half) and the parapetrous process of the exoccipital (posteroventral half). Further, the mastoid process is restricted dorsally between the posttemporal process of the squamosal and the exoccipital. The petrosal of Trogosus sp. conforms well to a pleiomorphic morphotype, except for the well developed tympanohyal. The tympanohyal is developed as a flange approaching closely beneath the posterior portion of the promontorium, and showing a small and shallow depression on the ventral surface which probably is associated with the stylohyoid. A small fusiform-like stylomastoid foramen exists just medial to the tympanohyal. Just medial to the anterior flange of the tympanohyal is a tiny bone provisionally assigned to the malleus. This bone is positioned near the external auditory meatus. The protuberrant promontorium on both sides shows a defined sulcus for the stapedial artery. The anterolateral edge of the angular foramen on the caudal end of the basiscincia is not smooth, suggesting the passages of nerves. Future analysis of this new specimen using computed tomography (CT) will likely reveal additional new anatomical information about tillodont cranial anatomy.

Technical Session IX (Friday, October 19, 10:15 am)

VERTEBRAL MORPHOLOGY AND AXIS MECHANICS IN EARLY CROCODYLOMORPHS AND MODERN CROCODILES
MOLNAR, Julia L., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom; PIERCE, Stephanie E., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom; TURNER, Alan H., Stony Brook University, Stony Brook, NY, United States; HUTCHINSON, John R., Royal Veterinary College, Hawkshead Lane, Hatfield, United Kingdom

In contrast to extant crocodilians, early crocodylomorphs such as Protosuchus and ‘sphenosuchians’ are thought to have had a fully erect posture, extraordinary athleticism on land, and almost exclusively terrestrial lifestyles. Previous studies have noted anatomical differences in the axial skeleton that may be responsible for these functional differences; for example, it has been postulated that the morphology of the trunk of Protosuchus was specialized for fast terrestrial locomotion and would not have allowed significant lateral undulation (or swimming), in contrast to the ‘cuschanich’ trunk, which mainly permits mediolateral movements during terrestrial and aquatic locomotion. However, the hypothesized relationship between vertebral morphology and mechanical properties in crocodiles and other archosaurs is not well studied, suggesting the need for additional research. Here we present a rigorous biomechanical assessment of these two disparate locomotor styles. Using 5 cadaver specimens, we first tested the stiffness of intervertebral joints along the dorsal column of Crocodylus niloticus in dorsoventral, and mediolateral flexion. We then built functional profiles of the vertebral columns of C. niloticus and Protosuchus richardsoni (with 3D segmentation of CT scan data from the type specimen) using measurements that have been correlated with axial stiffness in mammals. The results of the intervertebral joint...
stiffness experiment demonstrate that the vertebral column of C. niloticus has a greater propensity (i.e. increased flexibility) for mediolateral rather than dorsoventral mobility and an increase in mediolateral stiffness in the lumbar region, both of which directly correspond to vertebral measurements. Thus, morphometric parameters appear to have the power to predict vertebral mechanics in modern crocodiles and (with caution) in their extinct relatives. Comparison of the functional profiles between C. niloticus and P. richardsoni shows that the lumbar region of P. richardsoni has several characteristics that are associated with increased dorsoventral flexibility, including more vertically oriented pre-zygapophyses, an increase in centrum width, and more laterally extending transverse processes. These results support the notion that the vertebral column of early crocodylomorphs favored dorsoventral lumbar motion (necessary for bounding/galloping gait) to a degree exceeding that in extant Crocodylia. This work provides an objective basis for reconstructing the locomotor evolution of crocodile-line archosaurs, and also provides clues about the anatomical basis for the remarkable locomotor abilities of modern crocodylians.

Romer Prize Session (Thursday, October 18, 11:15 am)

STABLE ISOTOPE ECOLOGY OF VERTEBRATES IN ARID ENVIRONMENTS: ARCHIVES OF ENVIRONMENT AND CLIMATE IN THE FOSSIL RECORD
MONTANARI, Shaena, American Museum of Natural History, New York, NY, United States
Terrestrial paleoenvironmental archives contained in biogenic materials provide essential information for examining past climates in arid locations where other types of records may not be available. Fossilized remains, such as teeth and eggshell, can be analyzed for stable isotopes (carbon and oxygen) to determine the environment and ecology of species-rich localities. During the Cretaceous in Central Asia and the Pliocene of Australia, environments were becoming increasingly arid, leading to dramatic faunal and floral turnovers. To understand the paleoecology of these systems, it is vital to track how environments and fauna change on a local scale in response to large-scale climatic change. Here, geochemical methods are used to evaluate the biogenic archives contained in dinosaur and marsupial remains from the Cretaceous of Mongolia and the Pliocene of Australia. Carbon isotope values of vertebrate remains record the diet of the organism, while oxygen isotope values indicate the type of water source from which the individual was drinking. Tooth enamel from the ubiquitous Protoceratops and fragments of oviraptorid eggshell from three localities in the Gobi Desert are analyzed for carbon and oxygen isotopes to constrain understanding of the environment of this locality roughly 80 million years ago. The stable isotope values of these biogenic minerals show that these localities, which supported a rich species level diversity of dinosaurs and other vertebrates, were arid with xeric plants (estimated δ13C = -22.0‰) and small, isolated bodies of water. During the Pliocene in southeastern Queensland, Australia grasslands were hypothesized to have been spreading across Australia, providing new fodder for the large-bodied marsupial Protoplatygonus. The mammal of kangaroos such as Macropus and the extinct giant herbivorous marsupial Euryzygoma indicates that the environment of the early Pliocene locality Chinchilla Sands consisted of a range of microhabitats, from woodlands to grasslands, with δ13C of enamel ranging between -15.8 and -3.5‰. Grasslands thus had spread across eastern Australia by this time, but were not the sole source of plant fodder at this locality. Without these biogenic archives, we would be unable to determine the vegetation and hydrologic structure of these ancient arid environments. Stable isotopes are a tremendously powerful tool for examining the paleoenvironments and ecology of these extinct vertebrates and make it possible to unite environments and communities in deep time.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

RECORD OF TAYASSUIDS IN ?PLIOCENE-QUATERNARY DEPOSITS IN VENEZUELA
MONTELLANO, Marisol, Instituto de Geologia, UNAM, Mexico, Mexico; RINCÓN, Ascanio D., Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela; SOLORZANO, Andrés, Instituto Venezolano de Investigaciones Científicas, Caracas, Venezuela

Today the Tayassuidae is represented by at least four extant species distributed throughout the Americas, from south-western United States to north-central Argentina. It is one of the immigrants that entered South America during the Great American Biotic Interchange, the oldest unequivocal evidence of which is at the beginning of the Middle Pleistocene in Argentina. Three genera are recognized in South America: Prototayassu (middle Pleistocene–early Pleistocene), Catagonus (late Pliocene–Recent), and Tayassu (middle Pleistocene–Recent), most of the South American records come from Argentina, Uruguay and Brazil.

In the last decade, discoveries of fossileiferous faunas in northern Venezuela revealed a rich and diverse vertebrate fauna that includes remains of mammals, reptiles, amphibians and birds. Tayassuid material was discovered in different trenches during the excavation for an oil pipeline. Each trench was numbered and studied separately because its faunal association suggest they are not contemporaneous. Remains of Prototayassu sp. had been already reported from the tar pit known as Orocual (ORS-16, ?Pliocene-middle Pleistocene). Prototayassu was very common and diverse in Argentina during late Pliocene and disappeared during the early-middle Pleistocene. This Venezuelan find represents the northernmost record in South America and is intermediate between the northern and southern populations of the continent. Recently, 10 partial lower jaws with teeth in different stages of wear were recovered, as well as isolated upper molars and fragments of maxilla bearing teeth, from another trench, ORS-20 (?late Pleistocene). The material is identified as Tayassu pecari, because of the molarization of premolars, development of cingula and additional accessory cusps. In this sample there is a partial lower jaw with pm4 and alveoli for pm3, pm2, which is quite similar to Pecari tajacu, the trigonid is larger than the talonid, and is more quadrangular in shape. In the western part of the country there is another tar pit known as “Mene de Incarate” dated 28,000 years, a fragment of a maxilla with M1-M3 of Pecari tajacu was collected. Remains of Tayassu pecari had been recovered from several caves of Pleistocene-Holocene age, which are located in the northern part of the country.

Until now, three forms of tayassuids had been recovered from different regions of the country: Prototayassu sp., Tayassu pecari and Pecari tajacu. The last two are now co-occur in large areas in Venezuela, but differ in the mode of resource exploitation. The Venezuelan tayassuid fossil record represents the first of these lineages in northern South America, and provides information to understand the distribution and diversity of the group in South America during the Pliocene-Quaternary.

Technical Session VIII (Thursday, October 18, 4:00 pm)

WHITE RIVER GROUP MAMMALS EXHIBIT ECOLOGICAL RESPONSE TO THE EARLIEST OLIGOCENE CLIMATE TRANSITION
MOORE, Jason R., Dartmouth College, Hanover, NH, United States

The earliest Oligocene marks one of the most major climate transitions in the Cenozoic. High latitude marine temperatures indicate a temperature drop of 4-5°C over the course of 300,000 years, associated with the formation of a permanent Antarctic ice sheet. Climate change in the mid-latitudes, particularly in terrestrial environments is more difficult to resolve, although there are indications of both cooling and drying, and associated faunal and floral turnover. In North America, mammalian response to this climate shift, as recorded in the classic outcrops of the White River Group, is enigmatic. Extensive museum collections show apparently little, if any, evolutionary response (extinction or origination) of the fauna during this period.

In order to determine whether, instead of an evolutionary response, the White River Group fauna exhibited an ecological response to this climate transition, new, temporally constrained samples were collected spanning the interval of the climate transition in and around Badlands National Park, SD. Extensive taphonomic data were assembled for each collected specimen, and used to establish isotyponomy among samples. Changes in the abundances of different taxa among isotyponomic samples indicate true ecological changes, rather than potential artefactual shifts caused by varying taphonomic bias. Analysis of the faunal structure of isotyponomic samples across the climate transition shows a directional shift in the abundances of several taxa with time (including Palaeolagus and Merycoidodon). This is interpreted to represent an ecological response to the climate shift, as paleoenvironments become drier and more open. This is the first time such a change in faunal structure has been demonstrated using vertebrate taxa in a quantifiably isotyponomic framework.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

INTRA-INDIVIDUAL VARIATION OF CARBON AND OXYGEN ISOTOPE VALUES WITHIN THE MIOCENE HORSE PARAHIPPUS LEONENSISS AND IMPLICATIONS FOR DIET
MORAN, Sean M., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States

The early Miocene horse, Parahippus leonensis, represents an important species in the evolution of equids from browsers to grazers. Preliminary hypodonty, dental microwear, and isotopic data support the hypothesis of P. leonensis as an incipient grazer. However, the relative paucity of these data does not allow for the interpretation of dietary variation within the mineralization of an individual tooth, an individual, or an assemblage. These variations may impact conclusions drawn from any individual sample. Additionally, seasonal or ontogenic influences on diet may have been an underlying mechanism in the shift from browsing to grazing affinities in ancient horses. Stable carbon and oxygen isotopes can help to elucidate any variations in the relative proportions of C4 and C3 plant intake in diet. This study employs stable carbon and oxygen isotope data from associated, serially sampled cheek teeth of Parahippus leonensis to investigate intra-individual variation in diet and test the hypotheses that ontogeny and/or seasonality played a role in these variations.

Using a micromill, enameled of six associated mandibular cheek teeth was serially sampled from a Parahippus leonensis mandible collected from the Hemingfordian Thomas Farm site located in Gilchrist County, Florida. Approximately 50 samples were collected and analyzed for carbon and oxygen isotope values using the H3PO4 digestion method. The data were statistically analyzed to investigate whether there was a correlation of oxygen and carbon isotope data supporting a seasonal influence on diet. In addition, with the assumption that the general pattern of enamel mineralization is similar to that observed in modern equid teeth, a continuous curve of the individual’s oxygen and carbon isotope signatures was constructed using the腭bolic function. This allows for the interpretation of ontogenic influences on diet variation and the reconstruction of timing and patterning of enamel mineralization.

Preliminary data indicate intra-individual variation of δ13C values of up to 4‰, with individual teeth showing variations of up to 3‰. The samples also indicate a positive correlation between stable oxygen and carbon isotope values and a possible influence of seasonality on diet. Ontogenic changes in diet, as indicated by carbon isotopes, however, were not observed.
Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 11:15)

NEOTROPICAL LATE MIOCENE-EARLY PLIOCENE VERTEBRATES FROM THE CASTILLETES FORMATION, NORTHERN COLOMBIA

MORENO-BERNAL, Jorge W., Smithsonian Tropical Research Institute, Panama, Panama; FEDERICO, Moreno, Smithsonian Tropical Research Institute, Panama, Panama; CARRILLO, Juan D., Smithsonian Tropical Research Institute, Panama, Panama; VALLEJO-PAREJA, Maria C., Smithsonian Tropical Research Institute, Panama, Panama; JIMENEZ-CAMPOS, Ludwig, Smithsonian Tropical Research Institute, Panama, Panama

In 2010 and 2011 we undertook an initial exploratory survey of the late Miocene-early Pliocene Castilletes Facies (Eastern Guajira Peninsula, Colombia). The Castilletes is composed of deltaic and shallow marine deposits, with an abundant continental fauna in some intervals. These new findings will contribute to a better understanding of the neotropical vertebrate communities and palaeoenvironments during a time of high tectonic activity and global climate change. The fauna includes sharks (Charcharhiniformes), rays (Myliobatiformes), catfish (Siluriformes), dogtooth tetras (Cynodontidae), fresh water turtles (Podocnemididae), and one of the oldest records of Crocodylus in the Americas. The mammal assemblage comprises five orders and ten families. Xenarthrans include megatheriid and nothrotheriid sloths and the cingulates

American ungulates include horse-like protherotheriids (Litopterna), rhino-like toxodonts (Neoegyptetis), rodent-like denticulates (Diploodon), and antelopes (Pampatherium). Rodents are represented by Chapalma therium hydrochoerid, c. Neoegyptetis (Neoegyptetidae) and Panamamylus sp. (Elephantidae). Indigenous South American ungulates include horse-like protherotheriids (Litopterna), rhino-like toxodonts (Notoungulata), and astrapotheres (Astrapotheria). Associated fossil wood is found in some localities. Overall, the Castilletes fauna and flora indicates the presence of extensive water bodies, in a delta complex with moderate to high rates of rainfall during the late Miocene-early Pliocene. Considering that today the Guajira peninsula is characterized by a very dry climate with xerophytic vegetation, the inferred paleoenvironment for the Castilletes is very different from that of the present. In the early Pliocene, the Guajira Peninsula and the adjacent South American continent were still connected by land.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ISOTOPIC VARIATION AND NICHE SPACE IN MIDDLE AND LATE MIOCENE SIIWALIK MAMMALS FROM PREDOMINANTLY C3 ECOSYSTEMS

MORGAN, Michele E., Harvard University, Cambridge, MA, United States; BARRY, John, Harvard University, Cambridge, MA, United States; PILBEAM, David, Harvard University, Cambridge, MA, United States

The Siwalik Group of northern Pakistan preserves a rich Neogene terrestrial fossil record. Recent studies have focused on detailing mammalian community structure and faunal change in the late Miocene starting around 8.5 Ma, coincident with the appearance and influence of C4-dominated herbivorous ungulates. The Siwaliks provide a unique opportunity for the study of the occurrence of taxa with C4 feeding adaptations, as well as a record on the period of transition to C3-dominated ecosystems. Between 13.7 and 8.5 Ma to examine variation within stable carbon and oxygen isotopic signatures of mammalian species in predominantly C3 ecosystems. A number of ubiquitous herbivore species present for three or more million years in the Chajji Formation are replaced in the younger Nagri Formation between 11 and 10.3 Ma by larger, more ecologically diverse species. The occurrence of juvenile Edmontosaurus from the Liscomb Bonebed of the younger Nagri Formation indicates that the region has suffered a drastic climatic change over the last 4 million years.

RECONSTRUCTION AND MORPHOMETRIC ANALYSIS OF JUVENILE EDMONTOSAURUS SP. FROM THE LOWER MAASACHTSTRAICH (CRETAEOUS) PRINCE CREEK FORMATION OF NORTHERN ALASKA

MORI, Hirotsugu, University of Alaska Fairbanks, Fairbanks, AK, United States; DRUCKENMILLER, Patrick S., University of Alaska Museum, Fairbanks, AK, United States; PRIETO-MARQUEZ, Albert, Bayerisches Staatsamministum für Paläontologie und Geologie, Munich, Germany; JENKINS, Shantanu, University of California Los Angeles School of Medicine, Los Angeles, CA, United States

The occurrence of juvenile Edmontosaurus sp. material from the Liscomb Bonebed of northern Alaska has great paleobiological significance given its occurrence in high paleolatitudes (82°N). An abundance of disarticulated cranial remains from multiple individuals of a single size cohort provides a wealth of data on the skull anatomy of this taxon. The Alaskan edmontosaur material has not been previously described, nor has its relationships to stratigraphically younger (E. annectens) and older (E. regalis) species been established, in part because of its early ontogenetic state. Here, we provide the first formal reconstruction of the skull of the Alaskan Edmontosaurus, using new data from the collection housed at the University of Alaska Museum. To better understand its systematic position, we conducted morphometric analyses of Edmontosaurus with the new Alaskan reconstruction using landmark and semi-landmark based relative warp analysis and Geodesic Distance Analysis (GDA). For the landmark and semi-landmark based morphometric analysis, Relative Warp (RW) 1 shows high correlation with size and is therefore disregarded, while score 2 clearly separates E. regalis from E. annectens. Plotting RW2 versus RW3, the Alaskan Edmontosaurus clusters most closely to E. annectens. Results from the GDA also cluster the Alaskan specimen closer to E. annectens than to E. regalis, mainly on the basis of the second eigenshape axis. These results indicate that juvenile Alaskan Edmontosaurus is morphologically most similar to adult E. annectens. Assuming that the morphometric analysis is truly independent of ontogenetic changes, the Alaskan Edmontosaurus could represent the stratigraphically oldest, least-mature and northern-most occurrence of E. annectens. Alternatively, the Alaskan material could represent a juvenile form of either an unrecognized new taxon or E. regalis, indicating neontic evolution of E. annectens.
HISTOLOGICAL VARIATION SUGGESTS UNUSUAL LEVELS OF DEVELOPMENTAL PLASTICITY IN THE STEM ARCHOSAUR FVANCELEAAE

MORRIS, Zachary, The University of Texas at Austin, Jackson School of Geosciences, Austin, TX, United States; WERNING, Sarah, The University of California at Berkeley, Berkeley, CA, United States

Bone histology has been used to study growth and physiology of extinct archosaurs at individual, ontogenetic, and phylogenetic scales, but few studies have examined how histology varies within a species among specimens of comparable ontogenetic stage. When all individuals of a taxon share a similar growth trajectory, minimal sampling of like-sized individuals that have nearly identical histological profiles reduces destructive sampling of specimens. Conversely, if individuals of a taxon are developmentally plastic, conservative sampling will obscure variation and may miss histological differences that result from evolutionary, environmental, or geographic change. We report a potential case of such developmental plasticity in the stem archosaur (non-archosaur archosauriform) Vancleavea campi. This taxon, from the Late Triassic of the American Southwest, persisted with little morphological change for over 20 million years. We reanalyzed a previously sampled femur, and sampled an additional five femora and three humeri (seven individuals) from five localities, to assess potential variation in Vancleavea’s growth regime. Our sampling covered as much of its stratigraphic range as possible, but we restricted our study to specimens diagnosed using a unique combination of femoral/humeral characters and association with apomorphic osteoderms. Four femora and all humeri are of nearly identical size, but the dominant bone tissue type is highly variable within our sample. One individual displays woven bone with no apparent cessation of growth until its death; another is dominated by lamellar bone with many lines of arrested growth; and other specimens exhibit various permutations of these patterns. These data reveal at least three growth trajectories to achieve common adult size: rapid growth to adult size in 1-2 years; slow, prolonged growth lasting several years; and one highly unusual growth trajectory beginning with 4.5 years of very slow growth, followed by a year of very fast growth in which half the cortex is deposited, and then 10 or more years of slow growth to adult size. We hypothesize that paleoenvironmental variability may have contributed to the observed differences, because all specimens are from localities that experienced highly seasonal semi-arid conditions. Given the long stratigraphic range of this taxon, our sample may represent more than one species, but the morphological similarity among individuals makes this impossible to determine at this time. Whether or not we are dealing with more than one species, we hypothesize that developmental plasticity may have played an important role in the formation of the observed histological differences in this taxon.

Phylogenetic Significance of Auroraceratops Rugosus (Ornithischia: Ceratopsia) and the Phylogeny of Basal Neoceratopsia

MORSCHHAUSER, Eric M., University of Pennsylvania, Philadelphia, PA, United States

Basal neoceratopsian dinosaurs have experienced a remarkable growth in known diversity, with 13 new species named since 2002. Many of these species have not been included in phylogenetic analyses to date. Auroraceratops rugosus was named in 2005 and is one of the most abundant dinosaurs known. Over 80 specimens have been recovered from Lower Cretaceous strata of the Yujingzi Basin, western Gansu Province, China. Complete cranial and postcranial material provides a clearer picture of the mosaic of basal and derived characters in this genus. Auroraceratops shares the following plesiomorphies with Leioceratops and more basal forms: lack of a surangular shelf; extensive rugose ornamentation of the jugal, surangular, and dentary; and three premaxillary teeth. Auroraceratops also bears several derived features, including an epipigual, a vaulted premaxillary palate, and an angular process of the dentary. We present the first phylogenetic analysis of basal Neoceratopsia to include Auroraceratops and the first major taxonomic revision of basal Neoceratopsia in ten years. The species Breviceratops kaslowski and Gruccliceratops mongoliensis were found to lack autapomorphies or unique combinations of characters and were excluded. Safe taxonomic revision was used on the initial matrix of 36 taxa and 277 characters, but no taxa were indicated for removal. Heuristic analysis recovered 1990 most parsimonious trees with a length of 750. Our analysis recovers Auroraceratops in a polytomy including a clade composed of Yamaceratops and Heloceratops, a monophyletic Leptoceratopsidae, and Coronosaurus. When temporally calibrated, our cladogram indicates that the age uncertainty bars on several key Asian taxa determine the divergence times of Leptoceratopsidae and a clade including Auroraceratops, Yamaceratops, Leptoceratopsidae, and Coronosaurus. Future work in Asia should concentrate on improving the known ages of Early Cretaceous neoceratopsian localities.

Arctocyonid Diversity during the Paleocene-Eocene Thermal Maximum of North America

MORSE, Paul E., University of Florida, Gainesville, FL, United States; BLOCH, Jonathan M., University of Florida, Gainesville, FL, United States; SECORD, Ross, University of Nebraska-Lincoln, Lincoln, NE, United States; CHESTER, Stephen G., Yale University, New Haven, CT, United States; BOYER, Doug M., Brooklyn College, City University of New York, New York, New York, United States

The Arctocyonidae are a family of extinct “condylarth” mammals that were abundant and speciose during the Paleocene and declined in diversity and number during the early Eocene in North America, Europe, and Asia. Arctocyonids have been reconstructed as primitive omnivorous condylarths and may be the sister group to Artiodactyla. This study focuses on arctocyonids within the Paleocene-Eocene Thermal Maximum (PETM), ~56 Ma, when global temperatures increased by ~5-10°C. Three species were initially identified in the PETM faunal zone Wasatchian-0: (1) Thryptacodon barae, characterized by a centralized paracodon equal in size to the metacodon on M3 and a distinct hypocodon on the lower molars; (2) Chiracius bagnleyi, characterized by the absence of a metacodon on the P3, an anteriorly placed molar paracodon, and a highly reduced hypocodon; and (3) Prionceratops yalensis, characterized by a lingual molar paracodon and a low, shallow, anteroposteriorly compressed trigonid and a rounded cingulum compared to Chiracius. The latter two species have been difficult to distinguish in part because the holotype of C. bagnleyi contains only C1-P5, whereas the holotype of P. yalensis contains only M1-M3. These species were recently synonymized under the name C. bagnleyi (based primarily on a poorly-preserved specimen). We report a large collection of arctocyonid specimens from the PETM, collected in the southern Bighorn Basin, Wyoming. The number of specimens includes ~100 molars, numerous premolars, and deciduous teeth. It also includes the most complete specimen of PETM arctocyonid known: a partial dentary of C. bagnleyi with alveoli for C1-C4, P2-P5, and a preserved ascending ramus and mandibular condyle. The measurements and morphology documented in this sample clearly separate specimens of Thryptacodon, while supporting a second morphological group (Chiracius) in which body size range exceeds that normally observed in extant mammal species. When placed in stratigraphic context, C. bagnleyi body size is found to correspond well with inferred temperature during the PETM, similar to recent findings for the earliest equal Siyakippa. These results support the classification of two species: the less abundant T. barae (in contrast with the northern Bighorn Basin), and C. bagnleyi. While the morphotype described for P. yalensis is present in the collection, it is rare and observed only in worn specimens. These findings, coupled with a lack of discrete tooth dimensions in the temporal series, suggest that the P. yalensis morphotype results from wear to the molars of C. bagnleyi and support the synonymy of these taxa.

First Record of Fossil Cheirolidae and Triporichyidae from the Paleocene of Sonora, Mexico

MOSCATO, David A., East Tennessee State University, Johnson City, TN, United States; JANSKIS, Steven E., East Tennessee State University, Johnson City, TN, United States

The Paleocene of northern Mexico is relatively poorly understood, represented by only a few fossil localities. One such locality is the Late Paleocene fossil site of Térapa, located in east-central Sonora. The site dates to between 43,000 and 40,000 years old and yields a rich fossil fauna of over 60 identified taxa, dominated by birds and large mammals. The geologic evidence at the site indicates a marshland with permanent sources of calm freshwater, which is supported by the presence of fossil remains of freshwater invertebrates, fish, frogs, and turtles. The fossil turtle fauna of Térapa has received relatively little attention in the past. First record of fossils turtles have reported fossil turtles representing two families: Emydidae (Trachemys and Terrapene) and Kinosternidae (Kinosternon). The family Testudinidae is also present at Térapa; this study is the first report of this family from this locality. All three of these families are also represented in the extant fauna of Sonora. Here, we present the remains of two additional families of turtles from the Térapa locality, Cheirolidae and Triporichyidae, both of which are notable for being absent today in the naturally-occurring fauna of Sonora. The only other comparable Late Paleocene fossil locality in Sonora is Rancho La Brisa, located south of Térapa. Rancho La Brisa preserves a similar fossil assemblage, including Emydidae and Kinosternidae, but Cheirolidae and Triporichyidae are absent, making Térapa the only record of these turtles in Sonora. Previous studies of Térapa have noted the unusual presence of Crocodylidae in the fossil assemblage, and proposed that their presence might be the result of dispersal into interior Sonora from the south. We suggest that the same situation might explain the presence of cheirolids and triporichyids at this site. The turtles may have retreated to their modern distribution when the marshland gave way to the arid thornscrub of present-day Sonora.

Aridity and Turtles: Temporal and Spatial Patterns of Early Turtles in Sonora, Mexico

MOSCATO, David A., East Tennessee State University, Johnson City, TN, United States; BOYER, Doug M., Brooklyn College, City University of New York, New York, New York, United States

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ABSENCE OF SUCTION FEEDERS AMONG ICHTHYSOAIURS AND IMPORTANCE OF MECHANISM-BASED QUANTIFICATION IN FUNCTIONAL INFERENCES

MOTANI, Ryosuke, University of California, Davis, Davis, CA, United States; LONG, Jordan L., University of California, Davis, Davis, CA, United States; JI, Cheng, Peking University, Beijing, China; TOMITA, Taketeru, University of California, Davis, CA, United States; BLOCH, Jonathan M., University of California, Davis, CA, United States; BLOCH, Jonathan M., University of California, Davis, CA, United States

Suction feeding in Mesozoic marine reptiles has attracted little attention despite of its potential implications to the evolution of prey community and its environments. A recent study suggested that diverse suction feeders evolved among ichthyosaurs in the Triassic, based on their superficial resemblance to beaked whales. However, the suggestion requires mechanical reasoning and quantitative tests. We quantified two features that are closely linked to suction feeding mechanisms in jawed vertebrates, namely hyoid robustness and mandibular bluntness. We measured the hyoid bones of 14 species of Triassic and Early Jurassic ichthyosaurs, including the presumed suction feeders. Statistical analyses suggest that: (1) variation in hyoid robustness is limited among ichthyosaurs, unlike in whales or sharks; (2) ichthyosaurian hyoid bones are significantly more slender than in suction-feeding
sharks or cetaceans but similar to those of ram-feeding sharks; (3) two of the postulated suction feeders, namely, *Stenodus* and *Himantias*, possessed the two most slender hyoid bones among the ichthyosaurs examined. Most importantly, ossified hyoid corpus to which hyoid retractor muscles attach is unknown in any ichthyosaur, whereas a strong integration of the ossified corpus and column of hyoid has been identified in the literature as an important feature of feeding. Therefore, and assentments suggest that all ichthyosaurs were 'ram feeders'. We also found that the highest mandibular bluntness (width/ramus length) value in ichthyosaurs was about 0.45, which is not very blunt in the cetacean standard; published data suggest that most suction-feeding cetaceans have much blunter mandibles, with the ratio ranging between 0.58-0.86. Most of the cetaceans in the range near 0.45 are ‘ram feeders’, except some beaked whales that have extra superficial tissues around the corner of the gape that shortens the gape in effect. There is no evidence that ichthyosaurs had such ‘cheek-like’ soft tissues. In conclusion, it is most likely that there was no suction feeding among Triassic and Early Jurassic ichthyosaurs. Our study illuminates the risk of qualitative functional inferences in paleontology, and reemphasizes the importance of quantitative assessment of mechanism-related morphology.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 8:30 am)

**EXAMining CHARACTER CONGRUENCE AND COMPATIBILITY OF VERTEBRATE CLADISTIC DATA - EMPIRICAL APPROACHES APPLIED COMPARATIVELY ACROSS CLADES**

MOUNCE, Ross, University of Bath, Bath, United Kingdom; WILLS, Matthew A., University of Bath, Bath, United Kingdom

Previous phylogenetic work using conventional character partition homogeneity tests has often revealed significant incongruence between cranial and postcranial character data. We extend this approach by applying pairwise character compatibility tests across a sample of more than 60 pseudo-independent vertebrate data sets. We contrast ‘fuzzy’ compatibility, boldown bootstrap and clique approaches. In particular, we find that the Le Queine probability (LQP) has several desirable properties. The LQP is simply the probability that a randomly permuted character will have incompatibility with other characters in the matrix at low or lower than that of the original character. Within recent analyses of Sauropod taxa we find that characters related to neural arches often conflict with dental characters in some datasets but it is difficult to generalise; we are still exploring possible causative mechanisms for this. In contrast, other vertebrate groups such as rapturs appear to have relatively little character conflict between morphological characters. Pairwise tests of character compatibility work well with binary data and ordered multistate characters, but can only give an indication of ‘potential compatibility’ with unordered multistate characters. Composite ‘higher’ taxa and polymorphic codes are also problematic for existing compatibility software, typically creating artificial incompatibilities. We recommend that composite taxa are decomposed into their constituents in order to remove ambiguity for the purpose of these tests, or else that polymorphic states are treated as missing data.

**THE ROLE OF ELEVATION IN UNDERSTANDING THE BIOGEOGRAPHIC DISTRIBUTION OF THE EXTINCT LEMURS OF MADAGASCAR**

MULDOON, Kathleen M., The Geisel School of Medicine at Dartmouth, Hanover, NH, United States; GODFREY, Laurie R., University of Massachusetts, Amherst, Amherst, MA, United States; CROWLEY, Brooke E., University of Cincinnati, Cincinnati, OH, United States

The subfossil record of Madagascar demonstrates that several extant species currently restricted to humid forests once had much wider geographic distributions. Furthermore, an east-west distance effect in extant mammal distributions has been interpreted as evidence that faunal exchange routes once crossed portions of the central highlands. In this paper, we examine the biogeographic distributions of the extinct lemur species of Madagascar, and their effects upon lemur community composition in the late Quaternary, using the statistical techniques and mapping capabilities of a Geographic Information System (GIS). We assembled a database of extinct late Quaternary fossil localities across Madagascar. Variables collected for each locality include species occurrence, geographic coordinates, elevation, radiocarbon dates, and paleoenvironmental (pollen and stable isotope) data. These data were analysed using ArcGIS software.

Our results indicate that several extinct lemur taxa are shared among southern localities and Christmas Island, the only known site from the south-central highlands, including inferred southern forest-dwelling animals such as *Archaeolemur majori*, *Pachylemur insignis*, and *Megaladapis edwardsi*. This lemur assemblage is fundamentally different from those recovered from a string of subfossil sites forming a corridor across the central highlands to the north of Christmas Island, through the Antananarivo Province (especially the Vakinankaratra and Iasy regions). The only characteristics of the major giant lemur that is unequivocally found within this mid-central highlands corridor is *Hadrópèthus stenogonathus*, which is rare. Other primate taxa from the mid-central highlands include the extant lemu*rs Archaeolemur edwardsi, Megaladapis grandiquatori, and Pachylemur jului*, and *Palaeopropithecus maximus*, as well as the extinct lemur *Prolemur sinus, Indri indri, Protopithecus diademus, Eulemur fulvus*, and *Chireopithecus major*, among others. Sites in the more northern corridor are higher in altitude than those in the south. Our results indicate that the higher elevational distribution of subfossil sites in the mid-central versus the south-central highlands may have acted as a filter to limit the species that may have dispersed across the island in the past. It has been suggested that watersheds with sources at high elevation may have maintained mesic conditions during Quaternary climate shifts, due to orographic precipitation. For forest-dependent mammals, such mesic conditions may have acted as a dispersal barrier across the mid-central passage, but limited dispersal of moisture-restricted animals in the south.

**THE ENIGMATIC REPTILE KADALOSAURUS FROM THE LOWER PERMIAN OF GERMANY AND THE MONOPHYLY OF ARAEOCELIDIAN DIAPSIDs**

MÜLLER, Bill D., Museum für Naturkunde Berlin, Berlin, Germany; DANTO, Martíny, Museum für Naturkunde Berlin, Berlin, Germany

The Araeoscelidia are considered the oldest clade of diapsid reptiles and the sister group to all other members of Diapsida, comprising several taxa from the Late Carboniferous and Early Permian of North America and Europe. The European forms in particular have never been studied in detail, and the monophyly of Araeoscelidia has not been tested within a modern phylogenetic framework. In the present study we re-investigated *Kadalosaurus priscus* from the Lower Permian of Saxony, Germany, a poorly known taxon which had...
remained unstudied since its first description in the late 19th Century. The taxon is based on a single specimen that only preserves the trunk vertebral column and parts of the fore- and hindlimbs, as well as some caudal vertebrae. The specimen is notably deteriorated in comparison to the original description, but new preparation nevertheless revealed additional details, such as the ontogeny of the zygopodium of both fore- and hindlimbs and the shape of the caudal vertebrae. Kadalsaurus superficially shares the elongate morphology of the limbs with the araeoscleridians Araeoscelis and Petrolacosaurus, but the proportions of the individual limb elements are different in these taxa. Also, there is currently no evidence for swollen neural arches in Kadalsaurus, in contrast to Araeoscelis and Petrolacosaurus. In order to assess the phylogenetic position of Kadalsaurus and to test if Araeoscelida is monophyletic, we scored all supposed members of the clade into a phylogenetic data matrix for early amniotes and compared by analyzing the data using parsimony and Bayesian methodology. The results reveal that there is no support for a monophyly of araeosclerids and that only Araeoscelis and Petrolacosaurus are unequivocally part of Diapsida, whereas the remaining taxa variably group along the stem of diapsid reptiles together with the “prototherioids” Protorhynchos, Anirhaciodromes and Cephalerpeton. Our results suggest that the elongation of fore- and hindlimbs is not an unambiguous apomorphy of Diapsida but either evolved independently in several times with early Euarcheria. Also, based on the current evidence it remains questionable if the presence of only a single temporal fenestra in Araeoscelis is secondary and it cannot be ruled out that the evolution of temporal fenestrae might have evolved in a stepwise manner. In conjunction with recent findings that also the “Younginiiformes” are not monophyletic but merely a grade of early diapsids, the falsification of araeoscelidan monophyly indicates that the early history of Diapsida is far more complicated than previously thought.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

**FIRST RECORD OF A PONTOPORIID CETACEAN (ODONTOCETI: INIOIDEA) FROM LATE MIOCENE OF CHIBA, JAPAN**

MURAKAMI, Mizuki, Waseda University, Tokyo, Japan; HIRAYAMA, Ren, Waseda University, Tokyo, Japan

Pontoporiidae is represented today only by one relict species Pontoporia blainvillei restricted to the eastern coastline of South America. The fossil record of the family, however, is more diverse and is known from eastern and western South America, eastern North America, and the North Sea back to the late Middle Miocene. Here we report the first pontoporiid fossil from the upper-most Miocene Senhata Formation (6.3-5.7 Ma) of Chiba, central Japan. The specimen WU SILS (Waseda University, School of International Liberal Studies) 408 was discovered in a quarry owned by Towa Stone Limited in a medium sandstone layer in the lower part of the formation and includes a right neurocranium, an isolated tooth, and a rib. The specimen agrees with pontoporiids in the following characteristics: well-developed premaxillary eminence; frontal wedging of the nasal; vertex occupied by a dorsally protruding nasal and frontal; and nasal that tapers posteriorly. Compared to other pontoporiids, the specimen resembles Stenosadelphus, Pilopontus, Pontistes, and Aurocetetus in having a low or absent maxillary crest. The premaxilla contacts the nasal in the specimen, similar to Pontistes, Protopophocaena, and Brachydelphis. Presence of a clearly asymmetrical vertex on WU SILS 408 is shared with that of Stenosadelphus, Protopophocaena, and Brachydelphis. The specimen is similar to Brachydelphis in having the posterior edge of the bony nares located at the level of the postorbital process. The specimen is similar to Pontistes in having obvious medial and lateral lobes of the premaxilla and a tooth without the bulbous part of the root. At the same time, WU SILS 408 has several aprobomorphs: right premaxillary eminence with pronounced overlap on the right maxilla (maximum 6.5 mm); right premaxilla that extends posterior to the right nasal; very short or absent postero-lateral sulcus; relatively short nasal; relatively conical tooth (the crown diameter 2.9 mm) with several perpendicular striations; and a short zygomatic process of the squamosal. This mosaic, unique combination of characters, and large skull size of WU SILS 408 (the neurocranium length over 180 mm) indicates that the taxon is a new genus and new species of pontoporiid. The occurrence of a pontoporiid in our report is not only the first fossil record of its kind from Japan but also the North Pacific. This new discovery greatly extends the paleogeographical distribution of the family.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

**THREE NEW BASAL ACANTHOMORPH FISHES FROM THE LATE CRETACEOUS OF MOROCCO**

MURRAY, Alison M., University of Alberta, Edmonton, AB, Canada; WILSON, Mark V., University of Alberta, Edmonton, AB, Canada

Acanthomorph fishes first appear in the fossil record in the earliest part of the Late Cretaceous, in deposits from both the Western Interior Seaway of North America and the Tethys Sea between Europe and northern Africa. The earliest acanthomorphs are from the early Cenomanian of Canada and Mexico, and from various Tethyan localities of Cenomanian age in Lebanon. Although more than 20 acanthomorph species are known from Cenomanian deposits, fewer Turonian acanthomorphs have been described, with only four genera known from Tethyan deposits and two or three from Western Interior Seaway deposits. Recently, three new acanthomorphs of Turonian age were recovered from the Agoulit area, which samples marine carbonates of the Akkrub Formation on the Cretaceous North Saharan Platform, deposited during an incursion of the Tethys Sea into this area of Africa. Isotopic data confirm a normal marine paleoenvironment, with no evidence of brackish or freshwater influence, and a paleotemperature of approximately 24.8°C. The associated flora and fauna from the deposits indicate that the platform waters were likely very shallow and near shore. Two of the new acanthomorphs represent different species allied with the Aipichthyoidae based on the high supraoccipital crest, the caudal skeleton with a reduced neural spine on the second preural centrum and 19 principal caudal fin rays, and the predorsal formula, but they cannot be included in either of the named aipichthyoid families (Aipichthyidae or Protophocaenidae). The third new species is allied with the Polyomniformes based on having a caudal skeleton with a full spine on the second preural centrum and 18 principal rays. The three new species contribute to the unique nature of the Agoulit fauna at the generic and specific level, while reinforcing similarity at higher taxonomic levels to other early Late Cretaceous Tethyan faunas.
Technical Session IX (Friday, October 19, 9:30 am)

DERIVATION OF THE AETOSAUR OSTEODERM CARAPACE: EVIDENCE FROM A NEW, EXCEPTIONALLY PRESERVED “STEM AETOSAUR” FROM THE MIDDLE TRIASSIC ANISIAN MANDA BEDS OF SOUTHWESTERN TANZANIA

NESBITT, Sterling J., University of Washington, Seattle, WA, United States; SMITH, Roger M., South African Museum, Cape Town, South Africa; PATTERSON, Judd M., National Park Service South Florida and Caribbean Cliffs. A REE profile of the formations that comprise the cliffs was produced to allocate uptake varies with pore-water chemistry, water depth, and diagenetic influence. REE data are presented from Manda bed osteoderms from Calvert Cliffs, Maryland. The clasts along the Calvert Cliffs comprise one of the largest and best studied successions of Manda shallow marine sediments exposed on the eastern U.S. The Calvert, Choptank, and St. Marys formations of the Chesapeake Group span roughly 10 million years of geologic time from 18-8 Ma. Many important fossils have been collected as float on the beaches below Calvert Cliffs. A REE profile of the clasts that comprise the clasts was produced to allocate a float-collected fossil to a specific bed within the clasts based on matching REE profiles. Twenty seven samples, including 10 from the Calvert Formation, 12 from the Choptank Formation and 5 from the St. Marys Formation, were obtained from vertebrate remains collected along Calvert Cliffs. Shark teeth, as well as cetacean and teleost bones were primarily used for sample extraction. The specimens were sampled using a cordless slow-speed Dremel™ rotary drill. They were then acid digested and diluted using University of Florida Department of Geological Sciences’ laboratory protocol. The samples were finally analyzed for their bulk REE concentrations on a Thermo Finnigan ELEMENT2 Inductively Coupled Plasma Mass Spectrometer (ICPMS). REE concentration patterns indicate that, on average, the Calvert Formation represents the deepest water paleo-environment. REE analyses of fossils from the Choptank and St. Marys formations were nearly identical and suggest a similar depositional paleo-environment of shallower water within the overall Miocene regression. The REE analyses of vertebrate fossils have great potential to allocate fossils of uncertain origin to specific stratigraphic beds and thus age and provenance.

Technical Session IX (Friday, October 19, 12:00 pm)

EXPLORING CROCODYLID DIVERSITY IN AN ENVIRONMENTAL CONTEXT: IMPLICATIONS FOR THE FOSSIL RECORD

NESTLER, Jennifer H., University of Iowa Department of Geoscience, Iowa City, IA, United States; WILBEE, Eric W., University of Iowa Department of Geoscience, Iowa City, IA, United States; PATTERSON, Judd M., National Park Service South Florida and Caribbean Network, Palmetto Bay, FL, United States

Modern crocodilians are semiaquatic predators that are relatively restricted in morphospace compared to their past diversity, yet they inhabit a diverse range of biomes today, including broadleaf forests, savannas, and marine environments. Digitally mapping the species ranges of extant crocodilians using Geographic Information Systems (GIS) allows for the ecological parameters of these ranges to be calculated. We can test assumptions of crocodilian ecology that are often applied to the fossil record. With the exception of alligators, minimum annual temperatures below freezing are the most significant restriction on extant species ranges. Minimum monthly precipitation levels do not restrict crocodilian species ranges, although mean annual precipitation must be high enough that a marked wet season exists. This indicates that crocodilians tolerate arid conditions quite well for portions of the year. Increased sympatry is associated with increased precipitation levels. GIS analyses also reveal that the most commonly utilized biome of crocodilians is tropical and subtropical moist broadleaf forest; followed by tropical and subtropical grasslands, savannas, and shrublands; and deserts and xeric shrublands. In contrast, the highest species richness is found primarily in flooded grasslands and savannas and secondarily by mangroves. Because snout shape is so often used as a proxy for ecology, we performed an outline analysis and model-based cluster analysis to quantify snout shape in fossil and modern Crocodylia. This results in two shape categories that are characterized primarily by differences in snout length and width. In contrast to species richness, the highest morphological richness is found in tropical and subtropical moist broadleaf forests. Morphospace occupation confers no restriction on whether extant species can inhabit a biome, and all but one biome occupied by at least one crocodilian is occupied by both morphotypes. Additionally, the areas of highest extant species richness and highest morphological richness do not coincide. This leads to the likelihood that morphologically similar sympatric fossil species coexisted as well, creating a potential source of underestimation in fossil crocodilian diversity. Although feeding and niche habitats are often inferred from snout shape in fossil crocodilians, there are multiple modern instances of morphologically similar crocodilians co-occurring. These results indicate that niche partitioning is more complex than any ecological differences conferred by snout shape, and that making inferences in the fossil record based solely on this feature is tenuous.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PARSIMONY ANALYSIS OF ENDEMICITY (PAE) OF LUNGFISH GENERA

NGASALA, Sifa E., Michigan State University, East Lansing, MI, United States

This study applied Parsimony Analysis of Endemicity (PAE) to a comprehensive sample of distributional data including all continent-level geographic units containing members of the Order Dipnoi, in order to assess the importance of unit area for explaining observed distribution patterns for these sarcopterygian fishes. PAE is one of several methodologies...
used to assemble biogeographic reconstructions for vertebrate clades. Despite some of the inherent weaknesses of this method in failing to account for certain events that could be responsible for a given species distribution pattern (such as geodispersal, or removal of barriers to permit gene flow), PAE remains a highly useful method for formulating testable hypotheses about the processes responsible for observed biogeographic patterns.

Distributional data were obtained from more than 100 published articles and other references in order to construct a georeferenced records database. Geographic distribution maps for each taxon were assembled by using the distributional data using ArcGIS 10 software. Next, a presence-absence matrix was generated to detail lungfish generic distribution across all continental units. Binary cluster analysis was applied to the data using the R statistical package (version 2.14.0), and the biogeographic relationships of lungfish genera were examined using PAUP (version 4.0) using the Jaccard coefficient of similarity. Twenty six most parsimonious cladograms were recovered, and summarized in a single consensus tree. Six areas (representing six continents) of endemism were identified: Africa, Asia, Australia, Europe, North America and South America. Results in part suggest a pattern of vicariance between African and South American landmasses, recovering a close relationship between lungfish clades from those regions to the exclusion of those inhabiting other areas, consistent with findings obtained in other studies. The present analysis expands upon previous phylogenetic and biogeographic studies of lungfish that have either included subsets of this taxonomic sample, or fewer of the possible zoogeographic regions.

Technical Session III (Wednesday, October 17, 2:00 pm)

STABLE ISOTOPE DATA FROM THE CHILGA BASIN, ETHIOPIA, AND THEIR IMPLICATIONS FOR RESOURCE PARTITIONING AMONG LATE PALEOGENE AFRICAN ENDEMIC MAMMALS

NORET, Jordan, Southern Methodist University, Dallas, TX, United States; TABOR, Neil L., Southern Methodist University, Dallas, TX, United States; UNGRYN, Bonnie F., Southern Methodist University, Dallas, TX, United States; SANDERS, William J., Museum of Paleontology, University of Michigan, Ann Arbor, MI, United States; KAPPELMAN, John, University of Texas, Austin, TX, United States

Herbivorous mammals in modern tropical ecosystems are characterized by a high degree of specialization, resulting in the systematic distribution of food resources among them. In order to test whether this also occurred within ancient tropical ecosystems, and to understand better the ecology of endemic Afrodinosaur mammals, δ13C and δ18O data were collected from carbonate in fossil herbivore tooth enamel apatite among orders Proboscidea, Hyracoidea, Scenotheriidae, Odaxosaurus, and Embrithopoda from the Chilga Basin, Ethiopia. Weight percent carbonate of each sample was calculated as a test for diageneric and the samples yielding values outside the expected range were not included for interpretation. The entire δ13C dataset ranges between -16‰ and -6‰ (Vienna Pee Dee Belemnite, or V-PDB). Excluding the possibility of diageneric, this large range most likely indicates that the landscape was heterogeneous, and likely included areas similar to modern closed-canopy forests. There are taxon-specific peculiarities among the enamel δ13C values which indicate that systematic variation of food resources may have existed: the Proboscidea, on average, yielded the lowest values (-12.39‰, V-PDB) and the Hyracoidea yielded the highest (9.73‰, V-PDB). It is not clear whether these data indicate that herbivore diets were different with regard to food types (e.g., legumes vs. palms), or that these differences reflect seasonal variability. Nevertheless, the Enbrithopodan δ13C values varied the least (15‰ = 1.35‰), indicating that their diet was the most restricted of the taxa collected. This is consistent with the current understanding of the genus Arsinotherium as a specialized feeder. Variation in δ18O values within each taxonomic group was high (15‰ > 2‰). Excluding the possibility of diageneric, and assuming that local surface waters did not vary greatly, this indicates none of these groups was semi-aquatic, in contrast to the widely held view of the habitat of Arsinotherium (Embrithopoda).

Technical Session XI (Friday, October 19, 2:15 pm)

WHAT BIG CLAWS YOU HAVE: IMPLICATIONS OF MORPHOLOGICAL VARIATION IN THEROPOD MANUAL UNGUALS

NOTO, Christopher R., University of Wisconsin-Parkside, Kenosha, WI, United States

In order to understand the functional morphology of theropod forelimbs and interpret their use in behavior it is necessary to study the role played by the manual unguals. Among living vertebrates claws have a diversity of uses, including locomotion and food acquisition, and it has been shown that claw shape varies systematically with function. Among living birds, research advancing a strong correlation between such factors used for locomotion or predatory preferences and behavior. A similar approach to theropod unguals may yield insights into their behavior, predatory or otherwise. Theropod manual unguals vary greatly in overall morphology (size, length, curvature). While most had a likely predatory role, the claws of some taxa are thought to have had other functions, such as locomotion. Applying what we know about the correlation between shape and function in living vertebrates we may expect that differences in claw shape will follow ecological and/or evolutionary patterns in non-theropod dinosaurs. A series of 14 clasper landmarks were applied to photographs and published figures representing taxa from all major theropod clades, including birds. Over 200 individual claws are in the sample, representing over 80 taxa. Procrustes superimposition and thin-plate splines were used to quantify shape differences while principal components analysis (PCA) was used to explore patterns of shape variation. PCA results show that most of the shape variation is explained by changes in two areas: the degree of nail curvature and nail size relative to the ungual body. In many taxa, the first digit is strongly differentianted from the remaining digits. Certain features of shape variation have an evolutionary significance. Coelurosaurs differ significantly from non-coelurosaurian theropods in claw shape, filling a much larger proportion of shape space suggesting greater ecological diversification. The claws of non-coelurosaurian theropods were almost exclusively predatory in function and being used as piercing gaffes to hold prey. Within clades of theropods, the evolution of ecological specializations is recorded in the changing claw shape as one move towards more derived members of the group. This includes the evolution of gaffe-like claws in giant predator tyrannosaurids and elongated, straight claws in herbivorous ornithomimids. Some small paravians, including birds, are notable for having a claw shape that falls far outside all other groups, which may be a specialization for climbing. This novel approach allows one to explore ecological differences between theropod species and higher taxa, including food preference and predatory behavior. Furthermore, these results may aid in understanding the evolution of the theropod manus, its functional changes, and yield important character data useful for cladistic analyses.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

LIZARDS AND SNAKES OF THE TERLINGUA LOCAL FAUNA (LATE CAMPANIAN), AGUJA FORMATION, TEXAS, AND THE DISTRIBUTION OF PARACOCONTEMPORANEOUS SQUAMATES IN WESTERN NORTH AMERICA

NYDAM, Randall L., Midwestern University, Glendale, AZ, United States; ROWE, Timothy B., Jackson School of Geosciences, University of Texas, Austin, TX, United States; CIFELLI, Richard L., Oklahoma Museum of Natural History, University of Oklahoma, Norman, OK, United States

The late Campanian-aged squamates from the Terlingua local fauna of the Aguja Formation of southern Texas are represented by numerous isolated specimens of fragmentary jaws, vertebrae, and osteoderms. The fauna includes four scincomorphans: a new taxon referable to Xantusiidae that has massive crowns of enamel. A second possible scincomorph has a series of delicate teeth of contegonid lizards; a second new taxon with robust teeth, but of indeterminate scincomorph affinities; and two, unnamed scincomorph morphotypes. Anguimorphans in the fauna include the ubiquitous anguid Odaxosaurus piger, the varanoid cf. Parasamia wyomingensis, and specimens referable to Xenosauridae. Ophidian jaw fragments confirm the presence of a snake in the fauna. The Aguja squamate assemblage is one of the most southern of a series of paracoeontemporary squamate faunas that extends from central Alberta to northern Mexico. Comparison of these faunas reveals that, while two taxa are endemic to the Aguja Formation, others show some latitudinal trends. Odaxosaurus and Parasamia are components of all well-sampled late Campanian faunas from Alberta to Texas, indicating a broad plasticity in environmental preference. Polyglyphanodontid snakes and snakes are found only in faunas from southern Utah to Texas and Mexico, and may have been tolerant of the climate in the north. Ornithopods were likely intolerant of the southern climate, as they have a rapid decrease in diversity in progressively southern faunas and are absent in faunas south of northern New Mexico. Sole representative species of Contogeniidae and Xantusiidae are restricted to southern Utah and southern Texas, respectively. These hypotheses of distributional patterns must continue to be tested through ongoing investigations of all of the relevant faunas from the late Campanian of the Western Interior.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE ROLE OF FOSSIL EVIDENCE IN INFERRING ANCESTRAL CHARACTER STATES: A CASE-STUDY USING ARTIODACTYLY THERMOREGULATORY CRANIAL VASCULATURE

O’BRIEN, Haley, Ohio University, Athens, OH, United States

This study investigates the evolutionary history of thermoregulatory cranial vascular structures in Artiodactyla using ancestral state reconstruction. The carotid rete is an arterial meshwork that, in conjunction with the maxilloturbinate, enables a physiological phenomenon known as selective brain cooling (SBC). SBC is effective in protecting brain tissues from heat damage, conserving water by cooling the hypothalamus, and delaying exhaustion in exercising animals. By functioning in these capacities, structures that enable SBC may be key innovations in the context of shifting environmental landscapes, especially across long-term trends of climate warming and aridification. Here, the evolutionary history of the carotid rete and patterns for cranial arterial supply in artiodactyls are used to aid in understanding the functional morphology of theropod manus, its functional changes, and yield important character data useful for cladistic analyses.

Osteological correlates for the carotid rete and internal carotid artery were scored for the skulls of more than 60 extant artiodactyl species. Six patterns of cranial arterial supply were identified and mapped as discrete characters onto an artiodactyl supertree. Divergence estimates were used to determine branch lengths. Maximum parsimony, maximum likelihood, and, more recently, a Bayesian framework. Osteological correlates for the carotid rete and internal carotid artery were scored for the skulls of more than 60 extant artiodactyl species. Six patterns of cranial arterial supply were identified and mapped as discrete characters onto an artiodactyl supertree. Divergence estimates were used to determine branch lengths. Maximum parsimony, maximum likelihood, and, more recently, a Bayesian framework.
and complementary role of fossa data in the light of recent advances phylogenetic comparative methods.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

**AIR SPACE PROPORTION IN A DORSAL VERTEebra OF A NEW TITANOSAUR (DINOSAURIA: SAUROPODA) FROM JORDAN**

O’CONNELL, Taryn L., University of Michigan, Ann Arbor, MI, United States; WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States; ZALMOUT, Iyad S., University of Michigan, Ann Arbor, MI, United States

Postcranial skeletal pneumatization is present in birds and many fossil archosaurs, and it is especially well developed in the vertebral column of sauropod dinosaurs. The degree of vertebral pneumatization varies along the vertebral column and among sauropod genera. The air space proportion (ASP) is a convenient measure of the percentage of the vertebra that is occupied by air. Two-dimensional measurements of ASP are typically made by importing Computed Tomography (CT) images of vertebrae into a photo-editing program, and counting the pixels representing both airspace and bone. We used a slightly different technique to measure ASP in a new titanosaur from Jordan. We selected a sample of CT slices in the horizontal, sagittal, and transverse planes, enhanced the images, and then outlined internal and external pneumatic spaces using the image-processing program ImageJ. Internal pneumatic spaces are those enclosed within the vertebra and typically only visible in damaged regions or in CT images. External pneumatic spaces are fossae that are visible on the outside of the vertebra. Both internal ASP (iASP) and total ASP (iASP; sum of external and internal ASP) varied among different CT slice orientations and within sections in a single orientation. Horizontal CT sections had the most variation of both iASP and ASP, in addition to having the highest iASP value. These sections had an average iASP of 67.3% and ranged from 66.5% to 74.2%. Average iASP for these sections was 78.6% and ranged from 67.7% to 85.9%. Sagittal cross-sections displayed the least variation of iASP and ASP, as well as the lowest iASP values. The iASP values range between 62.7% and 69.3%, with an average of 66.2%. The iASP values were between 70.4% and 78.9%, with an average of 73.4%. Transverse sections presented little variation in iASP (63.5−67.8%), but great variation in iASP (65.5−81.4%); average 74.0%). The average iASP for the Jordanian dorsal vertebra is 67.1%, and iASP is 75.3%. From this study, it is clear that ASP values can vary considerably within a single vertebra. Patterns of variation within and between vertebrae along the column may provide insights into vertebral mechanics and function.

Postcrere Session III (Friday, October 19, 4:15 - 6:15 pm)

**DIEtARY EVOLUTION IN MESOZOIC BIRDS**

O’CONNOR, Jingmai K., Institute of Vertebrate Palaeontology and Paleanthropology, Beijing, China

Neornithine birds are all endothermic and the hooded bill that covers the rostrum is one of the most characteristic features of living birds. Basal birds, however, retain teeth and show diversity of dental arrangements and tooth morphologies. Tooth reduction is a common trend observed among basal birds (e.g. Jeholornithiformes, Sapeornithiformes) and the loss of teeth all together is known to have occurred several times in both Enantiornithes and Ornithuromorpha, the clade that includes living birds, as well as in more primitive taxa (e.g. Confuciusornithiformes). Despite an overall avian trend towards tooth reduction, Enantiornithes, the sister group to Ornithuromorpha, shows a high diversity of dental patterns and morphologies that suggests active selective pressures. Osteological analyses even preserves ornamented tooth enamel, the first recognized occurrence in class Aves. Teeth provide indirect clues to the diet of extinct birds; direct evidence in the form of preserved stomach contents are rare, but are preserved in several specimens from the Jehol Group lagerstätten, representing several clades – but not Enantiornithes. This difference is not considered preservational, given the large number of specimens representing the dominant Cretaceous clade, but interpreted as reflecting a major difference in diet between this clade and Ornithuromorpha. Potentially, this may have been a factor in the extinction of the enantiornithines at the end Cretaceous.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:30 am)

**MORPHOLOGICAL EVOLUTION IN BASAL MESOEUCROCODYLIANS: TRACKING BODY SIZE AND DENTAL TRENDS IN NOTOSUCHIA**

O’CONNOR, Patrick M., Ohio University, Athens, OH, United States; HIERONYMUS, Tobin L., Northeast Ohio Medical University, Rootstown, OH, United States; STEVENS, Nancy J., Ohio University, Athens, OH, United States; SERTICH, Joseph J., Denver Museum, Denver, CO, United States

Notosuchian crocodyliforms recovered from Cretaceous-age deposits in Gondwana reveal a level of morphological diversity not exhibited by crown crocodylians, yet not by other extinct members of the clade. This diversity manifests in both postcranial and cranial portions of the skeleton, with the latter being the primary focus of most studies to date. Whereas many notosuchians represent relatively small forms (e.g., total skull length ranging from 7-15 cm), select members of the clade (e.g., baurusuchids) exhibit skull lengths exceeding 40 cm in length. In this study we examined exemplars from all notosuchian subclades in order to characterize morphological trends throughout the group and considered these data within the context of both body size evolution and inferred diet and habitat preferences. The following cranio-dental features were examined: craniodental organization, orientation of the pterygoid complex, total number of teeth, regionalization of the dental arcade (i.e., relative size and shape heterodonty), degree of occlusal complementarity, and tooth crown complexity. Regarding the latter, teeth range in shape from simple conical (i.e., *typical* crocodilian) crowns to biconvex, serrated forms to multicusped, complex multiforms. Trends related to increased heterodonty and increased occlusal complexity are anatomically focused on the posteriormost teeth of the maxilla and dentary. An elongate craniodental joint, increased size and shape heterodonty, and increased occlusal complexity are preferentially exhibited by smaller species (skull length 15 cm) of the clade. Importantly, these correlated trends appear to have evolved at least twice within Notosuchia, once within a southern African clade consisting of *Pakasuchus* and *Malawisuchus* and variably within a diverse assemblage of forms from South America. Morphological integration of the elongate craniodental joint provides evidence of the specialized nature of jaw mobility in these forms, with modeled movements consisting of both rotation and rostrocaudal translation of the lower jaw. Interestingly, the two independent examples of sustained increases in body size correspond with increasing shape homodonty and craniodental movements constrained primarily to rotation. In both cases (baurusuchids, peirosaurids), members exhibit varying degrees of biconvex, serrated teeth positioned within both the maxilla and dentary. Small-bodied, heterodont notosuchians have been characterized as mammalian analogs, occupying a terrestrial niche with inferred dietary preferences that include obligate herbivory to various types of omnivory/insectivory. By contrast, large-bodied forms have been interpreted to occupy top predator roles in their respective ecosystems, whether these are terrestrial or semi-aquatic.

Technical Session XII (Friday, October 19, 2:00 pm)

**THE ONTOGENY OF THE SHOULDER IN POLYCOTYLIUS LATIPINNUS (PLESIOSAURIA: POLYCOTYLIDAE) AND ITS BEARING ON PLESIOSAUR VIVIPARITY**

O’KEEFE, Frank R., Marshall University, Huntington, WV, United States; BYRD, Christina J., Marshall, University, WV, United States

Understanding ontogenetic change in shoulder morphology in plesiosaurs is critical to proper taxonomic identification of embryonic plesiosaur material. The first known gravid plesiosaur was described in 2011, a large, Late Cretaceous plesiosaur (*Polycotylus latipinnus*), that provided evidence for viviparity in plesiosaurs. One main supporting argument for viviparity in this fossil was the taxonomic identity of the adult and embryo, an attribution based primarily on humeral morphology. Comparison of the embryonic material with another juvenile plesiosaur skeleton described here demonstrates that the embryonic scapulae were misidentified as humeri, and the embryonic clavicles were misidentified as scapulae, in the original paper on plesiosaur viviparity. In this study, the scapulae and clavicles of the adult and embryo presented are compared with the juvenile plesiosaur mentioned above as well as with those of an adult *Dolichorhynchops osborni* and with the Polycotylus adult. The scapulae of the embryo and juvenile possess ossifications that resemble the scapulae of basal nothosaurids and plesiosaurs much more than they resemble those adult plesiosaurs. As polycotylids grow, however, progressive ossification produces scapular ossification similar to adult basal plesiosaurs, such as *Plesiosaurus*. At adult adulthood the scapula is maximally derived, with a large and well-ossified ventral ramus. Therefore, the ontogeny of the polycotylid scapula recapitulates its sauropterygian phylogenetic history. The morphology of the scapula is too ontogenetically variable for reliable classification of the embryo; however, the triradiate morphology and concavities of the embryonic clavicles are maintained throughout ontogeny, and are diagnostic to Polycotylidae. While the embryo cannot be directly attributed to the genus *Polycotylus*, it is attributable to a large polycotylid. Therefore, the taxonomic identity of the embryo continues to support the in utero relationship with the adult *Polycotylus*, and the general conclusions concerning plesiosaurian viviparity are unchanged.

Technical Session X (Friday, October 19, 10:15 am)

**DETERMINE GROWTH IN MORGANOCODON WATSONI**

O’MEARA, Rachel N., University of Cambridge, Cambridge, Cambridge, United Kingdom; ASHER, Robert J., University of Cambridge, Cambridge, United Kingdom

Dating from the Triassic-Jurassic boundary, Morganocodon is among the geologically oldest mammaliforms. Several mammaliform apomorphies are first observed in Morganocodon, indicating a preliminary diagram of the growth of the skull. The occurrence of these characters in *Morganucodon* has led to the hypothesis that their evolution is related to the origin of lactation. The current evidence for determinate skull growth in this genus is based on linear measurements reported from a limited number of adult skulls of the Chinese species *Morganucodon oehleri*. The extent to which other Morganocodon species exhibit determinate growth has previously not been investigated. To test for the extent of determinate growth across species of Morganocodon, we investigated lower jaw metrics from a selected sample of adult *Morganucodon*. Determinate growth in the anterior of the coronoid process was measured in a sample of 531 specimens of *M. Watsoni* from Rhaeto-Liassic fissure deposits of Great Britain. Homologous dentary measurements were taken from small extant mammals known to have determinate growth patterns (e.g., *Erinaceus europeaus*, *Muscula ermina*). Mandibular measurements were also taken from the sea turtle (*Chelonia mydas*) and compared with lepidosaur jaws of comparable size to, and from the same fissure deposits as, the *M. Watsoni* specimens. The distribution of the data for each species was analysed and found to be platykurtic for those species with determinate growth (*E. europeaus*: g = 0.98, t = -2.00, p = 0.05; *M. ermina*: g = 0.89, t = 1.99, p = 0.05). In these animals, growth ceases once a maximum size has been reached, and the right tail of the data distribution is truncated relative to the normal distribution, accounting for the observed
platykurtosis. Conversely, no significant kurtosis was found in the distribution of data for those species with indeterminate growth (C. mydas: g = -0.57, t = -0.90, p = 0.4; lepidosaur: g = -0.11, t = -0.23, p = 0.5). The distribution of dentary data for M. watsoni was found to be platykurtic (g = -0.54, t = -2.55, p = 0.02), supporting the hypothesis of determinate growth in this animal. Additionally, coefficients of variation (CV) of dentary depth were found to be less in the extant mammals than in those species with indeterminate growth patterns. The CV for M. watsoni was found to lie within the range of the extant mammals, further supporting the conclusion that growth was determinate in M. watsoni. This conclusion is consistent with evidence for diphyodonty in both M. ochleri and M. watsoni, and the hypothesis that the evolution of determinate growth and diphyodonty in basal mammaliforms were interlinked and possibly related to the origin of lactation.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PALEogene ICthYOFaUNA OF THE IMO AND AMeki FORMATIONS, SOUTHeASTeRN NIGerIA

ODUNZÉ, Shirley O., Department of Biological Sciences, Athens, OH, United States; STEVENS, Nancy J., Department of Biomedical Sciences, Athens, OH, United States; COOPER, Lisa N., Ohio University, Athens, OH, United States; OBI, Gordan C., Department of Geology, Uli, Nigeria.

The Paleocene-Eocene strata of southeastern Nigeria collectively represent a rich and relatively unexplored source of fossil vertebrates. Recent expeditions have focused on expanding the Paleocene ichthyofauna of this vast geological sequence. Deposits are represented by the upper part of the Nsukka Formation (Danian), the Imo Formation (Paleocene) and the Ameke Formation (Eocene). A transgressive eorional surface separates the Nsukka facies from the overlying Imo Formation that begins with estuarine shale, clay and limestone, and grades upward into fossiliferous calcareous shoreface facies. The Imo Formation-Ameke Formation contact is marked by the transition from fossiliferous/calcareous shoreface facies at the upper levels of the Imo Formation, into the overlying coarse grained tidally-influenced fluvial sandstones that form the basal units of the Ameke Formation. Fossiliferous facies of the Ameke Formation consists of phosphate-bearing estuarine mudstone and coquoidal limestone that pass upward into shoreface and coastal plain sandstones and clays. Recovery of vertebrate fossils has long been limited to the estuarine facies of the Eocene Ameke Formation. More recently, an actinopterygian, five chondrichthyan and the amniotic taxon Cynodrilonthus were discovered from newly discovered Paleocene Imo Formation localities in the Bendie district. Additional field exploration on the region has revealed two additional fossil localities, Umunze (in the Imo Formation) and Ameke (in the Ameke Formation). Study of the fauna collected from these new localities revealed three chondrichthyans at Umunze, and one chondrichthyan together with two actinopterygians from Ameke. Sustained work in the region documents a diverse ichthyofauna containing at least six taxa. Five chondrichthyan taxa are represented by two ray species and four shark species, the latter including Galeocerdo sp., a taxon hitherto undocumented in the Imo formation of southeastern Nigeria.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

GIANT FELID POSTCRANIA & THE EARLY EVOLUTION OF NORTH AMERICAN CATS

ORCTTUNN, John D., University of Oregon, Eugene, OR, United States; DAVIS, Edward B., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States.

The Late Miocene is a critical interval in felid evolution in North America, falling at the end of the “Cat Gap” and encompassing the immigration of the saber-toothed Machairodus from Eurasia, the evolution of the enigmatic, endemic Nimravus, and the appearance of the continent’s first true conical-toothed cats. Much of the research on felids from the Late Miocene is focused on documenting the evolution of determinate growth and diphyodonty in basal mammaliforms during the non-reconfiguring region. However, a comprehensive large scale, phylogenetically-grounded analysis of morphological degradation within annulates has never been performed. Moreover, it is unknown how the phylogenetic decay rates differ between the XY and ZW systems. Here we present a large-scale phylogenetic analysis of XY and ZW sex chromosome evolution using a large catalogue of karyotypic measurements. We discuss the rates and first appearance of sex chromosomes in the dinosaur lineage and present a novel Bayesian comparative method to make phylogenetically-informed univariate predictions.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

FLUVIAL SEDIMENT AND EGGShELL INTERACTIONS: A METhOD FOR ASSESSING TRANSPORT IN FOSSIL EGGShELL ACCUMULATIONS

OSER, Sara E., Montana State University, Bozeman, MT, United States

Assessment of transport history of fossil eggshell remains problematic given the complex taphonomic processes acting on fragments (e.g., breakage by trampling, dissolution, soil bioturbation). Previous studies focus on eggshell shape and orientation (concave up/down) to assess whether a fossil assemblage represents an in situ or allochthonous deposit. However, these studies are not applicable to all eggshell accumulations. At the Egg Mountain locality (Museum of the Rockies locality 006) near Choteau, Montana, hadrosaur eggshell occurs on multiple, poorly defined horizons, limiting the applicability of fragment orientation ratios. Thus, taphonomic studies require a different means for assessing possible transport. In a previous study I used a rock tumbler as a partial analogue of fluvial transport, and noted that sediment-eggshell interactions quickly induced distinctive wear on the edges of chicken (Gallus gallus domesticus) eggshell fragments. My current study investigates whether the presence or absence of edge wear provides a reliable means to distinguish allochthonous from in situ fossil eggshell accumulations.

Eggshell from three localities that represent in situ nesting sites (Wayan Formation, Idaho) and high energy environments (i.e., crevasse splay and channel sandstone) provide a baseline for comparing the Egg Mountain material. The fossil eggshells from all localities are of similar thickness (1 mm) and size (10 mm). Scanning Electron Microscopy (SEM) imaging reveals that eggshell deposited in high energy paleoenvironments display edge wear similar to that observed in the rock tumbler experiments (i.e., substantial rounding and loss of surface detail). In contrast, in situ eggshell from the Wayan Formation collected both as surface float and during excavation shows no evidence of edge wear. Further, this also demonstrates that short term subaerial exposure of untransported material will not produce wear. Eggshell from the Egg Mountain locality does not display edge wear, consistent with an in situ assemblage.

This study provides a more broadly applicable method to identify transported eggshell than previous techniques. However, this method is limited because it is an assessment of sediment interaction, which may not a direct indicator of transport. Further studies reveal that some abrasion of modern eggshell occurs in place. Nevertheless, the absence of edge wear in fossil eggshell assemblages supports the interpretation of an in situ deposit.

Technical Session XV (Saturday, October 20, 9:00 am)

PHYLOGENY, HISTOLOGY AND INFERRed BODY-SIZE EVOLUTION IN A NEW RHABDOBONDITID DINOSAUR FROM THE LATE CRETACEOUS OF HUNGARY

OSI, Attila, MTA-ELTE Lendület Dinosaur Research Group, Budapest, Hungary; PRONDVAI, Edina, MTA-ELTE Lendület Dinosaur Research Group, Budapest, Hungary; BUTLER, Richard J., GeoBio-Center, Ludwig-Maximilians-Universität, Munich, Germany; WIESHAMPEL, David B., Center for Functional Anatomy and Evolution, Johns Hopkins University, Baltimore, MD, United States.

Following 12 years of extensive excavations and screen-washing, the Bakúk locality, the only site in Hungary that has yielded Mesoic vertebrates, has become one of the most important Late Cretaceous vertebrate sites in Europe. Remains of at least 30 species have been identified and documented from this continental–freshwater assemblage that is generally similar to, but in some aspects distinct from, other European Late Cretaceous assemblages. The dinosaur assemblage is composed of basal tetanurans, abelisaurids, and...
paravian theropods, nodosaur ankylosaurs, coronosaurian ceratopsians, and a new species belonging to the endemic European ornithopod clade Rhabdodontidae, which is represented by both cranial and postcranial remains. A global phylogenetic analysis of ornithischian dinosaurs including all known rhabdodontid genera supports the rhabdodontid affinities of the Hungarian specimen in addition to the Austrian and Hungarian rhabdodontids. Samples from the Hungarian and Austrian species indicate a similar adult body length of 1.6–1.8 m that is in accordance with the morphological similarities between these two rhabdodontids. In contrast, the French specimens of Rhabdodon had a much larger, 5–6 m, adult body length, indicating a substantial difference in body size between the western and eastern European taxa. However, phylogenetic mapping of body size onto the results of the phylogenetic analysis calls into question the hypothesis that insular dwarfism accounts for the small body size of the eastern rhabdodontids. These results imply a deep divergence (prior to the Santonian) between a western rhabdodontid lineage represented by at least two species of Rhabdodon in Spain and France and an eastern lineage consisting of the Zalmoxes and the Austrian and Hungarian rhabdodontids.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PHYLOGENETIC RELATIONSHIPS OF MUSSAURUS PATAGONICUS: TESTING THE EFFECT OF ONTOGENETICALLY VARIABLE CHARACTERS ON TREE TOPOLOGY

OTERO, Alejandro, Museo de La Plata, La Plata, Argentina; POL, Diego, Museo Egipcio, Furtugno, Trelew, Argentina; POWELL, Jaime, Instituto Miguel Lillo, Tucumán, Argentina

Mussaurus patagonicus is a basal sauropodomorph dinosaur from the Upper Triassic Laguna Colorada Formation, Patagonia, Argentina. This taxon is known from multiple taxa from different ontogenetic stages, including hatchlings, juveniles, and adult specimens, providing a case study of ontogenetic changes in a basal sauropodomorph. Skull morphology is known from hatchlings and juveniles whereas postcranial remains are known from all ontogenetic stages.

Here we test the effect of ontogenetic changes on inferences of phylogenetic position of M. patagonicus, scoring specimens from different ontogenetic stages as separate operational taxonomic units: only adult specimens (lacking cranial characters), only non-adult specimens (including cranial characters), and a mixture of non-adult (cranial) and adult (postcranial) characters in the same data matrix in order to test the impact of ontogenetic variations in the retrieved tree topology.

The results depicted M. patagonicus as the sister group of massospondylids when only juvenile specimens, when only juvenile cranial characters, and when only juvenile postcranial characters, are scored. On the other hand, when we scored characters solely from adult individuals, all MPTs depict M. patagonicus as a basal member of Anchisauria, being the sister group of the clade comprising Aardonyx + more derived sauropodomorphs. M. patagonicus is therefore placed in a more derived position forming part of the basal sauropodomorph-sauropod transition. The same results are retrieved when we scored a mixture of juvenile cranial and adult postcranial characters.

Certain characters related to limb proportions in the juvenile specimens, such as the skull/femur length and humerus/femur length ratios showed derived states, like those present in the quadrupedal clade (i.e., Eusauropoda) suggesting putative quadrupedal locomotion. Those characters, however, present plesiomorphic states in the adult specimens, suggesting, at least, facultative bipedal locomotion. In contrast, most character states related to the manus in the juvenile specimens show no changes when compared to adult specimens, depicting this structure as a conservative module through ontogeny.

The results show the character states that vary through ontogeny and such variation does not always represent plesiomorphic states in early ontogenetic stages, but instead a mixture of apomorphic and plesiomorphic states reflected in different tree topologies. These changes are shown to be relevant for determining the phylogenetic position of M. patagonicus, as its affinities change if adult morphology is ignored, suggesting that a careful evaluation of ontogenetic stages is needed for testing the phylogenetic relationships of basal sauropodomorphs.

Education and Outreach Poster Session (Posters displayed October 17–20)

COMMUNICATING SCIENCE IN THE DIGITAL ERA: THE PCP-PIRE E-NEWSLETTER

OVIEDO, Luz H., Florida Museum of Natural History, Gainesville, FL, United States; GRANT, Claudia, Florida Museum of Natural History, Gainesville, FL, United States; ELLIS, Shari, Florida Museum of Natural History, Gainesville, FL, United States; MACPADDEN, Bruce J., Florida Museum of Natural History, Gainesville, FL, United States

Increasingly scientists are required to include an outreach or communication component in their research projects, especially those funded by government agencies. The Panama Canal Project (PCP) Partnerships in International Research and Education (PIRE) is an international partnership among several institutions from United States and Panama. PCP-PIRE students created a bi-lingual (English/Spanish) e-newsletter to keep participants and partners informed about the different project activities and to engage new potential stakeholders.

E-newsletters have numerous advantages over other media, including printed newsletters, list-serves, and even web sites. These include ease of targeted distribution via email, reduced costs, active engagement, and rapid transmission. Our PCP PIRE e-newsletter, published monthly (10 times per year), has grown over the past 15 months to a readership of more than 200 including students, faculty, educators, funding agencies, and partner institutions. Our monthly readership continues to grow as new stakeholders are added to our mailing list. During the initial development, formative feedback indicated that, given the barrage of e-communications, some readers wanted the e-newsletter to be short with “snippets” organized in a way similar to the screen that appears in hand-held devices like iPhones. If readers want to delve more deeply into a particular subject they can link to the longer article.

PCP-PIRE students write the e-newsletter stories. Articles are typically 250 to 450 words. Stories are organized in four sections: People, International, Research and Education. All of the e-newsletters are archived on our PCP PIRE web site.

The PCP-PIRE e-newsletter open rate (42-58%) is higher compared to other newsletters with a similar scope. Also, 25% of recipients click on the links to learn more about the stories (click rate). People, International and Research sections are preferred by the recipients (23-27%). Only 13% of recipients read complete stories in the Education section. A variety of sections in the e-newsletter and the Spanish version of every story meet the needs of the different stakeholder demographics. Other similar projects may benefit from lessons learned such as how to write for a diverse audience, understanding readership reports, and avoiding being reported as a spammer.

Technical Session IV (Wednesday, October 17, 2:30 pm)

META-ANALYSIS OF REPORTED PTEROSAUR TRACKWAYS: TESTING THE CORRESPONDENCE BETWEEN SKELETAL AND FOOTPRINT RECORDS

PADIAN, Kevin, University of California, Berkeley, CA, United States; FALLON, Brenna, University of California, Berkeley, CA, United States

It is sometimes remarked that there is a “landslide of evidence” for ubiquitous trackways of pterosaurs in the Jurassic and Cretaceous Periods. We performed a meta-analysis of nearly 100 reports and reviews of alleged pterosaur trackways. We first focused on the redundancy of works that attributed trackmakers based on referrals of previous authors, but that provided no first-hand justification for the attribution. More than a third were redundant reports; fewer than 10% examined the evidence for attribution. There was a significant correlation among (1) attribution of trackways to pterosaurs, (2) no consideration of alternative hypotheses of trackmakers, (3) lack of anatomical or kinematic evidence for the attribution, and (4) referral of justification for the attribution to two (or very few) recurrent publications. We then focused on the justification for the attribution of trackways to pterosaurs. We found mostly that the tracks showed apomorphic characters of pterosaurs reflected in any diagnosis of trackways, including reformulations of the original diagnosis of Pterarchinus saltwashensis. In almost all cases of trackways referred to pterosaurian trackmakers (with the notable exception of the tracks from Crayssac, France) there is no evidence of pterosaurian apomorphies. Some of these assigned trackways, such as Purbeckopus, show clear crocodylian apomorphies reflected in their diagnoses. Others, such as Haenamichnus, show no discernible anatomical features. Over 90% of the ichnological literature contains no analysis of skeletal or functional features that an assignment to a pterosaurian trackmaker requires. Because no trackways assigned to pterosaurs are well enough preserved to determine either a manual or pedal phalangeal formula, it is impossible to reconstruct the skeletal manus and pedes of the trackmakers assigned to any Pterarchinidae (traditionally presumed to be tracks of pterosaurs). Nearly all trackways attributed to pterosaurs show (1) a gleno-acetabular ratio lower than commensurate with known pterosaurs, (2) a length-width ratio of the pes (metatarsals + phalanges) incompatible with known pterosaurs, and (3) a preservation so poor as to make attribution of a trackmaker impossible. The Crayssac trackways differ in derived respects from all other attributed trackways, despite deficient preservation, because they show true pterosaurian apomorphies; they should be systematically separated, as other authors have advocated. It is difficult to assign most tracks referred to Pterarchinidae to pterosaurs or any taxon. We propose morphological and preservational criteria by which to evaluate alleged pterosaur trackways. Our analysis has important implications for paleoecological and taxonomic assessments of ancient communities.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ON THE POSTORBITAL AND SUPRAORBITAL OSSIFICATIONS OF SNAKES: NEW INSIGHTS FROM OLD BONES

PALLI, Alessandro, University of Alberta, Edmonton, AB, Canada; CALDWELL, Michael W., University of Alberta, Edmonton, AB, Canada

Some snakes have two circumorbital ossifications that in the current literature are usually referred to as the postorbital and supraorbital. We review the arguments that have been proposed in the past in order to justify this interpretation and provide counter-arguments that reject those conjectures of homology. After examining the skulls of several lizards, including reformulations of the original diagnosis of Pterarchinus saltwashensis. In almost all cases of trackways referred to pterosaurian trackmakers (with the notable exception of the tracks from Crayssac, France) there is no evidence of pterosaurian apomorphies. Some of these assigned trackways, such as Purbeckopus, show clear crocodylian apomorphies reflected in their diagnoses. Others, such as Haenamichnus, show no discernible anatomical features. Over 90% of the ichnological literature contains no analysis of skeletal or functional features that an assignment to a pterosaurian trackmaker requires. Because no trackways assigned to pterosaurs are well enough preserved to determine either a manual or pedal phalangeal formula, it is impossible to reconstruct the skeletal manus and pedes of the trackmakers assigned to any Pterarchinidae (traditionally presumed to be tracks of pterosaurs). Nearly all trackways attributed to pterosaurs show (1) a gleno-acetabular ratio lower than commensurate with known pterosaurs, (2) a length-width ratio of the pes (metatarsals + phalanges) incompatible with known pterosaurs, and (3) a preservation so poor as to make attribution of a trackmaker impossible. The Crayssac trackways differ in derived respects from all other attributed trackways, despite deficient preservation, because they show true pterosaurian apomorphies; they should be systematically separated, as other authors have advocated. It is difficult to assign most tracks referred to Pterarchinidae to pterosaurs or any taxon. We propose morphological and preservational criteria by which to evaluate alleged pterosaur trackways. Our analysis has important implications for paleoecological and taxonomic assessments of ancient communities.
structural similarity, for a reinterpretation of the homology of the dorsal and posterior orbital ossifications of snakes. First of all, we note that the postorbital of lizards is typically an ossification that takes part in the formation of the upper temporal bar, and has little or no contribution to the posterior margin of the orbit. As a consequence of this, squamates that lost the upper temporal bar (e.g., some geckos, Uroplatus fimbriatus, Calotes versicolor, Lanthanotus, Amphiesma) are not comparable to lizards; the only possible exception could be represented by the Gekkota, where the postorbital may be retained if fused with the postfrontal, but this is still debated. Therefore, considering that snakes primitively lack an upper temporal bar, there is no reason to consider the postorbital as present in snakes. Moreover, considering that the posteroventral margin of the orbit is typically formed by the jugal, we conclude that the posterior orbital ossification of snakes is topologically more consistent as a homologue of the jugal of lizards. On the other hand, based on its ontogeny and morphology, the jugal and the jugal in snakes could be homologous. The dorsal orbital ossification that appears in some snakes (e.g., pythons, Loxocemus and Calabaria) should be considered as the homologue of the lacertilian postorbital. These primary homology statements are consistent with the observed anatomy of the fossil snake Dinilysia patagonica, and with a new interpretation of the jugal and postfrontal morphology and articulars for the fossil snakes Pachyrhachis problematicae and Eupodophis descouensi. As a consequence of our observations, we propose that the terms postorbital and supratemporal should be abandoned when talking about the circumorbital bones of snakes, and that they should be replaced with the terms jugal and postfrontal respectively. This re-interpretation of the circumorbital bones of snakes may have important repercussions on future phylogenetic analyses and consequently on our understanding of the origin and evolution of snakes.

A MICRO-CT INVESTIGATION OF MODES OF TOOTH IMPLANTATION AND REPLACEMENT IN EARLY TETRAPODS

PARDO, Jason D., University of Calgary, Calgary, AB, Canada; ANDERSON, Jason S., University of Calgary, Calgary, AB, Canada

Although tooth development and evolution is a potentially rich source of information on the origin of modern tetrapod groups, little is actually known about the morphology, histology, and development of teeth in early tetrapods. This is especially important because tooth morphology and succession are used to inform phylogenetic hypotheses, especially hypotheses concerning heterochronous processes, but without a solid baseline for comparison. Thus, comprehensive study of tooth morphology, histology, and succession in early tetrapods plays a critical role in contextualizing novel tooth morphologies and successional patterns in lissamphibians and amniotes, as well as informing debates on the relationships of modern groups to Paleozoic forms.

In order to investigate the evolution of the dentition in early tetrapods, we used a micro-CT approach to investigate morphology, implantation, and tooth succession on marginal tooth-bearing elements in a survey of early tetrapod taxa. We focused sampling on temnospondyls and lepospondyls, focusing primarily on dissorophoids and recumbirostrans, while also sampling representative reptiliomorphs. Along with gross morphology, we were able to reconstruct the alveolus, pulp cavity, canals within the bone housing the mandibular branch of the trigeminal and alveolar nerves, and tooth resorption zones associated with development of replacement teeth. Histological sectioning was performed on voucher specimens in order to confirm morphology imaged with micro-CT. Teeth in small temnospondyls typically attach to the medial surface of the dentary with a dentine stalk and are replaced lingual to the tooth row. Teeth of recumbirostran lepospondyls attach to either the lingual or occlusal surface of the dentary and lack a dentine stalk entirely, and the enamal can directly attach to the underlying dentary, and are replaced from a lingual or successional lamina. Teeth in the archosaur Archelon show deep sockets, but are replaced from a successional lamina lingual to the tooth row, with implantation into the alveolus occurring after replacement of the crown, in contrast to true thiodonty, where the successional lamina is housed within the alveolus. Replacement, when it occurs, is constrained to pairs, triplets, or series of teeth, and may occur in either an anterior or posterior direction, depending on the taxon and position within the jaw. Replacement modes are inconsistent with a global zahnreihe model of tooth replacement, an anterior or posterior direction, depending on the taxon and position within the jaw.

A FIELD GUIDE TO THE BIRDS (VOLANT VERTEBRATES) OF THE CRETACEOUS OF APPALACHIA

PARRIS, David C., New Jersey State Museum, Trenton, NJ, United States; CLEMENTS, Williams, Scott A., Burpee Museum of Natural History, Rockford, IL, United States; RAWLINGS, Sheila, Burpee Museum of Natural History, Rockford, IL, United States; CARLSON, Elizabeth C., Burpee Museum of Natural History, Rockford, IL, United States; FIVECOAT, Sue, Utah Bureau of Land Management, Hanksville, UT, United States

Jurassic Journey is an innovative program that introduces the general public to science-in-progress at an active dinosaur quarry through guided tours and engages students in hands-on paleontological field work. Since 2009 Burpee Museum has collaborated with the Utah Bureau of Land Management and the town of Hanksville, Utah to introduce the general public to the science behind the Hanksville-Burpee Dinosaur Quarry and promote the importance of fossil resources on public lands. The Hanksville-Burpee Dinosaur Quarry, located outside the town of Hanksville, Utah, was first excavated by Burpee crews in the summer of 2008, though the area had long been known to be rich in dinosaur fossils and petrified wood by local residents. The quarry is a sauropod dominated, Morrison Formation (Brushy Basin Member) locality. This locality has a high-density, bone bearing layer and has yielded fossils from Diplodocus, Camarasaurus, Apatosaurus, Allosaurus and potentially Barosaurus.

The first goal of the Jurassic Journey tours is to introduce the general public to the basics of field paleontology, but also to what one aspect of science “looks” like. Since 2009, the active quarry has been open for educational tours led by Burpee Museum education staff. The tours are the core of the Jurassic Journey project. For many visitors, these tours are their first visit to an active paleontological quarry. The tours cover a wide range of disciplines, including the geology, paleoecology and paleobiology of the quarry, as well as paleontological field work techniques. During the tour the Burpee lab staff, volunteers and students are encouraged to share with the group what they are working on and the techniques they are using.

The second goal of the Jurassic Journey project is to engage, in particular, undergraduate students in outreach education as they share their experience and knowledge with the tour groups that come through. Each dig season the quarry is worked by Burpee Museum lab staff, volunteers, and undergraduate students from as many as three universities. In the past three years the Hanksville-Burpee Quarry hosted over 1200 people including: school groups, visitors from nine countries and 20 other states. An additional 600 people are expected to visit the quarry during the 2012 dig season.

Very few institutions currently bring the general public in contact with science-in-progress at an active dinosaur quarry in North America. Fewer still, are the groups that pair exposure to science-in-progress with an educational experience. The Jurassic Journey project has the strong potential to serve as a framework for other projects to bring the general public in contact with science-in-progress at other active paleontological quarries and promote fossil resources on public lands.
flight associated with aquatic environments (including Anseriformes and Charadriiformes), the birds of Appalachian appear to be somewhat more so. As might be expected, the bird groups with strong flight capabilities populated both subcontinents, so that greater faunal similarity would be expected for birds than for non-volant vertebrates. However, the same cannot be said for the pterosaurs of the later Cretaceous, which have a rather meager record of primarily localized taxa. Even the apparently widespread Pteranodonidae have no certain record of a genus occurring on both subcontinents. The flight capabilities that enabled birds to populate large areas across continental borders seem to have been lacking in pterosaurs, even those of great size and strength. A corollary to this observation is the likelihood that pterosaurs were less capable of surviving the Cretaceous/Paleogene boundary catastrophe, which indeed they did not.

Technical Session I (Wednesday, October 17, 11:45 am)

THE FIRST INTACT SCAPULAR GLENOID REGION OF DEINONYCHUS ANTIHRIPPUS AND THE CONSEQUENT RE-INTERPRETATION OF DROMAEOSAURID FEATURES THAT ENHANCED THE EVOLUTION OF AVIAN FLIGHT

PARSONS, William L., Buffalo Museum of Science, Buffalo, NY, United States; PARSONS, Kristen M., Buffalo Museum of Science, Buffalo, NY, United States

Within Dromaeosauridae, the morphology of the glenoid region of the scapula is the key to understanding the overall mobility of the shoulder and thus the extent to which this joint functioned to enhance the evolution of avian flight. The discovery of the proximal ends of two scapulae of Deinonychus, each possessing a shallow, posterolaterally facing glenoid, helps to elucidate this understanding. The dorsal edge of the glenoid possesses a considerably curved embayment that would have presented no obstacle to the raising of the forelimb above the horizontal plane of the shoulder girdle; rather, it would have facilitated such upward arcing movement. Within this embayment there is a robust scapulohumeral ligament fossa. The humerus was held within the glenoid by a combination of the acrocoracohumeral ligament and the scapulohumeral ligament. The positioning of the scapulohumeral ligament fossa is at a pivot point along the rostral/caudal axis of the dorsal edge of the glenoid; this fossa is an anchoring point for the upward movement of the forelimb. The morphology of the glenohumeral joint of Deinonychus differs considerably from that of Velociraptor mongoliensis. Along with the fusion of the scapula/coracoid suture on Velociraptor, the posteroventral orientation of the glenoid of Velociraptor is secondarily derived from the more primitive posterolateral orientation as is found in Deinonychus and a number of other dromaeosaurs. Also, the embayment of the glenoid of Velociraptor is deeper than that on Deinonychus, and the movement of the humerus would have been restricted by a rostral coracoid tuber and a less robust caudal scapular tuber. Various features of the Deinonychus shoulder joint can be interpreted as possessing all the necessary elements for the evolution of the triossal canal. This current reinterpretation of the mobility potential of the shoulder joint of Deinonychus along with the unfused mobile suture between the coracoid and scapula and the relationship between the acrocoracohumeral ligament, M. deltoideus clavicularis, and M. supracoracoideus present a combined mechanical morphology that would allow for an alternative form of “wing-flapping” without humeral rotation. Additionally, it raises questions as to the functional aspects of other features that enhanced the evolution of flight, such as the flexibility of the cervical vertebral articulations and the caudal muscular contribution to mobility possessed by this and other taxa within Dromaeosauridae.

POSTER Session II (Thursday, October 18, 4:15 - 6:15 pm)

TAPHONOMIC COMPARISON OF MODERN EAST AFRICAN OWL PELLETS AND THE KANAPOI FOSSIL MICROMAMMAL ASSEMBLAGE

PATTERSON, David B., The George Washington University, Washington, DC, United States; DU, Andrew, The George Washington University, Washington, DC, United States; BOBE, René, The George Washington University, Washington, DC, United States; BEHRENSMEYER, Anna K., National Museum of Natural History, Washington, DC, United States; REED, Dan, University of Texas, Austin, TX, United States

Micromammals have long been recognized for their value in the reconstruction of hominin paleoenvironments, but they are relatively understudied in East Africa in comparison to large mammals. With the increased concentrations of micromammals fossils are recovered in the fossils of avian predators usually are invoked as the accumulating agent, even though other taphonomic processes—aluvial processes, catastrophic events, mammalian predation, etc.—could also play a role in concentrating small bones and teeth. This study tests the avian predator hypothesis by focusing on the taphonomy of micromammal assemblages. We compare a sample of East African micromammal fauna collected from modern owl roost localities to a fossil micromammal assemblage from East Africa hypothesized to have been accumulated by avian predators. The extant micromammal sample (> 4,000 NISP) was collected from five roost localities to the east of Lake Turkana in northern Kenya and nine roost localities from the Serengeti in northern Tanzania, while the fossil assemblage (> 600 NISP) is from Kanapoi in northwestern Kenya. Skeletal element and portion representation are compared between the modern and fossil samples to determine the degree of similarity between modern owl-accumulated and fossil micromammal assemblages from East Africa. Results indicate that skeletal element representation is consistent between the modern and fossil sample, however the portion of each element preserved is significantly different. These findings suggest that the primary taphonomic filter (i.e., avian predation) is consistent between the two samples, but postdepositional processes (i.e., diagenesis and excavation) drastically altered the taphonomic characteristics of the fossil assemblage. The implications of this pilot study can be used in conjunction with other taphonomic signatures (i.e., surface etching, degree of rounding/abrasion, mortality and age profiles, etc.) to improve interpretations of the biological and geological processes that formed micromammal assemblages in the fossil record and increase understanding of taphonomic processes that may bias reconstructions of hominin paleoecology.

FIRST INSIGHTS INTO THE DICRAEOSAURID (SAUROPODA: DIPLODOCOCIDAE) INNER EAR: THE ENDOCRANIAL MORPHOLOGY OF AMARGASaurus CAZAIU STUDIED USING CT SCANS

Paulina Carabajal, Ariana, CONICET-Museo Carmen Funes, Plaza Huincul, Argentina

The braincase of the sauropod dinosaur Amargasaurus cazaiu from the Lower Cretaceous of Neosquen Province, Argentina represents the only dicraeosaurid neurocranial material known from South America. Exception of an apparently natural endocast recently recovered from the Lower Cretaceous Mulichincho Formation, also in northern Patagonia. Furthermore, the morphology of the inner ear has not previously been described for any of the four known genera of this sauropod clade. The braincase of Amargasaurus has been CT scanned, allowing for a three-dimensional digital reconstruction of the endocranium (represented by the forebrain, midbrain, and hindbrain, plus the spaces related to the pineal and postparietal fenestrae) and inner ear. The labyrinth is dorsoventrally longer than the lagena, which is simple, conical, and relatively short compared to that of other sauropods. The anterior semicircular canal (ASC) is larger than the posterior semicircular canal (PSC), and the lateral semicircular canal (LSC) is markedly smaller than the PSC, similar to the morphology described for Diplodocus. In dorsal view, the angle formed by the ASC and PSC is approximately 90°. When the braincase is oriented with the LSC positioned in the horizontal plane, the occipital condyle is not as ventrally projected as had previously been stated, suggesting that the habitual posture of the head was similar to that reconstructed for Nigerasaurus, with the muzzle pointing downward. However, further studies of the cranial anatomy, myology, and cervical vertebral morphology of Amargasaurus are needed before the range of head and neck movements in this taxon can be defined.

A NEW SILESAURID DINOSAURIFORM FROM THE MIDDLE TRIASSIC (ANISIAN) NTAWERE FORMATION OF ZAMBIA REINFORCES PATTERNS OF ASSEMBLAGE DISSIMILARITY ACROSS SOUTHERN PANGAEA

PeeCook, Brandon R., University of Washington, Seattle, WA, United States; Sidor, Christian A., University of Washington, Seattle, WA, United States; Neshitt, Sterling J., University of Washington, Seattle, WA, United States; Angelczyk, Kenneth D., Field Museum of Natural History, Chicago, IL, United States; Steyer, J. S., Museum National d’Histoire Naturelle, Paris, France

The oldest diagnosable members of Dinosauria appear in the early Late Triassic (Carnian) of Argentina and Brazil. Successive sister taxa of Dinosauria, the non-dinosaurian dinosauromorphs, historically have been found in slightly older rocks of the late Middle Triassic (Ladinian), but in the same general area as the earliest Dinosauria. However, recent discoveries have been made in other parts of the world showing that non-dinosaurian dinosauromorphs had stratigraphic ranges extending tens of millions of years into the Late Triassic. Perhaps most surprising was the blossoming of Silesauridae, a clade that is currently recognized as the sister group to Dinosauria, contains at least seven species, was uneknownst to paleontologists before 2003 and only named in 2010. A suite of features characterizes the clade including a long limbed, quadrupedal bauplan, and a skull equipped with a beak and plant-eating teeth in more apomorphic members. We present the first silesaurid and archosaur from the upper portion of the Ntawere Formation of the Luangwa Basin, Zambia. The upper Ntawere has been correlated with both the Cynognathus Assemblage Zone, subzone C (CAZ-C) of the Karoo Basin in South Africa and the Manda Beds of the Ruhuhu Basin in Tanzania, the latter of which yielded the silesaurid Asilisaurus kongwe. A phylogenetic analysis including new pelvic characters, places the Zambian silesaurid with Late Triassic silesaurids such as Silesaurus, Salticusaurus and Eucoleophylus rather than sister to coeval Asilisaurus. With the later forms the Zambian silesaurid shares a laterally oriented brevis fossa on the ilia and transversely thin ischia in cross section, though both the Zambian silesaurid and Asilisaurus have high ilial blades relative to the acetabulum. The discovery of a silesaurid bonebed in 2011 likely contains referable material. Bird-line archosaurs, and silesaurids in particular, were more diverse than previously supposed in the Anisian. The new Zambian silesaurid Asilisaurus can be regarded as the two oldest known members of the bird-line archosaurs.
GEOMETRIC MORPHOMETRIC STUDY OF THE EVOLUTION OF THE HIND LIMB IN NON-AVIAN DINOSAURS

PELLETIER, Valerie, California State University, San Bernardino, San Bernardino, CA, United States

The postcranial skeleton of Varanops has been reconstructed in both dorsal and ventral views. The postcranial elements include the skull, the cervical, thoracic, and pelvic vertebrae, the ribs, the pectoral and pelvic girdles, the shoulder, hip, and ankle bones, and the tail. This reconstruction provides a complete picture of the postcranial skeleton of Varanops, allowing for a better understanding of the morphology and function of the hind limb in non-avian dinosaurs. The hind limb of Varanops is characterized by a relatively long femur and a short tibia, suggesting a cursorial lifestyle. The metatarsals are also well-preserved, allowing for a detailed analysis of their morphology and function. The hind limb of Varanops is more similar to that of other varanopids, but more robust than either Mycterosaurus and Varanops. The hind limb of Varanops is described in detail, including the morphology of the femur, tibia, fibula, and metatarsals. The results of this study provide new insights into the evolution of the hind limb in non-avian dinosaurs.
dromaeosaurs, which is contrary to the widespread view that dromaeosaurs were among the most cursorily adapted of all predatory dinosaurs.

**Postner Session II (Thursday, October 18, 4:15 - 6:15 pm)**

**IMPLICATIONS FOR MUSCLE RECONSTRUCTION IN FOSSILS FROM HISTOLOGICAL EVIDENCE FOR MUSCLE INSERTION IN EXTANT AMNIOTE FEMORA**

PETERMANN, Holger, University of Bonn, Freital, Germany

Identification of muscle attachment sites has been important for muscle reconstructions in fossil tetrapods ever since the 19th century. Therefore, numerous biological and palaeontological studies focused on the subject. In histological thin sections, Sharpey’s fibers have been the sole reliable feature for identification of tendon-bone or muscle-tendon-bone interactions at the microscopic level. However, muscles are not restricted to indirect attachment with tendons, but attach also directly with muscle fibers. The question of the identifiability of direct muscle attachment has not been addressed by previous studies. However, histological identification of direct muscle attachments is important as these attachments do not leave visible marks on the bone surface (e.g. scars and rugosities). Other than Sharpey’s fibers no indicators for muscle attachment have been provided. I dissected the right hind limb and mapped the muscle attachment sites on the femur of one rabbit (Oryctolagus cuniculus), one Alligator mississippiensis, and one turkey (Meleagris gallopavo). I then extracted the right femur and prepared 4 histological thin sections for the rabbit and the turkey and 5 histological thin sections for the alligator. I found that, additionally to Sharpey’s fibers, vascular canal orientation and a frayed periosteal margin can be indicative of indirect and direct muscle attachments. Orientation of Sharpey’s fibers to the cutting plane of the thin section can occur at high angles. Furthermore, two Sharpey’s fibers orientations can occur in one area, possibly indicating a second force axis, e.g. from the action of a tendon or ligament. However, of the mapped attachment sites only about 60% could be detected in thin sections, and histological features suggestive of muscle attachment frequently occurred outside of mapped areas. While these insights are expected to improve our ability to successfully identify and reconstruct muscles in extinct species, the limitations of this approach are also apparent.

**Postner Session I (October 17, 4:15 - 6:15 pm)**

**DISTRIBUTIONS OF INJURIES IN PACHYCEPHALOSAURIDS USING FRONTOPARIETAL LANDMARKS**

PETERSON, Joseph E., Department of Geology, University of Wisconsin Oshkosh, Oshkosh, WI, United States; DISCHLER, Collin, Department of Geology, University of Wisconsin Oshkosh, Oshkosh, WI, United States

The frontoparietal domes of pachycephalosaurs have long been hypothesized as weapons for agonistic bouts similar to the behavior of extant ungulates. This hypothesis has been supported by structural models and the recent identification of pathologies on the calvaria of frontoparietal domes. However, a standardized analysis of the spatial distribution of lesions on frontoparietal domes remains absent. Presented here are the results of an evaluation of frontoparietal domes that possess indented lesions along the calvarium. Lesions were differentially diagnosed based on CT data and the presence of gross pathological distributions, and include the sutural surfaces of the nasal, anterior supraorbital, posterior supraorbital, postorbital, squamosal, and frontoparietal suture. Lesions were classified based on their morphology and location in relation to homologous landmarks. The distributions of lesions on frontoparietal regions were compared for percent abundance and Kolomogorov-Smirnov Goodness-of-Fit tests (p<0.01). Based on these analyses, all specimens except Gravitholus illustrate a strong related distribution of lesions on the dorsal surface of the frontal region, regardless of dome mass, height, or taxon. Over 60% of all identified lesions occur on the dorsal surface of the frontal region, while nearly 30% occur along the frontoparietal suture on the dorsal surface. The strong clustering of lesions along the frontal and around the frontoparietal suture is in agreement with the expected location of injuries resulting from agonistic head-butting or shoving, suggesting that pachycephalosaurs sustained injury from such behaviors.

**Technical Session III (Wednesday, October 17, 2:30 pm)**

**NEW DIMINUTIVE CERCOPITHECINE TEETH FROM KANAPOI, KENYA, AND IMPLICATIONS FOR THE EVOLUTION OF DIVERSITY IN GUENONS**

PLAYCANY, J. Michael, University of Arkansas, Fayetteville, AR, United States; WARD, Carol V., University of Missouri, Columbia, MO, United States; MANTII, Frederick K., National Museums of Kenya, Nairobi, Kenya

Recent field work in Kanapoi, Kenya uncovered two small associated unworn second and third molar teeth of a primate. These molars show the bilophodont, quadratibucular morphology typical of cercopithecoid primates. Metric and morphological comparisons reveal that they are indistinguishable from those of the extant talapoin monkey (Miopithecus talapoin). The talapoin monkey is the smallest extant cercopithecoid, thought to be a phyletic dwarf associated with adaptation to dense riverine forest in West-Central Africa. Phylogenetically, talapoins are placed as the sister taxon to extant guenons (excepting *Allenopithecus*). Molecular phylogeny estimates the origin of extant guenons at approximately 11.5 million years ago. The Kanapoi site from which the specimen was found is dated to approximately 4.2 million years ago, making this the second oldest reported guenon fossil. The new fossils add to previously reported diminutive cercopithecine teeth from Kooki Fora, Kenya (minimally 3.4 million years ago), but are considerably older. Faunal and other analyses suggests open woodland habitat with patches of grasslands at Kanapoi. The paleosol yielding the new specimen also yields a rich fauna including rodents, anurans, bats, and hominins, with minimal evidence of transport. The small size and early age raise several intriguing and important possibilities about the evolution of African guenons. If truly *Miopithecus*, the specimen extends the geographic range of these monkeys to East Africa. Though extant *Miopithecus* is restricted to dense riverine forest habitat, the new specimens occur in dry, seasonal woodland habitat with open grasslands. The early age of the new fossils is consistent with the hypothesis that there was an early divergence between *Miopithecus* and other guenons (about 8.1 million years ago) as indicated by molecular evidence. The very small size suggests either that dwarfing occurred very early in this genus and small size has been maintained for than 4 million years, or that there have been separate dwarfing events within cercopithecines. Alternatively, the specimens may suggest that primitive guenon body size was small (about 1 kilogram), although this is contradicted by morphological evidence for dwarfing in modern talapoins and the fact that older fossil guenon teeth (5.4 million years ago) were the size of modern *Cercopithecus cephus*. Whichever is the case, the new specimens suggest that the modern diversity in guenon body size arose early in the history of the group, and that diminutive size is not uniquely associated with current talapoin habitat.

**Technical Session XIX (Saturday, October 20, 2:15 pm)**

**DR JESTER AND MR QUEEN: SPECIATION IN MAMMALS WITH LARGE GEOGRAPHIC RANGES IS A BIOTIC AND ABIOTIC PROCESS THAT REQUIRES MANY GLACIAL-INTERGLACIAL CYCLES**

POLLY, P. D., Indiana University, Bloomington, IN, United States

The impact of climate changes on geographic ranges ought to drive speciation, especially when populations are fragmented into refugia that promote allopatric differentiation. So, Quaternary glacial/interglacial cycles should have increased the rate of speciation across many groups. Previous studies have shown, however, that individual glacial cycles appear to have little or no impact on speciation. Here we examine a model species group, the *Sorex araneus-arcticus* complex (*Soricidae, Mammalia*), to study the impact of glacial refugia on speciation. The nine living species of this group are spread across Europe, northern Africa and North America with their deepest divergences in their latest common ancestor. One member, *Sorex araneus*, is genetically subdivided into more than 70 karyotypic types, many of which are well studied. To study the history of differentiation in this group, we used phylogenetic data, the rich and well-dated European fossil record of the group, habitat modeling and paleoclimata data, an extensive morphometric data set from across the modern geographic range, and genetic data (karyotypes and molecular measures of gene flow).

We found an iterative cycle in which species were genetically fragmented into as many as ten different refugia during glacial cycles. The number and location of these refugia was estimated using more than 200 European fossil occurrences of *S. araneus* in combination with habitat models projected onto paleoclimates. The fossil distribution is substantially more compatible with the Microclimate model for the last glacial maximum than the CCSM model. The geographic distribution of karyotype groups in *S. araneus* is consistent with these refugia. Gene flow between the karyotype groups is high in the modern world, with the chromosome differences forming only a minor barrier. Differentiation that accumulated allopatrically during the last glacial cycle is currently being lost; however the rate of gene flow is insufficient to homogenize the species during the roughly 15-20ka duration of an interglacial optimum. The climatic asymmetry of glacial-interglacial cycles means the species has spent more time fragmented into refugia than in its current conterminous state. Thus, phenotypic and genetic differentiation accumulates more than it dissipates with each cycle, resulting in an iterative process of differentiation. Speciation in the group occurred first at the strongest geographic breaks in the distribution. Despite the role of climate cycles in fragmenting populations, eight out of nine species in the *S. araneus-arcticus* group have the same climatic envelopes, indicating little adaptation to changing climates. While speciation in the group appears to be driven by climate-driving factors (a “Red Queen” mechanism), evolutionary changes in morphology, behavior, and ecology are apparently driven by other randomly changing factors (a “Red Queen” mechanism).

**Technical Session IV (Wednesday, October 17, 3:15 pm)**

**DINOSAUR CEPhALIC V ASCULAR ANATOMY AND ITS PhYSIOLOGICAL IMPLICATIONS: EVIDENCE FROM THE FOSSILS**

PORTER, William R., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Evidence of cephalic blood vessels is written into bone as osteological correlates (OCs). When these OCs are analyzed in the context of extant outgroups, we gain insight into vascular patterns in extinct taxa, which illuminate physiological processes. OCs found on dinosaur fossils were recorded, focusing on three sites (orbital, nasal, and oral cavities) that in extant outgroups are critical in thermoregulation. Most dinosaurs experienced high heat phases.
loads due to their high surface-to-volume ratios, and we tested the hypothesis that dinosaurs exploited these same three sites of heat exchange. Vascular OCs in extant taxa (birds, crocodilians, iguanas) were used to formulate hypotheses of dinosaur vascular anatomy. To test these hypotheses, we characterized OCs on dinosaur fossils using direct observation, CT scanning, and the Extant Phylogenetic Bracket approach. Dinosaur vascular anatomy was reconstructed in Azizov and Maya. OCs relating to the orbital region were observed in theropods (e.g., Rugops, Majungasaurus, Alioramus, Carcharodontosaurus, Albertosaurus, Daspletosaurus, Tyrannosaurus) as grooves traversing the postorbital bone. In the extant sample, an orbital plexus traverses the postorbital region. Grooves also traverse the ventral surface of the frontal, and then curve onto its dorsal surface in theropods, sauropods (Camarasaurus, Diplodocus) and Stegosaurus. In the extant sample, these grooves are formed by branches of supraorbital vessels supplying dorsal regions of skin on the head, which, in birds, correspond to brightly colored display surfaces. OCs relating to the nasal region were observed in theropods as grooves traversing the ventral surface of the nasals. In the extant sample, similar grooves correspond to vessels supplying the nasal region. Unique grooves found in the ventral aspect of the antorbital fossa in theropods indicate that the antorbital air sinus was well vascularized. OCs relating to the oral region were observed in theropods and sauropods as grooves on both the medial and lateral aspects of the maxilla. In extant taxa, these grooves correspond to branches of the dorsal alveolar vessels and palatal plexus. The large submaxillar foramen between the maxilla and premaxilla in sauropods indicates that large volumes of blood passed between the oral and nasal regions. In the extant sample, these vessels connect these same two sites of thermal exchange, suggesting an emphasis on the vasculature of these regions in at least sauropod dinosaurs. In general, the OCs found within dinocephalians differ from those that, when properly connected, offer a glimpse of regions of the head that may have been well vascularized and likely held important roles in key physiological processes.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 11:00 am)

UNDERSTANDING MAMMALIAN DIETARY EVOLUTION USING A PHYLOGENETIC AND COMPARATIVE APPROACH
PRUCE, Samantha A., UC Davis, Davis, CA, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; BOTERO, Carlos A., North Carolina State University, Raleigh, NC, United States

Diet has played a critical role in the evolutionary history of mammals as evidenced by their extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity. Previous studies of dietary evolution have focused solely on specific dietary categories or individual clades of mammals, which deprives us of the extraordinary dental diversity.
A phylogenetic analysis of 250 characters and 40 basal diapsids and saurians, including a complete sampling of drepanosaurid taxa, strongly supports a clade including the Ghost Ranch drepanosaurids and the pyrogryphid-eurypelthid-Uintan-aged taxon Dresnanosaurus to the exclusion of all other drepanosaurids. This relationship is supported by characters relating to the forelimb and vertebral column. Another drepanosaurid taxon from the Petrified Forest Member of the Chinle Formation, Dolobosaurus aequalitis, is resolved as basal to this clade. This topology suggests a complex biogeographic history for drepanosaurids, with multiple vicariance or dispersal events throughout their evolutionary history.

Postterrier Session I (Wednesday, October 17, 4:15 - 6:15 pm)

Simojovelhus, the oldest mammal fossil from central America, is a peccary, not a helohyid

Protérho, Donald T., Natural History Museum of Los Angeles County, Los Angeles, CA, United States; Beatty, Brian L., NYCOM, Old Westbury, NY, United States; Stickley, Richard, Denver Museum of Nature and Science, Denver, CO, United States

Simojovelhus pocitosense is based on a lower jaw fragment with three molars from the late Oligocene amber mine deposits near the village of Simojovel, Chiapas Province, Mexico. It is the oldest fossil mammal known from Central America. It was originally described as a helohyid, a group of primitive artiodactyls known from the Bridgerian and Uintan of North America (older than 37 Ma), yet it comes from early Arikareean deposits about 25-27 Ma, making it a very late helohyid living at least 10 m.y. after theirUintan extinction. We re-examined the specimen, and compared it to the large collection of recently described peccaries from the Chadronian (Prochoerus minor) and Orellana (Prochoerus nates). Once the range of variation of characters in helohyids and peccaries is accounted for, Simojovelhus shows more derived similarities to early peccaries, especially in the bunodont molars with inflated cusps, and none of the incipient lophodonty seen in helohyids, and the configuration of cristids and accessory cuspsules. In fact, the only real similarity between Simojovelhus and helohyids is its small size, but it is close to the size range of the small Chadronian peccary P. minor. Thus, based on both derived tooth characters and its age, it is much more parsimonious to regard Simojovelhus as a Mexican peccary from the Arikareean, not a very late helohyid.

Postterrier Session I (Wednesday, October 17, 4:15 - 6:15 pm)

The mioecene vertebrate faunas of Achiri, Bolivia

Pujo, François, CCT-CONICET-Mendoza, Mendoza, Argentina; Antoine, Pierre-Olivier, ISEM, UMR, Montpellier, France; Mamani Quispe, Bernardino, MNHN-Bol, La Paz, Bolivia; Abello, Alejandro, MLP, La Plata, Argentina; Andreade FLORES, Ruben, MNHN-Bol, La Paz, Bolivia.

The palaeontological locality of Achiri is located in the Bolivian Department of La Paz. The fossiliferous levels of the main locality, located hundreds of meters above the Ulloma Toba, are dated between 10.35 Ma (40Ar/39Ar, at Jankho Jakke Alto) and 8 Ma (K-Ar, west of San Andrés de Machaca). Late Mioecene mammals identified in the last several decades include: metatherian hithalayr strictus, Palaeotapioceras, and notoungulates. The Mammalidae litoptern, the chinchilla Prolagostomus, and the glyptodont Trachyclytaeina, are recognized. Rodents include a large hystrixgnath dinomyid, a medium-sized octodontid, two cavioids (a cardioyline and a dolichece), and the chinchillid Prolagostomus. Cingulates include the glyptodont Trachyclytaeina, the dasypod Chorobates, and the pampatherid Krauselvia. A diversity of sloths include an early Megatheriinae and a large lemur Lorisidae. Metatherian and eutherian affinities Yxophorus, and a small megatherian similar in size to Megathures.

Field exploration in 2010-2011 resulted in the discovery of two older levels, below the classic locality. The upper one, with amphibians, birds, and rodents, testifies to the presence of a lacustrine environment prior to the deposition of the latter (located ~200m above it in the same section). The lowermost one, located ~500m below it and more remote, yielded notoungulates, rodent, and cingulate remains. The most remarkable specimen is an elongated and long-snouted skull of a haplodontotherium toxodontid, with a complete dental formula (3/1-4/3-3).

Recognition of three successive fosseriferous levels in the vicinity of Achiri, the unexpected diversity of the assemblages, and the exceptional preservation of the vertebrate remains promise to contribute towards a better understanding of the evolution of vertebrates throughout the middle-late Miocene period in central Bolivia. Detailed study of these faunas, coupled with new field missions, will allow correlation with deposits farther south (Cerdas and Quebrada Honda, Bolivia; Maimara, Argentina) and north (La Venta, Colombia; Acre, Brazil; Urumaco, Venezuela).

Technical Session V (Wednesday, October 17, 4:00 pm)

Roadside whales in the Atacama: A mass death assemblage of marine mammals from Cerro Ballena, a new locality of the Bahia Inglesa formation, Atacama Region, Chile

Pyenson, Donald T., Smithsonian Institution, Washington, DC, United States; Gutiérrez, Carolina S., Universidad de Chile, Santiago, Chile; PARHAM, James F., Dr. John D. Cooper Archaeological and Paleontological Center, Santa Ana, CA, United States; Rubin-Larner-Rogers, David, Museo Nacional de Historia Natural, Santiago, Chile; Suárez, Mario E., Museo Paleontologico de Caldera, Caldera, Chile

Since the late Miocene, tectonic events in the South American Cordillera have created broad expanses of marine sediments in basins associated with the Humboldt Current System. In the Atacama Region of Chile, the Bahia Inglesa Formation preserves several sequences of marine rocks of late Miocene to Pliocene age, including fossiliferous units with marine vertebrates. Some of these taxa include extant lineages of marine mammals (phocid seals, roquay whales) and seabirds (Spheniscus sp.), as well as completely extinct lineages, such as aquatic sloths (Thalasocnus sp.), giant bony-toothed seabirds (Pelagornis chilenis), and walrus-convergent dolphins (Odobenocetus sp.). In the upper Bahia Inglesa Formation, road construction expanding the Pan-American Highway in 2010 and 2011 uncovered a mass death assemblage of fossil marine mammals in a quarry with an area of 250 meters by 20 meters. This site, called Cerro Ballena, is dominated taxonomically and numerically by incomplete, although mostly intact skeletons of 44 roquay whales (Balaeonidae). These mysticete remains are also associated with one skeleton of a stem sirenid, an incomplete pinniped postcranium, and a partial skull and skeleton of Odobenocetus. Notably, there are no less than four marine mammal-bone concentrations at the site with well-preserved vertebrae of seald, indicating that a recurring phenomenon created unique conditions for the preservation of marine vertebrates. A range of death mechanisms can explain the sequence of assemblages at Cerro Ballena, although only a few are consistent with the sedimentologic evidence from the sandstone sequence, which suggests a quiescent embayment setting or a restricted lagoonal environment. Based on long bone orientation and the degree of skeletal articulation, the assemblage of multi-lineage marine mammal remains at Cerro Ballena most strongly favor taphonomic pathways where death was relatively rapid (hours to weeks in duration), and likely caused by an allochthonous mechanism. Modern analogues of marine mammal deaths caused by red tides and domoic acid, both associated with harmful algal blooms, outline a possible mechanism that occurred repeatedly at Cerro Ballena during the Pliocene.

Technical Session IX (Friday, October 19, 8:15 am)

The homology of the basipterygoid process in eucryptodiran turtles and its phylogenetic implications

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The articulation between the basiphenoid and the pygrygoid is kinetic in the Triassic turtle Proganochelys quenstedti, the primitive condition for amniotes. All more derived turtles have an akinetic skull with locked basiliarion joints. Remnants of the basipterygoid process of the basiphenoid have been reported for the early paracryptodires Pleurosternon bullocki and Glyptops plicatulus but these have been subsequently regarded as neomorphic structures based on topological considerations. Their interpretation therefore remains controversial. Our observations of published and new material of basipterygoid taxa reveal that a laterally and slightly ventrally projecting process of the basiphenoid that fits into a pocket of the pygrygoid is also present in numerous Asian Mesozoic forms, including Annamospp., Ordosamsp., Dracuichas bicuspid, Hanguicosm hoberensis and Sinemys sp. Contrary to some previous suggestions, this structure should be considered homologous with the basipterygoid process of basal turtles given its identical topological position relative to the posterior foramen of the cranial branch of the carotid artery. Moreover, we were able to identify intermediate states in many basal turtles that record the transition between the ventrolaterally directed and postural articual process of P. quenstedti and the articulated condition seen in basal eucryptodires. The loss of the basipterygoid process in turtles is tightly linked to the bony enclosure of the carotid system in the basiracial region. A review of eucryptodirasi basiracialia reveals that the loss of the basipterygoid process is tightly connected to the reduction of the carotid fenestra (i.e., a fenestra located between the basiphenoid and pygrygoid within which the split of the carotid artery into the cerebral and palatine branches is exposed). Surprisingly, even though the loss of the basipterygoid process is optimized to be a synapomorphy of crown Cryptodira, the presence of a reduced carotid fenestra in the stem-trionychian Adocus sp., the stem-testudinoid Mongolmys elegans, and the tentive stem chelonioidea/konostemoidea Iadihamys sakanaki and Macrobaena mongolica indicate that the closure of the carotid fenestra occurred at least three times. The presence of a reduced carotid fenestra in the latter two taxa further confirms the phylogenetic distinction between “true macrobaenids” and the eclectic group of basal eucryptodires traditionally referred to Macrobaenidae. A reduced carotid fenestra is furthermore present in pleioschoelyids, eurytemyids, and protostegids thereby hinting at a phylogenetic position derived to classic sinemyidcs or additional levels of homoplasy.
ADAPTIVE RADIATIONS AND ECOLOGICAL DIVERSITY OF EUROPEAN ADAPIFORMS IN WESTERN EUROPE

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From Darwin’s finches to cichlid fishes, numerous examples of adaptive radiation can be seen in nature today. In these well-studied examples, factors such as differential environment or competition for available resources, are known to have led to divergent natural selection. However, the influence of these ecological factors in past examples of adaptive radiation is difficult to characterize, due to the difficulty of reconstructing the ecology of extinct taxa. With 14 genera and over 40 species, Adapiforms were a particularly successful group of Primates. They colonized a wide array of ecological niches over the course of the Eocene, and showed diversification in activity cycle (diurnal and nocturnal), and body size (from 60 g to 5 kg). A better understanding of this radiation can only be accomplished by a detailed characterization of how ecological and morphological diversity evolved throughout the Eocene. For the first time, a wide scale dietary reconstruction is proposed for Eocene primates from the earliest to latest Eocene in Western Europe. In this study, dietary hypotheses are proposed for 20 primate communities (including adapiforms and omomyiforms) occurring in Europe during the Eocene using three different approaches: body mass estimation, estimating quotients and dental microwear analysis. Early adapiforms were most probably fruit-eaters, at a time when primate diversification was still low and competition had not yet driven them towards dietary specialization. By the middle Eocene, cercamomine adapids had diversified and occupied a wide array of ecological niches. Maximum diversity was also reached during the middle Eocene, with only the small insect-eater Anchomomys surviving to the early late Eocene. Small-bodied cercamomines, which were insect and fruit eaters, disappear from the fossil record by the middle of the Eocene. Conversely, omomyiforms, such as Pseudoloris and Necrolemur, occupy a similar ecophenotypic niche in later primate communities. Medium to large-bodied cercamomines (fruit- and leaf-eaters) also decline in the fossil record during the middle Eocene, as adapines first occur in the European primate communities. These mostly large-bodied primates seem to have filled the ecological niche left vacant by the disappearance of cercamomines during the middle Eocene. Indeed, adapines do show specialization towards leaf-eating, and fruit-eating was also common among this group. These results demonstrate this radiation followed some typical trends, similar to those seen in extant examples, such as an increasingly fine ecological specialization. However, the influence of these ecological factors in past examples of adaptive radiation is difficult to characterize, due to the difficulty of reconstructing the ecology of extinct taxa. With 14 genera and over 40 species, Adapiforms were a particularly successful group of Primates. They colonized a wide array of ecological niches over the course of the Eocene, and showed diversification in activity cycle (diurnal and nocturnal), and body size (from 60 g to 5 kg). A better understanding of this radiation can only be accomplished by a detailed characterization of how ecological and morphological diversity evolved throughout the Eocene. For the first time, a wide scale dietary reconstruction is proposed for Eocene primates from the earliest to latest Eocene in Western Europe. In this study, dietary hypotheses are proposed for 20 primate communities (including adapiforms and omomyiforms) occurring in Europe during the Eocene using three different approaches: body mass estimation, estimating quotients and dental microwear analysis. 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Using the Extended Price Equation to Analyze Patterns of Body Size Change in Mammals Across the Paleocene-Eocene Thermal Maximum in North America

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The patterns of mammalian evolution across the Paleocene-Eocene Thermal Maximum (PETM) (approximately 56 million years ago) have been an important focus of research as interest in the response of mammals to dramatic climatic shifts during this interval has heightened. Among the most intriguing and often-cited of these patterns is the apparent dwarfing of many different taxa near the onset of the PETM, a phenomenon commonly attributed to elevated temperatures and/or higher carbon dioxide levels. Prior considerations of this pattern, however, have not been able to differentiate variations in body size into components attributable to separate evolutionary forces (e.g., natural selection). In this study, we use an innovative, extended adaptation of the Price Equation to analyze patterns of body size change in mammalian communities from the middle Clarkforkian through middle Wasatchian North American Land Mammal Ages of the Bighorn and Clarks Fork Basins of Montana and Wyoming. The extended Price equation, a comprehensive description of evolutionary change under all conditions, provides valuable insight into body size change by partitioning variation into three meaningful components: changes resulting from non-random speciation and extinction rates (e.g., losses among small-bodied taxa), substitutions in rates of growth for several dinosaur taxa, but members of the otherwise relatively well-known family Ceratopsidae have historically been excluded. The latter shows a surprising diversity of dental anatomy, ranging from the homodont dentition of Delorhynchus to the greatly exaggerated, large first incisoriform and relatively large caniniform teeth of Colobomycter: This indicates that the initial stages of parareptile evolutionary history is much more complex than previously envisaged.

NEW SMALL PARAREPTILES FROM THE LOWER PERMIAN OF RICHARDS SPUR, OKLAHOMA, AND THE EARLY DIVERSIFICATION OF PARAREPTILES IN LAURASIA

REISZ, Robert R., University of Toronto Mississauga, Mississauga, ON, Canada; MACDOUGALL, Mark J., University of Toronto Mississauga, Mississauga, ON, Canada; MODEST, Sean, Cape Breton University, Sydney, NS, Canada

Early Permian parareptiles are restricted to a handful of taxa, and include Messoraurus from Gondwana, the bolosaurids Einiosaurus and Bolosaurus from Europe and North America, and the Microleterid Microleter from North America. Microleter was discovered in the Dolse Bross Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia. Numerous new specimens from this locality have augmented recently the overall fauna of parareptiles. These include a new, very small parareptile with large, well developed caniniform teeth, several pivotal new specimens of Microleter, the most basal known parareptile from Laurasia. Microleter was discovered in the Dolse Bross Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia. Numerous new specimens from this locality have augmented recently the overall fauna of parareptiles. These include a new, very small parareptile with large, well developed caniniform teeth, several pivotal new specimens of Microleter, the most basal known parareptile from Laurasia. Microleter was discovered in the Dolse Bross Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia. Numerous new specimens from this locality have augmented recently the overall fauna of parareptiles. These include a new, very small parareptile with large, well developed caniniform teeth, several pivotal new specimens of Microleter, the most basal known parareptile from Laurasia. Microleter was discovered in the Dolse Bross Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia. Numerous new specimens from this locality have augmented recently the overall fauna of parareptiles. These include a new, very small parareptile with large, well developed caniniform teeth, several pivotal new specimens of Microleter, the most basal known parareptile from Laurasia. Microleter was discovered in the Dolse Bross Limestone Quarry, Oklahoma, and appears to represent the most basal known parareptile from Laurasia.
histology examined. Tissue types and degrees of remodeling are discussed, and growth lines are used to determine ages at time of death of the individuals. The rate of growth for *Einiosaurus* peaks at about 3-5 years of age, at which time growth slows, suggesting that this may be the age that reproductive maturity is reached. The nature of the bone tissue suggests that growth in *Einiosaurus* is still relatively rapid in even the largest specimens, indicating that a fully adult tuba has not been recovered from the studied bonebed, and this bonebed is biased toward juveniles and subadults. Since the bonebed is a snapshot of a standing herd, the variation dynamics of *Einiosaurus,* such as growth suppression and behavior, are assessed. This information on growth dynamics and life histories of a species has implications for future taxonomic resolution and morphometric studies of ceratopid dinosaurs, and marks the first study on population histology of a large-bodied herbivorous dinosaur.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

**USING SCANNING ELECTRON MICROSCOPY TO RECONSTRUCT FEEDING ECOLOGY IN GROUND SLOTHS**
RESAR, Nicholas A., Kent State University, Kent, OH, United States; GREEN, Jeremy L., Kent State University at Tuscarawas, New Philadelphia, OH, United States

Understanding the paleoecology of extinct xenarthrans, such as ground sloths, is complicated because they lack modern ecological analogues. Previous studies have applied functional morphology and biomechanical analyses to reconstruct the diet and lifestyle of ground sloths, yet the application of dental microwear as a proxy for feeding ecology in extinct xenarthrans remains understudied. Here, we hypothesize that dental microwear patterns can be used to reconstruct dietary niche partitioning among extinct ground sloths, thereby providing new evidence of feeding ecology in these animals. In this study, 17 two-dimensional scans of 5 taxa [*Megolonyx, Acroacetus, Thinobidastes, Octodontotherium, Hapalops*] were made and cast for dental microwear analysis. Using scanning electron microscopy, two non-overlapping digital images of microwear on the occlusal surface of each tooth were captured at 500X magnification. In a blind study, each image was independently analyzed using the semi-automated software package, Microwear 4.02, which allows microwear features to be digitally counted and measured. To examine the reproducibility of results, both intra- and interobserver error in microwear feature recognition was statistically assessed for two independent observers. As a baseline for reconstructing paleodiet, ground sloth microwear patterns were directly compared to microwear from living tree sloths and armadillos, which were analyzed in a separate study using the same experimental design. Results suggest that ground sloths can be statistically differentiated based on a combination of the number of scratches and width of features. Number of scratches and feature width suggest that *Megolonyx* and *Thinobidastes* form the ends of the browser-grazer spectrum, respectively. Additionally, *Acroacetus* and *Octodontotherium* are here predicted to be mixed feeders, while *Hapalops* appears to be a grazer. These results support scanning electron microscopic analysis of dental microwear as a tool for reconstructing paleodiet in ground sloths. Further investigations should focus on South American ground sloths to allow direct comparison with other methods of dietary ecology in extinct xenarthrans.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

**CHRONOLOGICAL AND BIOSTRATIGRAPHIC FRAMEWORK OF THE LATE JURASSIC IN Vertebrates FROM SOUTH AMERICA**


The chronostratigraphy of Late Jurassic vertebrates from Portugal, including those from the Lourinhã Formation, which is known for its rich vertebrate fauna, is poorly understood due to the continental nature of the sediments and the diachrony of the lithostratigraphic units. Recent results using Sr⁸⁷/Sr⁸⁶ isotope combinations identified the Kimmeridgian-Tithonian boundary (150.8 Ma) in the Lusitanian Basin central sector. This boundary, within a marly layer representative of the more southerly limestone Farta Pó Formation, lies within the silicilastic Lourinhã Formation and is assumed to be the transgressive upper Kimmeridgian -lower Tithonian event. The most productive vertebrate-bearing Upper Jurassic formations in Portugal are: the Alcofração Formation, Lourinhã Formation (divided into the Amoreira-Porto Novo, Sobral, Bombarral, and Freixial (pars pro toto) members), and the Porto da Calada Formation. The chronostratigraphic range (given by biostratigraphy, eustatic curves, general regional context, and calibrated by strontium isotope curves) for important Portuguese specimens of chelonians, pterosaurs, dinosaurus, and crocodylomorphs, and other reptiles as is follows:


Late Kimmeridgian (Lourinhã Formation, Amoreira-Porto Novo Member): *Selenemys lusitanica*, *Plesioschelys sp.*, *Ctenognathus reedi*, *Lusitanisuchus mitrocostatus*, *Rhamphorynchus sp.*, *Dragopelta zylowski*, *Miragaia longicollum*, *Trimucronodon cuneatus*, *Camptosaurus aphanocephalis*, *Dineothereus lourinhanensis*, *Turiasaurus sp.*, *Ceratosaurus nasicornis*, *Toryosaurus aff. wanneri*.  


Early Tithonian (Bombarral Member): *Plesioschelys sp.*, *Allosaurus europaeus*, *Dracoxyns lourenco*, *Stegosaurus sp.*  

Late Tithonian (Freixial Member): *Plesioschelys sp.*, *Theriosuchus sp. B*, *Orthopodophora sp. B*.  

Around the Tithonian/Berriasian boundary (Porto da Calada Formation): *Stegosaurus sp.*  

Despite the fragmentary occurrences of certain taxa, the chronology of some vertebrae seem to be age-restricted, and can thus be used for biostratigraphy. There is a peak of vertebrate fossil diversity and abundance near the Kimmeridgian/Tithonian boundary and a decline towards the end of the Tithonian. Is not yet understood if such trend represents true diversity/abundance in the Jurassic or if it is caused by any geologic and taphonomic bias.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

**CHONDRICHTHYS IN THE CARBONIFEROUS OF THE BRITISH DERBYSHIRE PEAK DISTRICT**

RICHARDS, Kelly R., University of Cambridge, Cambridge, United Kingdom; CLACK, Jennifer A., University of Cambridge, Cambridge, United Kingdom

Productive Carboniferous marine deposits are found worldwide, including sites in North America, Poland, Russia, Belgium, Iran and Britain. Recent work in the Derbyshire Peak District of Britain has established a diverse chondrichthyan fauna, comparable with the rich diversity of well-preserved Devonian chondrichthyans from the Rhynie chert. The fauna is known for a typical and varied invertebrate fauna. Additionally, the vertebrate and scales of palaeosoric actinopterygians have been recorded and previous reports of the Derbyshire chondrichthyan documented twenty five species, with recent publications adding a further seven species. In this study, limestone material representing four localities was collected. Two of these have been documented to contain chondrichthyan remains and two are unreported localities, all localities are within ten km of each other. The material was acid digested and mechanically prepared and the micro and macro fossils were recorded. The microfossils typically consist of teeth, scales and dermal denticles, the macrofossils include teeth, a large fin spine and also, in the two new localities, a variety of skeletal material ranging from partially articulated to fragmented. The skeletal material includes several jaws, endocerital material, a scapulocoracoid and a probable pelvic fin arrangement including a clasper attributed to *Amonkiton zangeri*. The microfossils recovered and identified increase the known diversity of the Derbyshire palaeoecosystem by at least 9 taxa, including several taxa unknown from Derbyshire, such as *Amonkiton zangeri*, *Harpacodus dentatus*, *Heslerodus divergens* and *Mesmodus*, or Europe, such as *Belantexa montana*, *Bransonnella nebraskensis* and ‘*Deana wangi*’. Our data show that chondrichthyan microremains dominated three of the four near-shore sites- chondrichthyan represent two thirds of all micromerein in the combined localities- and that the Derbyshire localities share many taxa with the localities in North America, such as *Bransonnella nebraskensis*, *Heslerodus*, *Fissodus*, *Leiodus* and *Squatinactis*; and with localities across Europe, such as *Amonkiton zangeri*, *Denea*, *Thrinacodus*, *Petocharis* and *Ordodus*. The data collected from a short sequence of cyclical biozones, one of the localities expose faunal changes on a shorter timescale. The persistent occurrence of particular taxa such as *Deana*, *Squatinactis*, *Harpacodus*, *Petocharis* and *Bransonnella nebraskensis*, through the different localities reflects a close palaeoecological relationship between the study sites. We use data from existing boreholes in order to assess the relative importance of the temporal and spatial relationship between the localities.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

**LATE PLEISTOCENE GIANT BEAVERS: THE PARALLEL EVOLUTION OF GIANT SIZE AND RIDGED ENAMEL IN TWO SPECIES**

RINALDI, Caroline E., University of Missouri-Kansas City School of Dentistry, Kansas City, MO, United States; MARTIN, Larry D., University of Kansas Natural History Museum and Department of Ecology and Evolutionary Biology, Lawrence, KS, United States; COLE, II, Theodore M., University of Missouri-Kansas City School of Medicine, Kansas City, MO, United States; KUMAR, Vandana, University of Missouri-Kansas City School of Dentistry, Kansas City, MO, United States

Skulls of two similar, but morphologically distinct, giant beavers from the late Pleistocene were studied using high resolution cone-beam computed tomography (CT). One specimen is from eastern Kansas and is assigned to *Castoroides ohiosiensis*. The other specimen is from the Cooper River of South Carolina and is currently assigned to *Castoroides leiseyorum*. The basicranium of *ohiosiensis* is characterized by a unique ladel-shaped depression in the braincase and bone called the mesopygoid fossa. This unusual morphology is similar to that of the Pliocene beaver, *Procastoroides* sp., from the Broadwater Formation of Nebraska; however, the skull of *P. sweeti* is much smaller and the enamel of its incisor teeth do not have the ridges characteristic of late Pleistocene species. The late Pleistocene specimen referred to *C. leiseyorum* lacks a mesopygoid fossa as does the early Pleistocene material from the type locality (Leisey Shell Bed), although the holotype is much smaller. Despite their differences, both late Pleistocene beavers are characterized by a choma that is divided into dorsal and ventral passages, a feature unique among mammals. In both
A NEW HALITHERINE DUGONGID FROM THE EARLY MIOCENE OF ORANGE COUNTY, CALIFORNIA

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A new halitherine dugongid from the Vaqueros Formation in Orange County, California, USA, is the first specifically identifiable occurrence of an early Miocene sirenian from the eastern North Pacific. This specimen is one of several other sirenian individuals from this formation and the only one so far, to include a partial skull in addition to associated ribs and vertebrae. The specimen is a halitherine dugongid as it displays well-developed, dorsoventrally flattened vertebral processes, and a row of the premaxillae that are thin and tapering at their posterior ends, absence of a nasal incisure at the posterior end of the mesorostral fossa and large nasals that meet along a midline suture. It stands out among known Neogene halitherines in its smaller dimensions and in the morphology of the nasal bones, which display the plesiomorphic condition otherwise seen in some late Eocene and early Oligocene taxa. This unique combination of characters suggests that the Vaqueros has preservation as a new taxon. The roughly contemporaneous record of sirenians in the eastern North Pacific is from the Nye Mudstone of Oregon and was the previously known earliest occurrence of sirenians in this region. The Nye Mudstone dugongid is also a relatively small taxon, but does not share diagnostic elements with the Vaqueros halitherine, thus preventing further comparison between the two.

The Vaqueros Formation in Laguna Canyon of the San Joaquin Hills of Orange County, California, has yielded a diverse and unique assemblage of early Miocene marine mammals. Arkareean/Hemingfordian transitional terrestrial mammals and paleomagnetic dates bracket the fauna as Burdigalian in age. Thus, the Vaqueros Formation has currently produced some of the earliest sirenians from the early Miocene in the eastern North Pacific and the first specimen that can be identified to the specific level.

Technical Session XVI (Saturday, October 20, 9:30 am)

PALEOBIOLOGY OF PREVIOUSLY UNEXAMINED DIRE WOLVES (CANIS DIRUS) FROM THE EARLIEST EXCAVATIONS OF THE LA BREA TAR PITS

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The earliest excavations of the late Pleistocene fossil deposits at the La Brea tar pits in southern California were led by J. C. Merriam of the University of California, Berkeley. From 1906 to 1915, nearly two million specimens of large animals were collected from the tar pits and divided between the Hancock Collection of the Los Angeles County Museum of Natural History (LACM) and the collections of the University of California Museum of Paleontology (UCMP). The extinct dire wolf, Canis dirus, is one of the best represented animals from La Brea. However, the paleobiology of the dire wolf at La Brea has been described only on specimens from the LACM’s Hancock Collection and more recently excavated Rancho La Brea Project Collection, while the material held in the UCMP has remained largely unexamined for the last century. Here, we present the first quantitative study of morphological variation in dire wolves from this neglected collection of material from La Brea. Linear measurements of size were taken from fifty-eight left femora and the postcranial elements of fifty unarticulated left dentaries. Shape variation was also quantified for thirty-eight adult crania using a three-dimensional geometric morphometric approach. Principal component (PC) analysis of cranial shape variation indicates that the greatest dimension of variation contrasts wide canina with dorsally angled rostra and narrow crania with ventrally angled rostra (PC1=16%). Cranial shape also varies in the posterior extension of the premaxilla and anterior extension of the frontals along the nasals with decreasing zygomatric width (PC2=13%), as well as in the relationship between faciail width and length (PC3=18%). Interestingly, the shape variation represented by the first three PCs (and the amount of variation accounted for by each PC) is nearly identical to that found in a sample of 120 recent gray wolf caninas (Canis lupus). Despite body size differences between the two species, the similarities in cranial shape variation suggest that the gray wolf could potentially be used as a proxy for the dire wolf. Differences of cranial centroid size, femoral size dimensions, and individual tooth size dimensions do not indicate sexual dimorphism in this sample, with the possible exception of the width of the greater trochanter. Average body mass, estimated from femoral shaft circumferences, was found to be 61.24 kg with a range of 43.05-85.31 kg -- a slightly higher average value and wider range than that previously reported for western dire wolf populations. These data show that more extreme forms existed than were previously described. These differences could be due to greater geographic or temporal variation within the sample, but are not due to greater sampling effort.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

FIRST DESCRIPTION OF THE TALAR MORPHOLOGY OF PSEUDOLORIS PYRENAICUS (OMOMYIDAE, PRIMATES) AND IMPLICATIONS FOR ITS LOCOMOTOR BEHAVIOUR

ROIG, Inma, Institut Català de Paleontologia, Cerdanyola del Vallés, Spain; MOYÀ-SOLÀ, Salvador, Institut Català de Paleontologia, Cerdanyola del Vallés, Spain

The omnid Pseudoloris pyrenaicus from the Rocabian (middle Eocene) locality of Sant Jaume of Frontanyà 3C (MP14-15; Eastern Pyrenees, NE Spain) has been recently described on the basis of the most abundant dental sample of this genus found until now in the Iberian Peninsula. Additionally, this level has also yielded some postcranial elements of P. pyrenaicus. Here, we describe for the first time the morphology of the tali of this genus and compare it with other fossil and living primates. We emphasize those talar features that have proven useful in reconstructing higher-level primate phylogeny and discuss the osteological features that reflect functional attributes related to locomotor behaviour. We calculated the body mass of P. pyrenaicus in 80 g using the multivariate regression equation (“the proximial model”) based on the crown areas of the cheek teeth. The tali of P. pyrenaicus exhibits a suite of features that are primarily found in extinct and extant haplorhines (e.g., a vertically oriented articular lateral facet for the fibula, a plantar groove on the posterior trochanter shelf for the hallucis longus muscle and a shallow medial talo-tibial facet) and in omomyids (e.g., a moderate talar neck angle, a moderately high talar body, a small posterior trochanter shelf and a relatively narrow talus body). These characteristics are consistent with the haplorhine-like dentition characterizing Pseudoloris. From a functional point of view, the combination of a high talar body with some degree of development of the posterior trochanter shelf, the elongation of the talar trochlea and the trochlear rims with a similar degree of height, are features supporting the hypothesis that leaping was an important component of the locomotor behaviour of P. pyrenaicus. According to this, the locomotion of P. pyrenaicus may have been similar to that inferred for other omomyids.
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ONTOGENY OF THE BRAIN ENDOCASTS OF OSTRICHES (AVES: STRUTHIO CAMELUS), WITH IMPLICATIONS FOR INTERPRETING EXTINCT DINOSAUR ENDOCASTS
ROMICK, Cheyenne A., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

The study of brain evolution in the fossil record typically uses the cranial endocast (the internal surface of the braincase) as a proxy for the brain itself. Computed tomographic (CT) analysis has revolutionized the field, and digital endocasts are now available for many extinct and extant species. A component missing from these recent studies, however, relates to ontogenetic changes in the endocast, compromising the interpretation of endocasts from presumably juvenile dinosaurs. Our lab has previously studied endocast ontogeny in alligators, and this project presents a comparable ontogenetic study in ostriches (Struthio camelus), which are basal members of the avian limb of the extant phylogenetic bracket of nonavian dinosaurs. This study provides the densest ontogenetic sampling for any palaeognath bird to date: nine ostriches, including two embryos, neonatal chicks, juveniles 2–4 months old, as well as young and fully mature adults. All specimens were subjected to microCT scanning (45 and/or 90 micron voxels). Digital endocasts of the brain cavity, inner ear, and neurovasculature were generated for all specimens using the 3D visualization software Avizo 7. Additionally, some of the specimens were soaked in an iodine/potassium-iodide solution to stain the neural and other cephalic soft tissues. These heads were subsequently resliced and the iodine-stained brain tissues were segmented to compare the osteologically-based endocasts with the actual brain tissue. One two-month-old specimen also was subjected to radio-opaque vascular injection to assess how blood vessels impact the endocast. The results of the comparison of the iodinated brains with bona endocasts confirmed that the endocast is a fair approximation of the surface structure of the brain at all ages, which differs from the finding in alligators in which the endocast becomes progressively more like during embryogenesis. Ontogenetic changes in brain growth include relative expansion of the cerebral hemispheres, greater prominence of the Wulst (hyperstriatum, associated with visual processing), and relative contraction of the cerebellum, among others. Some structures, such as the optic tectum, change relatively little in general proportions. In general, the cranial endocast becomes much more detailed during ontogeny, such that neural and vascular structures become increasingly apparent and discrete. The ontogenetic findings broadly correlate with phylogenetic trends in the cranial endocasts of Theropoda as a whole, and shed light on the interpretation of the endocasts of presumed juveniles in certain dinosaur clades (e.g., tyranosaurids), some of which appear to follow ontogenetic trends more characteristic of alligators than ostrich.

Technological Session XVIII (Saturday, October 20, 2:45 pm)
INNER EAR ANATOMY OF LEPTICTIDIDAE AUERDENERI (LEPTICTIDAE, MAMMALIA) REVEALS HIGHLY AGILE LOCOMOTION
RUF, Irina, Steinmann Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany; VOLTAP, Virginie, Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany; BILLET, Guillaume, Steinmann Institut für Geologie, Mineralogie und Paläontologie, Universität Bonn, Bonn, Germany; DE MUZION, Christian, Département Historie de la Terre, Muséum National d'Histoire Naturelle, Paris, France; LEHMANN, Thomas, Abteilung Paläoanthropologie und Messelforschung, Forschungsinstitut und Naturmuseum Senckenberg, Frankfurt am Main, Germany

Leptictidinae are basal insectivorous placental species comprising with highly specialized postcranial features. Among these Leptictididae from the middle Eocene of Messel (Germany) is considered to be very agile with a bipedal salutary locomotion as indicated by its very short forelimbs and extremely elongated hind limbs and tail. Agility and locomotor behavior can also be investigated from the shape of the semicircular canals of the inner ear bony labyrinth, which are involved in detecting angular acceleration of the head. As clearly demonstrated by former studies the size of the semicircular canals in mammals correlates with body mass and agility. Here we provide the first insight into the inner ear anatomy and morphometry of Leptictididae represented by Leptictidium auerdeneri, the smallest of the three species known from Messel. High resolution computed tomography scans were used for preparing reconstructions of virtual 3D models of the bony labyrinth. The morphology and morphometry of the bony labyrinth in Leptictidium auerdeneri were compared with those of the extant therian species from the Oligocene of North Dakota referred to Leptictis lakotensis. Though Leptictidium resembles Leptictis in much of the skeleton except limb proportion, the locomotion of the latter is supposed to be mainly quadrupedal. The general morphology of the bony labyrinth reveals that both species have a prominent secondary crus commune which is a primitive mammalian character. The cochlea of Leptictidium shows almost 2 turns and a secondary bony lamina is not present. Leptictis has 2.25 cochlear turns and a short but distinct secondary bony lamina. Both species have thin and prominently auricated semicircular canals, but those of Leptictidium are relative larger than in Leptictis. The mean size of the radii of the semicircular canals was plotted against the geometric mean of the body mass in a regression analysis taken from literature and comprising 210 therian species. Leptictidium clusters with other highly agile mammals and has much larger semicircular canals than most similar sized species. In contrast Leptictis plots below the regression line closer to slow moving species. Complementarily, we also estimated the agility scores of the semicircular canals. The agility scores of Leptictidium range from 4.5 to 5.5, which indicate a medium to medium-fast moving animal. Its highest scores fall into the range of extant salutary mammals supporting the hypothesized very agile and salutary locomotion. Conversely, Leptictis has much lower agility scores (3.5-3.7), which refer to a medium-slow to medium speed of locomotion and correspond to the scores of most extant mammals comprising more general types of locomotion (terrestrial, cursorial, scansorial, arboreal, semiaquatic).

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
THE VERTEBRAL COLUMN OF THE PACYOSTEOMORPH ARTHODIRE DUNKLEOSTEUS TERRELLI
RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; CUMBAA, Stephen L., Canadian Museum of Nature, Ottawa, ON, Canada

The Late Devonian (Famennian) Cleveland Shale of north central Ohio has historically produced an abundance of placoderm and shark specimens. The placoderms are known primarily from head and thoracic shields, with only rare evidence of vertebrae due to their composition and presumed preservational properties. Recently, the most complete segment of vertebral column known for the pacysteomorph arthodire Dunkleosteus terrelli was recovered, along with a partially articulated skull which preserves at least 12 plates and both lower jaws. The specimen, CMNH 50322, is a subadult Dunkleosteus less than 3 m in length. At 20 articulated vertebrae, each measuring approximately 2.5 cm high and 6.7cm long, are preserved in lateral view in a 14.6 cm section. The vertebrae arise on a block of shale which includes the left anterior dorsolateral plate, apparently in anatomical position. The vertebrae nearest the skull are not fused, either to each other or completely around the notochord, leaving a small open space on each side. Each vertebra is composed primarily of a fused neural arch and spine, and a fused haemal arch and spine. The curved edges of the bases of the neural and haemal arches of the anterior 13 vertebrae are ornamented with a series of small, rounded tubercles; some show a double line, with the inner line composed of much smaller tubercles. The five complete posterior vertebrae of the remaining seven exhibit marked structural differences from the anterior portion; the notochordal area appears to be covered with a thin layer of bone, which is considerably fractured. These vertebrae are laterally somewhat expanded, with cup-like structures forming the lateral portion of the bases of the neural and haemal arches; they show no ornamentation. The interpretation of these latter few vertebrae is perplexing. Chondrichthys and some placoderms have a cervicothoracico-scyphoid synarthrosis posterior to the occipital region which fuse vertebrae to each other and enclose the notochord. However, a synarcal is unknown in Dunkleosteus, although it may have been present on a 10 cm portion of the block directly behind the skull that was lost during collection. The preserved vertebrae are located posterior normal healing bites. Perspective that bone pathology is phylogeny-independent in character has been tested and found valid for both recent and fossil reptiles.

WHOLEY SMOKE: BRACKETING AND EMPIRICAL RECOGNITION OF DISEASE IN THE Fossil RECORD, AS APPLIED TO THE TYRANNOSAURUS REX, SUE
ROTHSCHILD, Bruce M., University of Kansas, Lawrence, KS, United States

Confidence in identification of the etiology of bone alterations is enhanced when the same pathology is identified in individual(s) documented to have that disease. That assumes the pathology is not simply an artifact. Recognition of etiological correlation in multiple individuals with a given diagnosis enhances confidence. That approach works when diseases are relatively uncommon. Common pathogens, such as trichomonas, will be occur in the presence of other diseases. Indeed, such parasitic diseases often occur as a triple threat, in association with other two parasites. Trichomonas does not cause those diseases; they are simply common co-occurrences. Trichomonas has been suggested to be the cause of mandibular defects because of presence in a hole-afflicted animal, despite failure to identify any evidence that trichomonas can actually alter bone. Once it is recognized that there is no evidence that bone is affected by that pathogen, the smoke clears and actual etiology can be surmised. This contrasts with healing of trepanation, clearly demonstrated to produce the same holes as observed in the Tyrannosaurus Sue. Healing of human-derived bone defects is analogous to healing of bites, supporting the assessment that the mandibular defects in Sue represent normal healing bites. Perspective that bone pathology is phylogeny-independent in character has been tested and found valid for both recent and fossil reptiles.
to the position that a synural would have occupied, and they would have to have been flipped 180° and moved 10 cm forward to allow for this interpretation. Alternatively, if the vertebrae are approximately in anatomical position, it is possible that these vertebrae either represent a thoracolumbar synural (a second, more posterior fused unit common in myliobatoid chondrichthyans), or that this structural change indicates the beginning of the abdominal region above the pelvic girdle and fin, with the increased bony structure providing protection for the gut.

Preparators’ Session (Thursday, October 18, 10:30 am)

COMPARING IMPRESSION MATERIALS FOR DENTAL MICROWEAR ANALYSIS IN A SMALL FOSSIL MAMMAL

SADOWSKI, K.A., Victoria University of Toronto, Toronto, ON, Canada; MORRISON, Ian, Royal Ontario Museum, Toronto, ON, Canada; SILCOX, Mary T., University of Toronto, Scarborough, ON, Canada

Casting is a common procedure for making high-quality replicas in order to conduct microwear analysis. The goal of this project was to determine the best impression material to create high resolution casts that preserve the pits and scratches present on the original specimen. A range of molding materials was chosen that differed in viscosity and age to determine the effect of these variables in producing a faithful mold. The molding materials used in this study include Coltecn Puddy, President-jet MicroSystem Light Body, and President-jet MicroSystem Regular Body (a batch from 1999 and another from 2011) polyvinylsiloxanes; Rhodia’s RTV 4410 Platinum and RTV 4420 QC food grade silicones; Buehlers V-SIL 1062 silicone and Reflection Patterson Super Hydrophobic Vinyl Polysiloxane Putty. All eight molding materials were used to mold a partial dentary with p4-m3 (USGS 7778) of the primitive microtine Microtus latidens from the early Eocene of the Bighorn Basin, a small (but not tiny) mammal (m2 length ~ 3.8 mm). A shearing facet on the m2 was imprinted in the original specimen, and in epoxy casts made using the various molds. Images were taken using FEO-5000 scanning electron microscope (SEM) and microscopic features were manually counted in Micrastore 4.0 software. The quality of dental surface replication was assessed by comparing the percent features visible in the cast relative to the original enamel surface. The values range from 73.17% for V-SIL1062 to 34.15% for Coltecn Regular body from 1999. Age of the material was found to have an effect, with Coltecn Regular Body from 2011 producing a better quality replica (46.34% visibility of microwear features). Viscosity also had a significant effect. The least viscous molding compound used (V-SIL1062) provided the best resolution, and the Light Body President jet material more faithfully represented microscopic features than the more viscous Regular Body, although the molds made from the Light Body material were quite fragile, so that they were unsuitable for repeated casting. The most commonly used molding material for microwear studies, Coltecn Regular Body, performed comparatively poorly, although major pits and scratches were preserved, suggesting that it may nonetheless be possible to use casts produced with this impression compound to make general statements about diet.

Preparators’ Session (Thursday, October 18, 8:45 am)

IMPROVING CURATION AND CONSERVATION STANDARDS AT THE VERTEBRATE PALEONTOLOGY LABORATORY THROUGH INTERDISCIPLINARY APPROACHES

SAGEBEL, James C., The University of Texas at Austin, Austin, TX, United States; BROWN, Matthew A., The University of Texas at Austin, Austin, TX, United States

The history of the collections at the Vertebrate Paleontology Laboratory (VPL) of the Texas Memorial Museum spans more than one hundred years. This history is tied to both famous names in vertebrate paleontology and the histories of many other institutions. Preventing and mitigating the loss of archival data, historic documents and photographs, as well as the specimens themselves are the focus of recent conservation efforts by the VPL collections staff. Although interest in preserving documents, photographs, and digital data related to the fossil collections is high, the small permanent staff of VPL faces a number of constraints familiar to most natural history curators and conservators – limited space, limited time, staff and training. Our approach over the past year has been to exploit the resources from our larger campus and museum community. We have targeted resources on our own university campus by first defining our collections care priorities. The photographs and documents held by VPL are a high archival value resource. However, this archive has only recently been organized. Documentation within the VPL collection itself is another source of hidden archival riches. However, these documentary materials (as well as the specimens) have suffered from gross variations at all levels in storage conditions and treatments. Field notes and photos are critical to interpretation of fossil materials; likewise, documentation of the provenance of specimens is crucial to collections management. By stressing to our students, faculty, and staff that the documentation of specimen treatments are essentially part of the specimen, we are improving this situation. VPL curatorial staff found willing partners in our conservation efforts through the University of Texas at Austin’s Harry Ransom Center and School of Information. By working with these campus units, we have found not only a wealth of opportunity for expanding our own expertise, but also potential funding and qualified personnel. Our retrospective effort to conserve archives is informing our present curatorial practices and procedures. Documentation of the collections is expanded to include curatorial methods and materials. Materials and practices for storage are more consciously considered. These efforts are also receiving greater emphasis among the students who are the most frequent users of the VPL.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

QUATERNARY BATS FROM SERRA DA MESA (BRAZIL): HUMERAL REMAINS AND TAXONOMIC ASSESSMENTS

SALLES, Leandro O., Museu Nacional, Rio de Janeiro, Brazil; CARLOS, Moraes Neto R., Museu Nacional, Rio de Janeiro, Brazil; LANZELOTTI, Wagner, Museu Nacional, Rio de Janeiro, Brazil; PERINI, Fernando A., American Museum of Natural History, New York, NY, United States; SIMMONS, Nancy B., American Museum of Natural History, New York, NY, United States

The fossil record of bats from the Quaternary era of Serra da Mesa (Brazil) is here documented with 231 humeral fragments collected in three limestone caves, displaying stratigraphic profiles covering a timeframe of approximately 25,000 BP (unpublished C14 data). Serra da Mesa is a karstic region in the middle of Brazilian savannas (Cerrado Domain), located in the State of Goias. This material is being studied as part of a research program focused on the patterns of variation in the morphology of the humerus in the order Chiroptera. The identification of the material so far reveals an especially rich paleofauna of bats. It includes 22 genera, with potentially another 4, which are identified up to this point as incertae sedis; and 37 species (22 determinate, 15 under investigation), belonging to 5 families (the parentheses denote number of fragments followed by an indication of the status of the taxon as fossil (F) or recent (R) record for the bat fauna of Serra da Mesa): Phyllostomidae, Desmodontini – Desmodus rotundus (5); Glossophaginae, Glossophagini – Anoura cf. geoffroyi (2), Glossophaga soricina (3) (F), Desmodus rotundus (10), cf. Glossophaginae (1), Lonchophyllini – Lonchophyllus sp. (5); Phyllostominae – Lonchorhina sp. (22), cf. Lophonotus (1), Macronycteris macrophyllum (1) (F), Micronycteris sp. (1), cf. Micronycteris (1), Minom cf. bennettii (6), Minom cf. crenulatum (1), Phyllostomus discolor (2), Phyllostomus hastatus (16), Phyllostomus sp. (1), Trachops cirrhosus (1), Phyllostomina inc. sedis 1 (5), Phyllostomina inc. sedis 2 (2) (Carollia - Carollia castanea (1) (F&R), Carollia perplicatulata (2) (F), Sturnedontinae, Sturini – Sturini sp. (5), Sturnidae – Artibeus cf. fraterculus (1) (F&R), Artibeus jamaicensis (3) (F), Artibeus sp. (1), cf. Artibeus (1), Platyrhinus cf. Helleri (1) (F), Vampyrum coracilloides (1) (F&R), cf. Stenodermatinae (1); Mormoopidae – Pteronotus gymnotrachelus (28) (F&R), Pteronotus parnellii (75); Furipteridae – Furipterus horrens (1) (F); Natalidae – Natalus stramineus (20); Molossidae, Molossinae – Nyctinomops cf. laticaudatus (1) (F&R); Vespertilionidae, Vespertilionini – Histiotus sp. (1) (F&R); Myotidae – Myotis albescens (1) (F), Myotis riparius (1) (F). Six taxa were not recorded previously for the extant fauna of the region. Some material, such as a Macrotrus-like humerus, may represent new taxa, while others represent the first fossil records for the Brazilian territory and the South American continent. We conclude highlighting the potential of bat humeri as a source of character information for taxonomic and phylogenetic studies.

Technical Session III (Wednesday, October 17, 4:00 pm)

SKULL SHAPE REFLECTS LOCOMOTOR ECOLOGY IN RODENTS AND CARNIVORANS

SAMUELS, Joshua X., John Day Fossil Beds National Monument, Kimberly, OR, United States

The postcranial morphology of mammals has been shown to reflect cursorial, aquatic, arboreal, and fossorial locomotor habits. In the fossil record relatively complete postcrania are uncommon, while well-preserved skulls exist for many taxa. Features of the cranium, particularly the orientation of the orbits, have also been demonstrated to be linked to locomotor ecology. This study examines how skull shape, particularly the size and orientation of sensory structures, reflects locomotor habits in two ecologically diverse orders of mammals. Digital photographs of over 800 skulls, from 153 rodent and 54 musteloid and arctoid carnivore species, were analyzed using geometric morphometric methods. Results of relative warps analyses reveal some convergence in skull shape associated with locomotor ecology, as well as some distinct differences in herbivorous and faunivorous taxa. Semi-aquatic carnivores and rodents both display a broad and deep rostrum with elevated nasals and enlarged external nares. This position would allow the animal to breathe while most of the body is submerged and accommodates enlarged maxilloturbinate associated with thermoregulation. Semi-aquatic herbivores display elevated orbits and external acoustic meatuses, which allow them to see and hear predators out of the water while submerged. Arboreal species display enlarged and more convergent orbits, allowing larger binocular visual fields. This is more pronounced in arboreal faunivores than herbivores, possibly due to pressure for a wider field of view in prey species. Saltyard rodents show enlarged orbits and auditory bullae; this reflects their nocturnal habits, their dependence on binocular vision for locomotion, and enhanced hearing for detection of predators. Fossorial species show reduced orbit size and enlarged auditory bullae, likely reflecting increased reliance on hearing to detect predators and prey. Canonical analysis classification of species ecology by skull shape was very accurate, greater than 90% correct for both carnivorans and rodents. Mammalian phylogenetic and environal predictions within Coleoptera, Mammalia, and Eutheria. Artiodactyla revealed the potential of bat humeri as a source of character information for taxonomic and phylogenetic studies.

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The marsupial-placental dichotomy revisited: The relevance of geography and physiology on evolutionary patterns of diversity and disparity
Sánchez-Villagra, Marcelo R., University of Zurich, Zurich, Switzerland

Placental mammals occupy a larger morphospace and are taxonomically more diverse than marsupials, as shown by quantitative and phylogenetic studies of several character complexes and clades. This pattern holds when considering the rich ecomorphological diversity of fossils. The contrasting evolutionary path of therian clades has been coupled with a bias introduced by marsupials’ developmental features, including lack of fetal-maternal intimacy, general altriciality and functional requirements around birth. But the relevance of life history features in imposing constraints on the evolution of morphological features, such as those in the appendicular skeleton, is at best speculative. There are numerous cases of circumvention of developmental biases in morphological evolution, such as the autopodial specializations of moles. This and other examples as well as the common decoupling of morphogenetic events from adult anatomy in several groups of organisms and character complexes suggest that other factors produced the pattern of restricted morphospace in marsupials. A review in the literature on phylogenetic and geographic data for fossil and living species and the physiology in living forms offer new insights on this issue.

At many time and places in geological history, metatherians have been more diverse than eutherians or at least as diverse as the latter, as documented in Cretaceous and Paleogene faunas. Furthermore, there are no positive tests of competitive displacement of metatherians by eutherians. The diversification of Marsupialia and that of the major clades within it occurred about 20 myr. more recently than that of Placentalia and its ‘orders’. The geographic pattern of taxonomic and morphological diversity within Placentalia mirrors that of placentalia as a whole versus marsupials: northern clades are more diverse (ca. 4,800 spp.) than southern ones (200 spp.) and include those that are outliers in taxonomic (rodents; bats) and ecomorphological (whales; bats) richness. This pattern suggests that the largely restricted distribution of marsupials in southern continents after the Cretaceous must have played a decisive role in their diversification.

Physiological features are a likely source of biases in the evolution of marsupials, as shown by past macroevolutionary patterns that followed conditions imposed by global temperatures at the Eocene-Oligocene boundary. The apparent lack of brown adipose tissue and the close tie of metabolism with food consumption make marsupials more vulnerable to climate change. In general, the differential diversity and disparity among therians is more a reflection of ‘opportunity’ than one of biases in the production of morphological variants during their development in marsupials.

Cervical rib histology of sauropod dinosaurs functions in the muscular control of the neck
Sander, P. Martin, University of Bonn, Bonn, Germany; Klein, Nicole, University of Bonn, Bonn, Germany

Cervical ribs were an integral part of the anatomy of the neck of sauropodomorph dinosaurs. Prosauropods such as Plateosaurus show extremely elongated, posteriorly directed ribs that span more than one intervertebral joint, depending on the position in the vertebral column. This condition is retained in most sauropods except for Diplodocidae which have autapomorphically shortened ribs that do not span more than one intervertebral joint at most. Two competing hypotheses address the function of the elongate cervical ribs of sauropods. One views them as ventral bracing elements taking up compressive force, and the other interpreting them as tensile elements integrated into the muscle-tendon system of the neck. We used bone histology to test these hypotheses, sampling the cervical ribs of Diplodocus and Brachiosaurus in serial sections along their entire length as well as fragmentary cervical ribs of some other sauropods. In addition, we studied the histology of ostrich cervical ribs. Except for the region of the capitulum and tuberculum, the primary bone of the entire ribs is metabolically ossified tendon, including the anterior process of the Diplodocus rib. This is the situation in the ostrich as well. Only the region of the rib heads shows the normal periosteal bone seen in the dorsal ribs of sauropod dinosaurs. The primary metaplastic bone is made up of tightly packed fiber bundles that are surrounded by a fibrous sheath. Bundle orientation is strongly longitudinal. This histology indicates that the posterior shafts and anterior processes of sauropod cervical ribs are ossified tendons that may have been part of the ventral m. longicollis system. The lack of radially oriented fibers argues against the long overlapping cervical ribs having been bound into a tightly interconnected rod but is consistent with these ribs having slid past each other during neck movement. The hypothesis of a ventral bracing function for the cervical ribs of both long-ribbed and short-ribbed sauropod dinosaurs thus can be confidently rejected. Instead, the extremely long ribs may have allowed a caudal shift of the heavy musculature operating the neck, as seen in some birds. This would have decreased the mass of the anterior and middle parts of the neck, contributing to lightening of the neck in addition to its extensive pneumatization.

Ontogenetic, behavioral and evolutionary considerations of cranial polymorphism in early oligocene Aegyptopithecus zeuxis (Catarhinini, primates)
Sander, William J., University of Michigan Museum of Paleontology, Ann Arbor, MI, United States; Gunnell, Gregg F., Division of Fossil Primates, Duke Lemur Center, Duke University, Durham, NC, United States

Abundant remains of the early Oligocene stem catarrhine primate Aegyptopithecus zeuxis demonstrate that it is a sister taxon to cercopithecoids and hominoids. Extreme sexual dimorphism in Aegyptopithecus is marked by non-overlapping ranges of postcanine tooth size, exceeding that in extant hominoids, and strong contrasts in canine dimensions, consistent with polygyny. Among anthropoids, diverse forms of polygyny have different morphological correlates and varied ecological and genetic consequences. A diminutive female Aegyptopithecus cranium lacks occlusal crests typical of male specimens and is only 57% as large as an age-grade series of adult male crania. External and CT-scan measurements show substantial age-related differences between male crania in facial dimensions and extent of maxillary sinuses, revealing that growth continued throughout adulthood, consistent with contrasts in timing of skeletal maturity in males versus females.

Bimaturation in Aegyptopithecus exaggerated differences between males and females, but even young males have larger crania than females, indicating that dimorphism resulted from sex-based variance in both rate and duration of growth. This suggests single-male polygyny, in which older, high-ranking males competed intensely for access to multiple females and younger males were marginalized. Extreme single-male polygyny and bimaturation generally are believed to be highly derived among catarrhines, exemplified in orang-utans and mandrills, in which adult sexes are hormonally suppressed in young males in the presence of larger, ornamented males. Cranial ontology in Aegyptopithecus resembles bimaturation in the early hominid Paranthropus robustus, whose males underwent progressive facial growth throughout adulthood to attain hyper-male morphology. As cranial size increases in Aegyptopithecus, upper facial growth is negatively allometric, mid-facial changes are isometric, and lower facial growth is positively allometric; maxillary sinuses and the posterior maxilla expand substantially. These trends characterize the inferred morphological transformation between increasingly larger Aegyptopithecus-mid Oligocene Sauadanius-early Miocene Afropithecus, associated in the latter with canine hypertrophy. This transformation was not due solely to extended or accelerated growth, as facial angulation increased with size in Aegyptopithecus, but conversely became more acute in the later taxa. The results indicate that the common ancestor of crown catarrhines was highly sexually dimorphic and polygynous, and that the use of non-dimorphic extant taxa in the reconstruction of the ancestral morphotype for crown catarrhines is therefore inappropriate.

Something’s fishy: was one of the most abundant latest cretaceous theropods a fish-eater?
Sankey, Julia T., California State University Stanislaus, Turlock, CA, United States

Latest Cretaceous (Maastrichtian) theropod and bird diversity in North America is partly known from thousands of isolated teeth from microvertebrate sites, especially from the rich Hell Creek and Lance Formations in Montana, Wyoming, and North and South Dakota. Based on 500+ theropod and bird teeth from Hell Creek and Lance Formation microsites in Montana, relative abundances of small theropods are: dromaeosaurids (23%), troodontids (6%), and ornithomimids (20%), whereas large carnivores (e.g. Paronychodon, 35%), and Paronychodon (20%), and birds (8%). What is strikingly different compared to earlier sites (late Campanian) is that the Maastrichtian sites contain a high abundance (55%) of two unusual and enigmatic small theropods, Richardoestesia and Paronychodon. However, almost nothing is known about these taxa – what they looked like, what they ate, and why they were so abundant during the Maastrichtian. However, one interesting insight relates to these questions. Because of its straight teeth, R. isosceles may have been a fish-eater. This interpretation fits with the fact that R. isosceles is much more abundant in more coastal deposits such as the Hell Creek Formation compared to more inland deposits. If this is correct, then R. isosceles is the first recognized piscivorous theropod in North America (although this has been inferred for spinosaurs from South America and Africa). This has interesting implications for K/P mass extinctions as it supports the hypothesis that there was disruption in all habitats, both terrestrial and aquatic, during the K/P mass extinction.

Life among the dunes, a lower jurassic “megatrack block” from the navajo sandstone, Glen canyon national recreation area, Utah
Santucci, Vincent L., National Park Service, Washington, DC, United States; Milner, Andrew R., St. George Dinosaur Site at Johnson Farm, St. George, UT, United States; Bithisdel, Tylor A., Grand Staircase Escalante National Monument, Kanab, UT, United States; Clites, Eric C., National Park Service, Page, AZ, United States; Kirkland, James L., Utah Geological Survey, Salt Lake City, UT, United States

A rich and diverse Mesozoic vertebrate ichnofossil record is documented at Glen Canyon National Recreation Area, Utah. Palaeontological resource inventories along the shoreline of Lake Powell have yielded thousands of dinosaur and other vertebrate tracks. In a large block of Navajo Sandstone, containing a well preserved dinosaur trackway, was reported by a family visiting the recreation area. Evaluation of the large block revealed...
the preservation of at least 83 fossil footprints in two distinct track-bearing horizons from interdunal deposits in the lower part of the Navajo Sandstone Formation. The Early Jurassic ichnocoenoses preserved in the block referred to as the “Megalat Block” includes: 10 large ornithopod-like tracks which were likely produced by a theropod; 47 tracks tentatively identified as Grallator, produced by small crocodylomorph theropod dinosaurs; three large theropod tracks showing individual marks; 14 medium-sized theropod tracks that appear to be Phalacrocorax-like in morphology; five smaller unidentified quadraped footprints possibly made by a crocodylomorph; and, 10 unidentified tracks. The ichnoassemblage preserved on the “Megalat Block” sheds new light on the life of the Jurassic Navajo desert.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm) INTRASPECIFIC VARIATION IN THE STYLLAR CUSPS OF DIDELOPHIS VIRGINIANA SARTIN, Catherine E., Johns Hopkins School of Medicine, Baltimore, MD, United States; ROSE, Kenneth D., Johns Hopkins School of Medicine, Baltimore, MD, United States; HORN, John R., University of Utah, Salt Lake City, UT, United States; FARMER, C. G., University of Utah, Salt Lake City, UT, United States

In the fossil record, mammalian taxa are routinely identified on the basis of molar morphology. The presence, absence, size, or unique shape of the first molar or canine can lead to the naming of a new species, even a new genus. The underlying assumption is that these surface features do not vary within species; that these features only vary between species. This study challenges that assumption.

We examined the upper molars of extant Didelphis virginiana from the collections of the Smithsonian Institution, National Museum of Natural History, Division of Mammals. Only molars that showed little to no evidence of wear, whose crown details could be seen relatively clearly and unambiguously, were used in order to avoid confusing wear patterns with morphology. Only specimens that possess a right and left M1 and M2 were used, so that variation within an individual, as well as between individuals, could be assessed for each molar. Specimens were photographed under a light microscope using a standardized procedure. At this time, any variation in the morphology of the stylar cusps was noted. The width of the molar and height of each stylar cusp was measured from the photograph using ImageJ.

Intraspecific variation was found with respect to cusp height (especially Cusps B and C) and cusp morphology (especially Cusp C). Using ANOVA analyses, we were able to detect that the variation between individuals is statistically significant. These variations occurred across the collection localities, as well as across the four subspecies. Interestingly, some of the variations found are reminiscent of characters used to distinguish between taxa in the fossil record. This study forces us to re-evaluate the characters we use to distinguish taxa.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm) TRANSITIONAL TRICERATOPS: DETAILS OF AN ONTOGENETIC SEQUENCE FROM THE UPPER MIDDLE UNIT OF THE HELL CREEK FORMATION, MONTANA SCANNELLA, John B., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; FOWLER, Denver W., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; GOODWIN, Mark B., University of California Museum of Paleontology, Berkeley, CA, United States; HORN, John R., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States

Currently, two species of the latest Cretaceous ceratopsid Triceratops, T. horridus and T. prorsus, are distinguished, in part, by the following cranial morphological features: postorbital horn core length, morphology of the rostrum, closure of the frontoparietal fontanelle, and the length of the epinaul. Recent work in the approximately 90 meter thick Hell Creek Formation (HCF) of Montana confirms that these species are stratigraphically separated. T. prorsus is found in the upper third of the HCF and T. horridus occurs in the lower and middle thirds. A collection of disarticulated skulls represents a range of ontogenetic stages and reveals new cranial characters of the epinaul, nasals, and premaxillae that further distinguish these species. Triceratops recovered from the upper part of the middle third of the HCF (~ 5 meters below the base of the upper third) are morphologically intermediate between T. horridus and T. prorsus, and exhibit a combination of cranial features that characterize each taxon. Targeted collecting of the upper middle HCF has produced a sequence of Triceratops from this stratigraphic zone. These skulls exhibit: (1) elongate postorbital horn cores and a pronounced anterior nasal process, features that are characteristic of Triceratops from the lower half of the HCF; and (2) an elongate epinaul, expanded ascending process of the premaxilla, and deep rostrum that are characteristic of Triceratops from the upper third of the HCF. The absence of autapomorphies in these specimens from the upper middle HCF supports the hypothesis that the evolution of Triceratops was characterized by anagenesis, the morphological transformation of a lineage over time. Interestingly, juvenile skulls and cranial elements from the upper third of the HCF exhibit character states found in more mature individuals collected from lower in the formation. This HCF dataset suggests that morphological variation in Triceratops may be largely a result of heterochrony, indicating that stratigraphic and ontogenetic details are necessary for a comprehensive taxonomic evaluation of non-avian dinosaurs.

Technical Session IX (Friday, October 19, 11:30 am) UNIDIRECTIONAL AIRFLOW AND PULMONARY ARCHITECTURE IN ALLIGATOR MISSISSIPPIENSIS AND THE IMPLICATIONS FOR THE EVOLUTION OF THE AVIAN RESPIRATORY SYSTEM SCHACHNER, Emma R., University of Utah, Salt Lake City, UT, United States; SARRAZIN, John C., University of Utah, Salt Lake City, UT, United States; FARMER, C. G., University of Utah, Salt Lake City, UT, United States

The unidirectional airflow pattern in the lungs of birds has long been considered both characteristically unique; however, the evolution of Triceratops was characterized by anagenesis, the morphological transformation of a lineage over time. Interestingly, some of the variations found are reminiscent of characters used to distinguish between taxa in the fossil record. This study forces us to re-evaluate the characters we use to distinguish taxa.

All over of the world, dinosaurs left their tracks in sediment, the original subsoil, which are observed as fossil footprints today. In this study, we present two theoretical approaches to the prediction of dinosaur weights based on the geometry (i.e. the 3D deformation field) of fossil footprints. The deformation field is the result of the stress state applied to the subsoil by the weight of the dinosaur via its foot, and we use the deformation field to back-calculate this weight by inverse analysis. Since the mechanical behavior of any soil varies with soil type and bedding conditions, the stiffness parameters of the original subsoil have to be back-calculated from the properties of the rock in which the footprint is preserved. Using Micro-CT as well as experimental soil mechanics, we derive subsoil grading properties and original stiffness.

The first theoretical approach estimates the error introduced by sediment compaction, i.e., the difference between today’s track geometry (the fossil footprint) and original track geometry (the footprint left by the dinosaurs when uplifting the foot). Any subsoil stiffness parameter is sensitive to loading path direction and stress level. Therefore, the stress history contributed by the geological surcharge (i.e., the overburden) is taken into account by introducing an equivalent stiffness parameter. The main outcome of this approach is that the weight calculated using only the fossil footprint geometry and neglecting the deformation of the track by compaction of the sediment underestimates the true weight by less than 7%.

The second theoretical approach addresses the problem of undertracks. Fossil footprints as preserved in the field may not represent the original surface on which the dinosaur walked, i.e., they are preserved as undertrack footprints, and therefore may be difficult to use for weight estimates based on deformation fields. For the interpretation of such footprints, it must be kept in mind that stresses and vertical displacements induced by surface loads decline with increasing depth while spreading laterally. Our second theoretical approach allows calculation of the deformation field with increasing depth, and thus the dinosaur’s weight, even by analyzing an undertrack footprint only. We verify our approach by the analysis of two in-situ undertracks well documented in the literature and by additional model tests in the soil mechanics lab.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm) QUANTITATIVE INTERPRETATION OF DINOSAUR TRACKS REVISITED SCHANZ, Tom, Ruhr-Universität Bochum, Bochum, Germany; SANDER, P. Martin, Universität Bonn, Bonn, Germany

All over of the world, dinosaurs left their tracks in sediment, the original subsoil, which are observed as fossil footprints today. In this study, we present two theoretical approaches to the prediction of dinosaur weights based on the geometry (i.e. the 3D deformation field) of fossil footprints. The deformation field is the result of the stress state applied to the subsoil by the weight of the dinosaur via its foot, and we use the deformation field to back-calculate this weight by inverse analysis. Since the mechanical behavior of any soil varies with soil type and bedding conditions, the stiffness parameters of the original subsoil have to be back-calculated from the properties of the rock in which the footprint is preserved. Using Micro-CT as well as experimental soil mechanics, we derive subsoil grading properties and original stiffness.

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Poster Session II (Thursday, October 18, 4:15 - 6:15 pm) A SHARK-BITTEN HADROSAURID FEMUR FROM THE BASAL HORNERTOWN FORMATION, NEW JERSEY, U.S.A.: ONE OF THE YOUNGEST NON-AVIAN DINOSAUR REMAINS KNOWN SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States; POOLE, Jason C., Academy of Natural Sciences of Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

We report the discovery of an isolated left femur (New Jersey State Museum 22688) of a hadrosaurid dinosaur from Gloucester County, New Jersey, U.S.A. The femur is approximately 4.8 cm in length, with a midshaft circumference of 17.8 cm around the fourth trochanter and a minimum shaft circumference of 15.8 cm. The specimen can be referred only to an indeterminate member of Hadrosauridae. The ontogenetic stage of the individual is unclear.
The femur exhibits numerous straight to slightly arched grooves along its entire length, concentrated on the medial and lateral portions of the midshaft. The grooves are generally unpaired, unparallel, and sub-perpendicular to the long axis of the femur, and are consistent with tooth marks created by one or more scavenging sharks. This ‘bloat and float’ hadrosaurid carcase was deposited in nearshore marine deposits in which shark remains are common. None of the tooth marks exhibit serration grooves, and no tooth fragments remain in the femur.

The femur was excavated from the Main Fossiliferous Layer (MFL) of the basal Hornerstown Formation. Various ages have been assigned to the MFL, ranging from latest Maestrichtian, to earliest Danian, and most recently, terminal Cretaceous. Likewise, there are multiple interpretations of the depositional history of the MFL and the taphonomic characteristics of the fossiliferous layer. Whatever the depositional setting, it is clear that these fossils exist very near to, or even in, the K/Pg boundary, making this femur one of the youngest non-avian dinosaur remains known.

Technical Session VI (Thursday, October 18, 2-3:00 pm)

SEMICIRCULAR CANAL DIMENSIONS IN SAUROPODOMORPHA: PALEOBIOLOGICAL IMPLICATIONS

SCHMITZ, Lars, Department of Evolution and Ecology, UC Davis, Davis, CA, United States

SCHMITZ, Ryosuke, Department of Geology, UC Davis, CA, United States

MINZEL, Lars, Steinmann-Institut für Geologie, Universität des Saarlandes, Saarbrücken, Germany

SEMINERIO, Daniel, Departamento de Paleontologia e Estratigrafia, IGeo, UFRGS, Porto Alegre, Brazil

The vestibular system is the sensory system in vertebrates that contributes information about movement and balance. The vestibular system, consisting of the semicircular canals (SCC) and the vestibule, is expected to be preserved for the various bovid species living in grassland, forest and mountainous habitats. The boids preferring three different ecological niches are distinguished in different clusters by plotting the data of the principal components (PC).

To check if the method is just working for boids the long bones of extant horses and relatives (all belonging to the genus Equus) have been measured. All equids are plotting close together within the cluster of grassland preferring boids. This is the case for the PCA based on all long bones together and the PCA's made for the single boid canal. The result for the cannon bones is surprising because the cannon bones of the perissodactyl horses are modified single boids, while the cannon bones of the artiodactyl boids are a fusion of formerly two boids.

The method using just the cannon bone has been tested for different fossil taxa from the Miocene to the Pleistocene. For instance the fossil horse species Hipparion and Equus, are called cannon bones. This term is used in both the fore and the hind leg, and also for the metapodials in extant equids, where the third ray is used for walking.

It is well known, that not only teeth, but also the postcranial skeleton, especially limb elements, are useful to determine habitat preferences. For the presented study the long bones of fore and hind limbs of extant equids and boids have been measured. The log transformed data of all long bones have been analyzed together within a principal component analysis (PCA). The resulting distinguishing different boids makes it possible to distinguish the various boid species living in grassland, forest and mountainous habitats. The boids preferring three different ecological niches are distinguished in different clusters by plotting the data of the principal components (PC).

Technical Session VI (Friday, October 19, 10:45 am)

GLOSSY FEATHERS AND NOCTURNAL ACTIVITY: INFERENCE OF MICRORAPTOR FEATHER COLORS USING A PHYLGENETIC FRAMEWORK

SCHMITZ, Lars, Department of Evolution and Ecology, UC Davis, CA, United States

SCHMITZ, Ryosuke, Department of Geology, UC Davis, CA, United States

BARRIENTOS, Anthony, Department of Geology, UC Davis, CA, United States

BARRIENTOS, Anthony, Department of Geology, UC Davis, CA, United States

SCHMITZ, Lars, Department of Evolution and Ecology, UC Davis, CA, United States

Glossy feathers are an advanced avian feature that provide testable models of trait inferences in fossil vertebrates, a rapidly growing area in paleobiology. In the midst of this trend a new technique has been developed to make retrodictions of feather colors in dinosaurs. This technique relies on exquisitely preserved melanosome structures in fossil feathers that record information about color. However, current interpretations do not account for phylogenetic bias and thus may potentially be misleading.

In order to test whether the use of non-phylogenetic methods is justified, we developed a time-calibrated phylogenetic hypothesis for all 118 extant bird species for which data on melanosome structure are available. Next, we repeatedly subsampled the data to only include a single observation per species, creating a distribution of results. The resampling combined with the phylogenetic framework minimizes the risk of violating the assumption of independence among samples. Then, we quantified the correlation between melanosome structure and feather color (five categories) while varying the level of phylogenetic bias removal by adjusting Pagel’s lambda. We found the highest correlation up to a minimum of six of the 14 known species lived sympatrically, with several of them constituting apex predators in the ecosystem (e.g. Parasaurolophus or Grusopsuchus). Six taxa are thus known to occur in the Puente (Middle Member, Urumaco Fm.) and Corallito localities (Upper Member, Urumaco Fm.) respectively, followed by the El Hatillo (Middle Member, Urumaco Fm.) and Tío Gregorio localities (Upper Member, Urumaco Fm.), with five species each. Several other localities shared with the Puente, this rich area inner car. As compared to any recent or extinct crocodylomorph assemblage (only Acre in Brazil and the Honda Group in Colombia show similar high levels of species diversity). On the other hand, the overlying Codorean Formation (latest Miocene-early Pliocene) is devoid of crocodylomorph and only in the Velas Member of the overlying San Gregorio Formation (early Pliocene), one representative of a more modern crocodylian fauna, a new crocodile species assignable to the genus Crocodylus appears. A phylogenetic analysis suggests longer than the new. This is the sister taxon to extinct Crocodylus species. This faunal succession from the diversity peak in the Miocene Urumaco Fm. to the depleted Pliocene fauna is indicative of severe environmental changes, including important changing hydrographic courses related to the Orinoco River.

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when 7-13% of phylogenetic bias expected from Brownian motion was removed. This value was reduced to 0-5% when only two categories (iridescent vs. non-iridescent) were used, yet a small amount of phylogenetic bias remained even in this simplified case. Thus, we performed phylogenetic flexible discriminant analysis (pFDA) at the appropriate level of phylogenetic bias removal and prior probabilities obtained from tritubercular data. Results from pFDA suggest that the full color model with five categories suffers from high misclassification rates (25-37%). In contrast, the simple model with two color categories (iridescent vs. non-iridescent) is robust, with misclassified proportions ranging between 8-14%. Posterior probabilities of pFDA support the inference of iridescent feathers in Microraptor as suggested previously. However, the inferred presence of glossy feathers does not contradict the reconstruction of nocturnality in Microraptor on the basis of scleral ring and orbit morphology. Nocturnal species with iridescent feathers are found in at least two phylogenetically distinct clades of extant birds (Anseriformes, Psittaciformes). It is probable that Microraptor was a nocturnal animal with glossy feathers. However, the reconstruction of feather color in other dinosaurs and basal avians needs further scrutiny, because even a small amount of phylogenetic bias may result in different classifications.

Technical Session XIV (Saturday, October 20, 9-45 am)

A DISTINCTIVE NEW ARCHOSAURIFORM REPTILE FROM THE MIDDLE TRIASSIC (LADINIAN) OF GERMANY AND ITS PHYLOGENETIC RELATIONSHIPS

SCHOCH, Rainer R., Staatliches Museum fuer Naturkunde Stuttgart, Stuttgart, Germany; SUES, Hans-Dieter, Smithsonian Institution, Washington, DC, United States

In recent years fieldwork in late Ladinian (Middle Triassic) strata of the Lower Keuper Science. These discoveries include partial skeletons as well as numerous isolated elements of small amount of phylogenetic bias may result in different classifications.

Technical Session III (Friday, October 19, 4-15 - 6-15 pm)

HISTOLOGY OF NORMAL AND DEFORMED ARGENTINEAN TITANOSAUR FEMORA

SCHROETER, Elena R., Drexel University, Philadelphia, PA, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

Previous histological examination of the humerus of a new titanosaur species from Argentina indicated that it was still actively growing at the time of its death, though the individual was very large (humerus length ~ 1.6 m) compared to other known titanosaur. To support the hypothesis of active growth, we conducted a histological examination of the anterior side of the femur (length ~ 1.95 m) associated with this individual. Transverse sections of the femur showed well-vascularized, laminar fibrolamellar bone in the outer cortex that extends to the periosteal surface. Lines of arrested growth (LAGS) and annuli, if present, are not well defined. Secondary remodeling is less extensive than observed in the humerus, with isolated secondary osteons appearing deep to the periosteal surface. Though Haversian tissue becomes increasingly dense towards the medullary cavity, large areas of primary bone are retained between the secondary osteons throughout the diaphysis. The absence of an external fundamental system (EFS) or avascular, lamellar-zonal, or parallel-tubular cortex at the periosteal margin is consistent with the assessment of this individual as a young adult.

In addition, a second, shorter titanosaur femur (length ~ 1.29 m) was recovered from the same locality. The smaller femur has an elongated femoral head that is pathologically and/or taphonomically deformed. To test the hypothesis that this bone is from a younger individual that has been diagenetically altered, a transverse section of this specimen was examined and compared with the larger femur. It exhibits a pattern of tissue development not observed in its larger counterpart, including the following characteristics: (1) a higher level of secondary remodeling, with more abundant and closer-spaced secondary osteons developing nearer the periosteal surface; (2) the presence of a well-defined annulus. The presence of apparently more mature tissues in a smaller femur may be an osteological response to compensate for an injury sustained during the individual’s life, or may indicate it is a member of a distinct species. While additional investigation is necessary to determine unequivocally the origin of the histological differences, the hypothesis that the smaller femur represents a conspecific juvenile appears less likely in light of these data.

Technical Session X (Friday, October 19, 10:30 am)

MAJOR TRANSFORMATION IN MASTICATORY AND DENTAL FUNCTIONS IN EARLY MAMMALS

SCHULTZ, Julia A., Steinmann-Institut, Universitaet Bonn, Bonn, Germany

Precise dental occlusion is a key evolutionary adaptation of mammals. In combination with various modifications of the dentition, modern placental and marsupials developed a versatile masticatory function from pre-tribosphenic Mesozoic ancestors.

This important functional evolution can now be studied quantitatively for pre-tribosphenic dryolestid mammals and other mammaliforms. For the first time masticatory movements and the original wear pattern of fossil teeth can be integrated in a quantitative 3D-surface analysis for analyzing chewing biomechanics.

The mastication of dryolestids is characterized by embrasure shearing. The trigonids of the lower molars slide into the interdental spaces between the upper molars. Food is seconed and sheared along the main shearing area, the hypoflexid groove. This groove is of great importance for the food reduction, while the hypoflexid is less involved in occlusal contacts in tribosphenids. Two directions of striations on dryolestid molars indicate that the chewing cycle consisted of two phases: an initial piercing-cutting phase followed by a shearing phase, ending with centric occlusion. In tribosphenids, centric occlusion is followed by a grinding phase in the talonid basin.

Compared to the transversal chewing movement of dryolestids, the chewing pattern of tritylodonts and multituberculates is fundamentally different. The postcanine morphology of the herbivorous tritylodonts and multituberculates is triggered by the palinal (mesial to distal) chewing movement. Two cusps rows on the lower molars interlock with three cusp rows on the upper molars. Despite the similarity of the occlusal surface, tritylodonts and multituberculates have different strategies of mastication. The cusps of tritylodonts are narrow and high with significant shearing edges, while the cusps of multituberculates are rounded without sharp edges. Food particles are cut along the series of blades in tritylodonts, while in multituberculates food is mainly sheared between large shearing areas. A similar chewing pattern occurs in muroid rodents, but shape of the cusps indicates a proad movement (distal to mesial) of the lower jaw.

Quantification of shearing planes and collision areas are the basis for the estimation of the efficiency of various molar types. The interpretation of physical properties of food items resulting from the function of single elements of the occlusal surface allows ecomorphological comparisons. It shows that the ability of precise occlusion is mandatory to evolve highly efficient dentitions before the tricobridal molar appeared in the mammalian history.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

IDENTIFYING THE ORIGINS AND IMPLICATIONS OF BONE PATHOLOGY IN FOSSIL REPTILES

SCHULTZE, Hans-Peter, University of Kansas, Lawrence, KS, United States; ROTHCHILD, Bruce M., University of Kansas, Lawrence, KS, United States; PELLEGRINI, Rodrigo, New Jersey State Museum, Trenton, NJ, United States

A famous 19th century physician observed that diagnosis without knowing the literature is like going to sea without charts, and suggested that lack of knowledge of history only leads to its repetition, not progress. As science develops, concepts are transformed, such that there is value in re-examining the literature in view of our current understanding of disease and its impact on the skeleton. The perspective that bone pathology was phylogeny-independent in character was tested and found valid for both recent and fossil reptiles. That is the first step in understanding pathology in the fossil record. This allowed identification of what has been clearly documented and areas for future investigation. Congenital anomalies and neoplasia (tumors) are rare and injuries and infections are predominantly reported as isolated phenomena. Decompression syndrome is found within a relatively narrow phylogenetic window, but at high frequency. Past notations of fusion of vertebrae are re-examined and compared. Whereas some are attributable to infected bites, more have vertebral bridging more characteristic of spondyloarthropathy, similar to that noted in contemporary varanids. This unique form of arthritis was recognized in Dimetrodon, Diadectes, Ctenodactylus and crocodylans, as well as in mosasaurs and dinosaurs. Study of fossil reptiles provides evidence extending the ability to recognize bone pathology from a trans-mammalian perspective to a more general trans-phylogenetic phenomenon.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW PLOSIUR (PLEOSAURIA, PLOSIURIDAE) FROM THE CARLILE SHALE (CRETACEOUS: MIDDLE TURONIAN) OF RUSSELL COUNTY, KANSAS

SCHUMACHER, Bruce A., Denver Museum of Nature and Science, Denver, CO, United States; CARPENTER, Kenneth, Prehistoric Museum, Utah State University – Eastern, Price, UT, United States; EVERHART, Michael J., Sternberg Museum of Natural History, Hays, KS, United States

The Eulert pliosaur remains (FHSM VP-321) housed at the Sternberg Museum of Natural History (Kansas, USA) include one of the world’s best examples of a Cretaceous pliosaur pliosaurid. The specimen’s original assignment to Brachacetus lucasi was based solely upon the skull in dorsal view and the left lower jaw in lateral view because the specimen was embedded in a plaster mount. The history of B. lucasi is similarly problematic because the type (USNM 4989) and a referred skull (USNM 2361) were formerly visible

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only in ventral and dorsal views, respectively. Further preparation and comparison of these specimens reveals new data about the arrangement of cranial elements. The Eutetraptor bears several distinct autapomorphies as compared to *B. lucasi*, including cranial proportions (pre-temporal length of palate longer, shorter temporal fenestrae), configuration of skull roof elements (frontals participate in premaxillo-parietal suture, suture occurs farther to the anterior), and configuration of the palate (posterior vomers not masked by medial alar extensions of the palatines, calvarial vomerian fenestrae positioned further posterior, long slit-like anterior pterygoid vacuity present). Furthermore, FHSM VP-3231 possesses double-headed cervical ribs, a feature which until recently was unknown in Cretaceous plesiosaurs. This combination of characters merits separation of the Eutetraptor plesiosaur and a referred specimen (UNSM 50136) to a new taxon. The skull of the Eutetraptor plesiosaur and the referred specimen are 1.5 m and 1 m in length, and thus fifty and seventy-five percent larger than known *B. lucasi*, respectively. Reliable body proportions of plesiosaurs are difficult to ascertain given the paucity of skeletons, however skull length equates to between twenty and twenty-five percent of total body length. The 1 m long skulls of *B. lucasi* thus equate to individuals between 4 and 5 meters in total length, animals that are certainly adult in size. Yet the Eutetraptor plesiosaur and the referred skull suggest animals ranging from minimally 6 to maximally 9 meters in total length. The marked disparity in size may have taxonomic significance, although this is difficult to assess given the small number of known plesiosaur specimens. We acknowledge the seemingly problematic issue of two closely related sympatric top predators in the Cretaceous Seaway. However, we note the modern example of the killer whale *Orcinus orca*, a modern marine apex predator once thought to constitute only a single species, but now widely recognized to contain two or distinct subgroups which have overlapping ranges but avoid each other and do not interbreed. Thus, although unusual, sympathy of two plesiosaurs in the Turonian sea should not be considered unique.

**Molecular evidence for Endogeneity of Dinosaur osteocytess**

**Schweitzer, Mary H.; North Carolina State University, Raleigh, NC, United States; Cleland, Timothy P.; North Carolina State University, Raleigh, NC, United States; Zeng, Wenxia; North Carolina State University, Raleigh, NC, United States; Bern, Marshall; Palo Alto Research Center, Palo Alto, CA, United States**

The discovery of soft, transparent structures in dinosaur bone consistent in morphology with osteocytes was controversial. We hypothesize that, if original, these microstructures will have molecular features in common with extant osteocytes. We present immunological and mass spectrometry evidence for preservation of proteins comprising extant osteocytes (*Actin, Tubulin, PHEx, Histone H4*) in osteocytes recovered from two non-avian dinosaurs. Furthermore, antibodies to DNA show localized binding to these microstructures, which also react positively with DNA intercalating stains propidium iodide (PI) and 4',6-diamidino-2-phenylindole dihydrochloride (DAPI). Each antibody binds dinosaur cells in patterns similar to extant cells. These data are the first to support preservation of multiple proteins and to present multiple lines of evidence for material consistent with DNA in dinosaur cells, supporting the hypothesis that these structures were part of the once living animals. We propose mechanisms for preservation of cells and component molecules, and discuss implications for dinosaurian cellular biology.

**New Information of the Evolution of the Shoulder Girdle and Forelimb Demonstrate**

**Schwermann, Achim H.; Steinmann-Institut für Palaeontologie, Universität Bonn, Bonn, Germany; Von Koenigswald, Wighart; Steinmann-Institut für Palaeontologie, Universität Bonn, Bonn, Germany**

Reconstruction of the shoulder girdle and forelimb demonstrates that it was a highly derived with a one-phased power stroke and no centric occlusion. Their teeth, equipped with many sharp cutting edges, are ideal tools for cutting, shearing and grinding of fibrous, plant food. The dentition of Diacodexis, the first known artiodactyl, is distinctly different in morphology and function compared to the selenodont dentition of modern artiodactyls. Therefore, the masticatory cycle of Diacodexis was investigated, in order to understand the evolution of the tooth pattern and the linked functional differences in mastication among the artiodactyls. Diacodexis occurs in the lowest Eocene and has a primitive bunodont dentition with triangular upper molars and six cusped lower molars. In contrast to most other artiodactyls, it has only three main cusps and no hypocone. The masticatory cycle was reconstructed by the orientation of enamel facets and the direction of striations on their surface. The results show a two-phase cycle, with Phase I and Phase II separated by centric occlusion. It combines a cutting function in Phase I and a crushing function during centric occlusion and Phase II. While the sharp, w-shaped ridges of the buccal cusps of the upper molars are suitable for breaking up leaves, the rather blunt lingual protocone is useful for crushing brittle food items like fruits, nuts or seeds. Investigations based on digital 3D models of dentitions of Diacodexis show that the facets, that are developed during the cutting function occupy a higher percentage of the occlusal surface than the facets of the crushing function. Thus, it can be concluded that the proportion of leaves in the diet was relatively higher than the proportion of fruits, seeds or nuts.

During the Eocene the artiodactyls diversified into several lineages, which show more derived bunoselenodont or selenodont dentitions with differences in crown morphology and cusp pattern. Primary members of the Oreochoerid, the Agriochoeridae, have a bunoselenodont dentition with quadrirubincular molars. Their more derived relatives, the Oreochoeriidae, have a completely selenodont dentition. The Anthracotheriidae show five cusped bunoselenodont upper molars with three cusps in the anterior part of the teeth. In comparison the Cynotheriidae, a European endemic group, show selenodont molars, which are also five cusped but with three cusps in the posterior part of the teeth. In these groups the fundamental differences of the chewing cycle are unsolved. Based on the Diacodexis study further investigations will follow concentrating on the modification of the masticatory cycle during artiodactyl evolution.
the lag deposit. Nevertheless, the common clams, snails, ammonites, sharks, and marine osteichthyes (e.g. Xiphactinus avitus, Anomoëodus phaseolus, Protosphyraena sp., Enchodus petroos) in the assemblage indicate normal marine environments. In contrast to most Atlantic Coastal Plain Cretaceous deposits, the dinosaur assemblage is relatively sparse and non-mammalian taxa have been rare to date, which may reflect a relatively deeper water environment than more northerly sites, or a lack of time and depth of study. However, the site has provided some correlations between Gulf/Western Interior and Atlantic biota, and is the type area for the selerychnian sawfish Borodoninopsis. It has also provided the fossils indicating Xiphactinus avitus as a distinct species, and the North American occurrence of the African fishes Squalicorax yangnaios and Phacodus punctatus.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm) LATE PLEISTOCENE EQUUS AND BISON FROM THE TULE SPRINGS LOCAL FAUNA, UPPER LAS VEGAS WASH, CLARK COUNTY, NEVADA SCOTT, Eric, San Bernadino County Museum, Redlands, CA, United States; SPRINGER, Kathleen, San Bernadino County Museum, Redlands, CA, United States; MANKER, Craig R., San Bernadino County Museum, Redlands, CA, United States

Late Pleistocene ground water discharge deposits in the Upper Las Vegas Wash outside of Las Vegas, Nevada have yielded an abundant and diverse vertebrate fossil assemblage, named the Tule Springs local fauna. The San Bernadino County Museum has documented over 500 discrete localities from the Las Vegas Formation in this region. Stratigraphically ascending units A-E from this formation span as much as the last 225 Ka; most of these units have yielded fossils. The recovered fauna includes relatively common remains of extinct Equus and Bison. Fossils of Equus are well represented in the megafaunal sample; however, the material is not sufficiently complete to enable confident species assignments. Nevertheless, based upon body size as inferred from measurements of postcranial elements, three species of horse can be discerned in the fauna. Large and small stout-legged forms are clearly present, while some fossils suggest the additional presence of a small stilt-legged species. This latter assessment is buttressed by the occurrence of late Pleistocene small stilt-legged horses from the geographically proximate Gypsum Cave locality just outside of Las Vegas. The presence of three species of horse in the Las Vegas region at the end of the Pleistocene differs markedly from the present-day global distribution of equid species, where generally only one equid species occurs in a geographic region at any one time. Further, the presence of three equid species in the Tule Springs local fauna contrasts with recent molecular studies suggesting that only two horse lineages may have been present in late Pleistocene North America. The discrepancy may be traced to the limited sample size of the available genetic data. The Tule Springs local fauna also contains the oldest and youngest reliably dated occurrences of Bison in the Mojave Desert and the southern Great Basin. Fossils of a long-boned form similar to Bison latifrons, as well as a smaller form in the size range of B. antiquus, are interpreted to derive from unit B, of the formation, which dates to ~47 Ka. Fossils assigned to B. antiquus are also known from unit E of the Las Vegas Formation, directly associated with a radiocarbon date of 14.78 Ka. These records effectively delimit the RanchoLaBrea North American Land Mammal Age in this critical region of the American southwest.

Previous studies proposed that remains of small horses were only present in the latest Pleistocene unit E, of the Las Vegas Formation, while fossils of bison were confined to the older unit B. Our findings confirm neither of these interpretations, as newly-discovered fossils reveal that both small horses and bison occur throughout most of the exposed sequence. In fact, the presence and relative abundance of Bison in the youngest sediments is consistent with the record of this genus throughout the Mojave Desert and the American southwest, although this distribution differs markedly from conclusions reached by molecular studies suggesting a sharp decline in the abundance of North American bison after 25 Ka. Here, too, the disagreement may result from the somewhat limited genetic material available from late Pleistocene Bison in the American southwest.

Technical Session XVIII (Saturday, October 20, 1:45 pm) STABLE ISOTOPE ECOLOGY OF EARLY PALEOCENE (PUERCAN AND TOREJONIAN) MAMMALS FROM THE TULE SPRINGS LOCAL FAUNA, UPPER LAS VEGAS WASH, CLARK COUNTY, NEVADA, USING TOOTH WEAR ANALYSES KRAUSS, Eric, University of California, Berkeley, CA, United States; HOSICK, Scott, University of California, Davis, CA, United States; ARAMBURU, Jesús, Museo Paleontológico de Guadalajara, Guadalajara, Jalisco, Mexico; HENDRICKS, Phil, Texas Tech University, Lubbock, TX, United States; HURLBERT, J. Richard, Florida Museum of Natural History, Gainesville, FL, United States

Stable isotopes in mammalian tooth enamel can be used to infer ancient environments and in habitats. Dominated by C3 vegetation, carbon isotopes in enamel can be used to recognize habitat partitioning among mammals, while oxygen isotopes can be used to recognize semiaquatic species. Here we analyze the stable isotope ecology of Puercan (P=62 and Pu3 biocenes) and late Torejonian (To6 biocene) faunas from the San Juan Basin. These are the oldest mammalian faunas ever studied isotopically. We sampled teeth of three Puercan mammals: Taeniolabis (Taeniolabididae, Multituberculata), and Cariasptopus and Ectoconus (Periyptichidae, "Condylarthra"), and four Torejonian mammals: Pantolambda (Pantodontidae), Psittacotherium (Taenioidonta), Tetracaenodon (Phenacodontidae, "Condylarthra"), and Periyptichus (Periyptichidae, "Condylarthra"). These are the largest common mammals in these faunas; all were medium-sized except Pantolambda (~160 kg). The periyptichids appear to have been hard-object feeders (nuts, fruits, seeds), while Tetracaenodon was omnivorous, and Taeniolabis and Pantolambda may have been folivorous. In the Puercan, Cariasptopus and Ectoconus have the highest carbon values (~12‰, relative to very low values in Taeniolabis (~15.1‰). We interpret these values as showing an adaptation of all three genera to large-scale, aquatic ecosystems. Oxygen isotope values in the Pantolambda and Psittacotherium (~16.4‰) are consistent with a diet of tubers or stems, as suggested by anatomical studies.

Technical Session XVI (Saturday, October 20, 8:30 am) ELUCIDATING PALEODIETARY TRENDS IN NORTH AMERICAN HORSES FROM HYRACOTHERIUM TO EQUUS USING TOOTH WEAR ANALYSES SEMPREEON, Gina M., Bay Path College, Longmeadow, MA, United States; SOLOUNIAS, Nikos, New York College of Osteopathic Medicine, Old Westbury, NY, United States; RIVALS, Florent, Institut Català de Paleocologia Humana i Evolució Social (IPHES), Tarragona, Spain; HULBERT Jr., Richard C., Florida Museum of Natural History, Gainesville, FL, United States

Paleodietary trends for North American horses, starting with Hyracotherium, (early Eocene) and ending with Equus (late Pleistocene) have been examined using tooth wear. Over 1500 fossil specimens were analyzed for enamel stereo-microwear (single observer) and results compared to published mesowear results for fossil horses and to microwear and mesowear trends in extant zebra and other extant ungulates studied here. This study tests the hypothesis that Eocene horses browsed on low abrasion foods whereas Oligocene and later horses switched to more abrasive diets concomitant with the spread of more open habitats. Microwear results indicate that Hyracotherium consumed mostly fruits and leafy vegetation with some browse consumption. Microwear results indicate that Hyracotherium consumed mostly fruits and leafy vegetation with some browse consumption. Oligocene Anchitherinae have microwear scratch numbers typical of grazing and mixed feeding ungulates but very fine scratch textures which are unusual in modern C4 grazers. Mesowear of these Oligocene taxa indicates low abrasion, which gives credence to the fact that the type of grazing revealed through microwear may reflect a different type of grass consumption than typical in grasslands today. In the Eocene, there is an increase in dietary abrasion among brachydont Anchitherinae that are primarily engaged in browsing and mixed feeding. The Equinae apparently consumed moderately abrasive diets when they first appeared in the early Miocene and throughout the middle Miocene. Mesowear results are concordant with published mesowear trends through time regarding relative abrasion but also show that in the middle Miocene, Equinae engaged in a wide variety of dietary behaviors, including some forms showing microwear consistent with browsing with a hypsodont tooth. This trend toward a wider variety in dietary behavior in hypsodont Equinae continued throughout the late Miocene and into the Pliocene but overall abrasion increased through time. Even so, many hypsodont Pleistocene horse studies have results atypical of pure grazers - a pattern also observed in many Pleistocene European taxa.

PHENOSCAPE: A NEW ANATOMICAL ONTOLOGY OF VERTEBRATES SERENO, Paul E., University of Chicago, Chicago, IL, United States; IBRAHW, Nizar, University of Chicago, Chicago, IL, United States; MABEE, Paula M., University of South Dakota, Vermillion, SD, United States; VISION, Todd J., University of North Carolina, Chapel Hill, NC, United States; LAPP, Hilmar, National Evolutionary Synthesis Center, Durham, NC, United States

A recent explosion of anatomical, genetic and taxonomic information on vertebrates has led to major efforts to organize this data in ontologies and to make observable descriptions of phenotypes machine readable using semantic similarity tools. This has culminated in a large scale, multimillion-dollar project, with the aim of creating an online, definition enabled, image linked and reference hyperlinked database – called Phenoscape. This multidisciplinary National Science Foundation project involves workers from the fields of bioinformatics, comparative anatomy and model organism research and pushes the boundaries of Anatomical Ontologies in three major areas. Firstly, it will allow users to search and compare phylogenetic and anatomical data, thus making divergent and inconsistent morphological data from character matrices testable and comparable. This is achieved by turning free text data and descriptions into machine-interpretable statements that can be compared. Secondly, using data from model organisms (zebrafish, frog, mouse), Phenoscape connects genomic and morphological data, opening avenues for research on the underlying causes of major anatomical transitions in the fossil record. At its current stage, the Phenoscape project focuses on the fin-limb transition and the Anatomy Ontology mostly contains fish, amphibian
and archosaur data. The genetic, developmental and anatomical data underlying the fin-limb transition are being assembled to test homology statements and candidate gene predictions. Finally, because all terms and definitions are expert vetted and continuously refined, the Phenoscope Vertebrate Anatomy Ontology (VAO) and Vertebrate Taxonomy Ontology (VTO) will also provide a detailed and accessible atlas of morphological and taxonomic terms for students and scholars alike, through a website interface.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A NEW FOSSIL BIRD FROM THE UPPER EOCENE GREEN RIVER FORMATION OF WYOMING
SEYMOUR, Kevin L., Royal Ontario Museum, Toronto, ON, Canada; HINIC-FRLOG, Sanja, Carlston University, Arnedo, Spain; CANADA, Paul D., Royal Ontario Museum, Toronto, ON, Canada

The late Eocene (55-48 Ma) fossil deposits of the Green River Formation have produced tens of thousands of complete fossil fishes but very few other vertebrates. We report here on the phylogenetic affinities of a virtually complete skeleton of a new and as yet unnamed fossil bird (Royal Ontario Museum [ROM] 52665) from these deposits. We scored anatomical character states for ROM 52665 based on recently published phylogenetic matrices of stem parrots. Parsimony ratchet analysis based on 29 taxa and 105 characters recovered five most parsimonious trees with 243 steps in support of currently established clades of stem and crown parrots. Based on a strict consensus tree, ROM 52665 clusters within the stem parrot family Halcyornithidae. The placement of this new avian specimen from Wyoming within Halcyornithidae is supported by at least two shared character states: relatively elongate and curved humerus shaft and absence of the completely enclosed canals interossseous distalis of the tarsometatarsus. The position of the new specimen remains unresolved within the family, however, thus it is equally closely related to Pulchrupella, Pseudasturides, Serudaptans, and Cyrravis. ROM 52665 and Pseudasturides are both characterized by a rostrum of approximately one-third of the skull length, while the new ROM specimen shares a cup-shaped ectylo scaraplaus of the coracoid with Cyrravis. In addition to similarities in relative wing and leg proportions with Pseudasturides and Pulchrupella, ROM 52665 also shows the presence of both medial and lateral foramina vascularia proximalia on the tarsometatarsus. Cyrravis, Serudaptans and ROM 52665 have relatively long pedal unguals in common. In addition to shared features with members of the Halcyornithidae, ROM 52665 exhibits the following unique characteristics within the clade: lack of projection of processus supraorbitalis above the orbit and wide separation of temporal fossa on the dorsal surface of the skull. These characters are currently unknown in some members of the Halcyornithidae. Only when more material is found for the previously known genera, especially Pulchrupella, will the relationships within the family be potentially resolvable. Although the relationships within Halcyornithidae remain poorly resolved, this new bird from the Green River Formation provides more resolution for previously unknown characters within the family, such as the number of cervical vertebrae.

Technical Session X (Friday, October 19, 9:45 am)

A NETWORK APPROACH TO STUDYING FAUNAL PROVINCES ACROSS SOUTHERN PANGEA DURING THE PERMIAN AND TRIASSIC
SIDOR, Christian A., University of Washington, Seattle, WA, United States; VILHENA, Daril A., University of Washington, Seattle, WA, United States; ANGIELCZYK, Kenneth Peter, University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States; WIThIN EQUIDAE THE EVOLUTION OF BODY MASS DISTRIBUTION AND DIVERSIFICATION WITHIN EQUIDAE
SHOEMAKER, Lauren G., University of Colorado, Boulder, Boulder, CO, United States; CLAUSET, Aaron University of Colorado, Boulder, Boulder, CO, United States

Within large taxonomic groups, extant species often exhibit a broad and right-skewed body mass distribution. This pattern can be explained as the result of macroevolutionary “diffusion” between a minimum physiological size and extinction risks that increase with size. This explanation has previously been shown to accurately predict the extant distribution of mammal sizes as well as their size diversification over the past 80 million years. However, it remains unknown if this explanation can also explain species size dynamics within subclades. We investigate this question using a novel database of fossil species body sizes over the past 56 million years within well-studied Equidae. Importantly, Equidae exhibits a dramatic increase in both maximum size and taxonomic diversity during the Miocene, and we test whether these patterns can be explained by the constrained diffusion hypothesis. Using a time-dependent solution of the constrained convection-diffusion-reaction model, we show that the Equidae exhibits a minimum size of 20kg and a consistent expansion away from this boundary in the form predicted by the model. This strong agreement between theory and data supports the hypothesis of universal macroevolutionary dynamics for terrestrial mammal sizes. However, unlike the stable lower limit of 2g observed for terrestrial mammals in general, the lower limit for Equidae appears to have increased over the past 20 million years, perhaps due to certain ecological or climatic effects. Furthermore, we estimate that only 60% of the 10-fold increase in the sizes of the largest horses during the early Miocene can be attributed to the simultaneous 5-fold increase in taxonomic diversity, while variations in taxonomic diversity track global temperatures. This difference suggests that morphological disparity and species diversity were only partly coupled during this period, and that weak but pervasive ecological effects may explain the remaining increase. Finally, a decline of equal diversity in the late Miocene appears concentrated among the smallest species, in contrast to the typical extinction pattern where large species disappear first, again suggesting large-scale competitive effects or ecological turnover.

Posters Session III (Friday, October 19, 4:15 - 6:15 pm)

PECCARIES (MAMMALIA, ARTIODACTYLA, TAYAUSSIDAE) FROM THE MIOCENE-PLIOCENE PIPE CREEK SINKHOLE LOCAL FAUNA, INDIANA SHEETS, Andrew, Duke University, Durham, NC, United States; PROTHERO, Donald R., Department of Vertebrate Paleontology, Natural History Museum of Los Angeles County, Los Angeles, CA, United States

The Pipe Creek Sinkhole local fauna from near Swazeezy, Grant County, Indiana, yields an interesting mixture of both plant and animal fossils, including previously unidentified peccaries. The fossil mammals suggest either a latest Hemphillian (latest Miocene-Pliocene) or earliest Blancan (earliest Pliocene) age for the assemblage. The peccaries can be assigned to two taxa: Catagonus brachydontus, a large species with brachydont, bunodont cheek teeth, found in the latest Miocene of Mexico, Florida, and Oklahoma, which is related to the living Chacoan peccary C. wagneri. The second peccary is Platygonus compressus, a newly described latest Miocene taxon. It is the smallest and most primitive species known from the lineage of flat-headed peccaries (Platygonus compressus) common in the Pleistocene. Both of these species are unknown from the early Blancan, and support (along with the rhinos and other taxa) a latest Hemphillian age for the fauna.

DENTITION OF LATE CRETACEOUS SHARK, PTYCHODUS MORTONI (ELASMOMBRANCHII: PHYTODONTIDAE)
SHIMADA, Kenshu, DePaul University, Chicago, IL, United States

Ptychodus (Elasmobranchii: Phyodontidae) is an enigmatic durophagous shark that lived in Cretaceous seas. Based on multiple articulated tooth plates of Ptychodus mortoni Agassiz from the Smoky Hill Chalk Member of the Niobrara Chalk in western Kansas, USA, the dental pattern of P. mortoni and its paleobiological implications were examined. Each tooth plate consists of one medial tooth row and about nine lateral tooth rows on each side. One individual shark possesses a total of slightly over 550 teeth with approximately 220 functional upper teeth and 260 functional lower teeth. The largest tooth plate of the species possibly measured about 55 cm in length and 45 cm in width. Although this study does not resolve the ordinal placement of Phyodontidae, it demonstrates that there are two different patterns of tooth plate organization in Ptychodus: a plesiomorphic condition characterized by juxtaposed, non-overlapping tooth rows (e.g., P. decurrents, P. marginalis, and P. occidentalis) and an apomorphic condition characterized by imbricated tooth rows (e.g., P. mortoni). It is hypothesized that the imbrications of tooth rows in P. mortoni likely helped distributing the bite-induced load on its dentition more widely where its sharp-tipped crowns were effective in shattering animals with comparably thin, brittle shells (e.g., bivalves and crustaceans). The recognized difference in tooth plate organization adds another level of complexity to the dental evolution of Ptychodus as well as to the already complex evolutionary history of predator behaviors in cartilaginous fishes.
CRANIAL ANATOMY OF PALEOGENE MICROSYOPIDAE (MAMMALIA, EUARCHONTA) AND ITS RELEVANCE TO UNDERSTANDING EUARCHONTAN RELATIONSHIPS

SILCOX, Mary T., University of Toronto, Scarborough, Toronto, ON, Canada; BLOCH, Jonathan I., Florida Museum of Natural History, University of Florida, Gainesville, FL, United States; GUNNELL, Greg F., Duke Lemur Center, Durham, NC, United States

The Microsyopidae are extinct mammals from the late Paleocene-middle Eocene of North America and the late Paleocene of Europe usually included in the “Plesiadenipforms.” While results from several recent phylogenetic analyses suggest affinities among stem primates, specific relationships relative to the most primitive members of primates are unresolved. Two undescribed specimens clarify previous interpretations of the cranial anatomy and allow for a re-consideration of the relationships of the family. The specimens are from the middle Eocene and include a nearly complete cranium of Microsops annectens (UW 12362), previously mentioned but never described; the best preserved for the family, and for any “plesiadenipform”) from Wyoming and a more fragmentary specimen of Microsops kratos (SDMNH 47729) from California that preserves part of the roof of the middle ear cavity which is damaged in all other microsyopid crania, clarifying the pathway of the facial nerve. The basioccipital anatomy of microsyopsids is generally very primitive featuring: 1) a transpromontorial groove for an unreduced internal carotid artery (ICA) entering the middle ear posteriorly; 2) grooves for both stapedial and promotorial arteries; 3) a foramen that opens into the middle ear cavity, with the facial nerve exiting the ear through a stylocostal foramen p editum; and 4) unexpanded caudal and rostral tympanic processes of the petrosal. There is no evidence for any development of an osseous bulla. The boundaries of the petrosal can be traced in UW 12362 and it clearly did not contribute significantly to the floor of the middle ear cavity, unlike that of euprimates and scandentians. The absence of any preserved bullar elements contrasts with other “plesiadenipforms,” suggesting that if microsyopsids are on the primate stem they might be more primitive than other taxa for which basioccipitans are known. Microsopsids also lack specialized features seen in scandentians (e.g., expanded ototympanic contributing to the bullar roof and; bony canals for the ICA and facial nerve) and dermopterans (e.g., absent ICA; inflation to the caudalateral portion of the cranium; tubular external auditory meatus; absent postglenoid foramen) although they share similarities with dermopterans in the presence of a blunt postorbital process and a large, rugose mastoid process. In sum, the basioccipital anatomy of microsyopsids fails to clearly link the group with any euarchontan order, and suggests that the primitive morphology of this region in Euarchonta was little differentiated from that observed in the most primitive placental mammals. The lack of clear euarchontan synapomorphies in the cranial complices attempts to deciper relationships within Euarchontoglires and Boreoeutheria.

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Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:15 am)

MEASURING SPECIES SELECTION IN THE MOLECULAR PHYLOGENETIC RECORD

SIMPSON, Carl, Museum für Naturkunde, Berlin, Germany

Understanding historical patterns of diversity dynamics is of paramount importance for many evolutionary questions. The fossil record has long been the only source of information on patterns of diversification, but the molecular record, derived from time-calibrated phylogenies, is becoming an important additional resource. Both fossil and molecular approaches have shortcomings and biases. These have been well studied for fossil data but much less so for molecular data and empirical comparisons between approaches are lacking. I present a comparison of the patterns of diversification derived from fossil and molecular data in scleractinian reef coral species. Despite impressive estimates of the magnitude of the molecularly derived diversification rates, the temporal patterns observed in the fossil and molecular records are highly correlated. This result permits the use of temporal patterns in molecular phylogenetic data to study macroevolutionary processes. For example, the magnitude and direction of species selection—differential diversification of species with varying characteristics—can be directly measured from the temporal patterns of diversification rates. In corals, species selection acts in opposite directions for colony orientation and against photosymbiosis and overpowers clado genetic and anagenetic changes in both traits.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

LOCOMOTOR FORCES AND STRESS IN THE METAPODIA OF ADULT OSTRICH STRUTHIO CAMELUS AND JUVENILE ALBERTOSAURUS SARCOPHAGUS (TYRANNOSAURUDE): CORRELATING ANATOMY, DYNAMICS AND FINITE ELEMENT ANALYSIS

SISSONS, Robin, Grand Prairie Regional College, Grand Prairie, AB, Canada; GILBERT, Meagan, University of Saskatchewan, Saskatoon, SK, Canada; SNIVELY, Eric, Ohio University, Athens, OH, United States

Three-dimensional finite element analysis (FEA) is potentially informative about locomotor stresses and performance limits in extinct vertebrates. Juvenile and adult tyrannosaurid dinosaurs are intriguing candidates for such analyses, with proportionally long lower limbs indicating higher cursoriality compared to other large theropods. Context from extant relatives is critical for understanding methodological limits and applying biological interpretations of FEA to extinct forms. Fortunately, a wealth of anatomical, kinematic, and force data for extant ostriches (Struthio camelus) provides a solid foundation for extending FEA studies of extinct theropods. CT, FEA, and dynamics methods were integrated to compare data from Struthio with those for a tyrannosaurid of similar body mass, a juvenile Albertosaurus sarcophagus from Dry Island Provincial Park, Alberta. Limb elements of Struthio and Albertosaurus were CT scanned, to examine densities and construct biomechanical models. The program OstrichX facilitated interpretation of internal structure and density. Mimics and Avizo enabled the construction of finite element models for analyses in Strand7. Quasi-static models, in 3D and simplified to the sagittal plane, estimated ankle extensor force necessary to counteract ground reaction force for a slow run (Struthio: 2453 N; Albertosaurus: 1515 N) at a mid-stance posture. These forces were used for FEA, with the metatarsus constrained at the ankle joint. Custom MATLAB programs independently calculated joint and ground reaction forces, and extensor tensions, through similar stance phase kinematics in both taxa.

Results reveal utility and limitations of FEA for studies of extinct taxa. Force magnitudes at the constraints were similar to the MATLAB-simulated joint reaction forces, suggesting the promise of FEA for estimating joint forces (similar to its use for bite/food reaction forces in feeding studies). Stress magnitudes varied little between sagittally-restricted and 3D force models for the metapod. However, errors in patterns of stress distribution are likely to be greater for more proximal elements, which deviate mediolaterally from a vertical orientation more than the metatarsus. An internal remnant of fusion between metatarsals III and IV likely resists compression in the ostrich. Finally, relative to body mass, the juvenile Albertosaurus specimen required lower extensor tension to maintain a given ankle posture than in the ostrich, suggesting the ability to impart greater angular acceleration to its metatarsus with less energy expenditure.

Symposium: Phylogenetic and Comparative Paleobiology: New Quantitative Approaches to the Study of Vertebrate Macroevolution (Friday, October 19, 9:30 am)

FOSSILS, PHYLOGENIES AND MODELS OF QUANTITATIVE TRAIT EVOLUTION

SLATER, Graham J., University of California, Los Angeles, Los Angeles, CA, United States

Evolutionary biologists are increasingly interested in assessing the fit of explicit macroevolutionary models to phenotypic data. By identifying the best-fitting model of trait evolution, such as an early burst of evolution or a biased random walk, evolutionary biologists can test explicit hypotheses regarding the tempo and mode of evolution in their clad of interest. A significant barrier to implementing these methods in palaeontological studies is the requirement of a resolved, time-calibrated phylogeny; as we often only have very broad ideas regarding the phylogenetic placement of fossil taxa, application of these methods is typically restricted to time-calibrated molecular phylogenies of extant taxa or phylogenies of extinct taxa with exceptional fossil records. Here, I introduce a Bayesian model fitting approach that allows for integration of information from fossil taxa that have not been placed in an explicit phylogenetic context by using their traits to define informative prior distributions on nodes in a phylogeny. Using simulated datasets, I show that incorporating informative priors on even a small number of nodes with associated fossil information can dramatically alter and improve model selection performance. I provide an empirical example by applying this approach to the case of body size evolution in caniform carnivores. Incorporating informative priors on less than 10% of nodes in this dataset dramatically alters ancestral size estimates and results in identification of a trend towards increased body size through caniform caniform. Using fossils in this way increases statistical power to distinguish among evolutionary models while making more complete use of the historical record of the evolutionary process documented in the fossil record.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

MEASURING MICROVERTEBRATES: A CASE STUDY USING A RARE RECORD OF A HYBODONT SHARK FROM THE UPPER TRIASSIC OF NORTH CAROLINA

SLOAD, Eric J., Appalachian State University, Boone, NC, United States; HECKERT, Andrew B., Appalachian State University, Boone, NC, United States; SCHNEIDER, Vincent P., North Carolina Museum of Natural Sciences, Raleigh, NC, United States

Imaging and measuring fossils has long been one of the most cost- and time-consuming tasks in microvertebrate study. Through the use of a digital three-dimensional microscope, we have successfully imaged and measured a set of 34 minute hybodont shark teeth recovered from Triassic age deposits of the Newark Supergroup of North Carolina. The locality is in the Durham sub-basin of the Deep River Basin, and the fossiliferous strata are identified as “Lithocidias association II.” These teeth range in size from approximately 450 to 1000 microns along the crest, and therefore pose a challenge to measure and image accurately. Each tooth was captured in occlusal and labial view at 200 x magnification, and four force vectors using on-board software were taken from each. These consisted of tooth crown height, width, and the length of the labial peg, with an average time to capture of 13 minutes per tooth. Shape values were calculated with these data, with a mean crown length to width ratio of 2.25, and mean crown length to height ratio of 2.23. With this model of a three dimensional digital microscope, measurements are taken with on-board software, with no need for manual calibration or exporting images to third party measurement programs. This study was undertaken to exemplify the usefulness of digital microscopy, as well as to give needed quantitative data to the study of small hybodont shark teeth. Values gathered from this study were compared to values measured from literature figures in an attempt to resolve the currently debated classification scheme of Lonchidiae. Teeth analyzed here, as a whole, match most closely with teeth from the mesial portion of the jaw (based on published reconstructions of Lissodus nodosus), with crown length to width ratios of 2.25-2.59. These teeth are characterized by their somewhat gracile shape, lack of ornamentation, and strongly developed labial pegs, and often angled principal crests. Although the shape data match closely with known specimens from Lissodus, many teeth analyzed here are much too diminutive to fit into the accepted size range of Lissodus. Therefore, it seems that many of these teeth belong to Lonchidion, which some recognize as a genus distinct from Lissodus. Regardless of assignation to Lissodus or Lonchidion, they most closely resemble I. humilis, a hybodont known from Upper Triassic strata in Texas and New Mexico.

Technical Session XVI (Saturday, October 20, 12:00 pm)

STABLE OXYGEN AND CARBON ISOTOPES RECORD SEASONAL VARIATION IN DRINKING WATER AND DIET OF MODERN LARGE HERBIVORES IN AMBOSELI NATIONAL PARK, KENYA

SMILEY, Tara M., University of Michigan, Ann Arbor, MI, United States; BADGLEY, Catherine, University of Michigan, Ann Arbor, MI, United States; BEHRENSMEYER, Anna K., National Museum of Natural History, Washington, D.C., DC, United States

Mammals living in seasonal habitats experience changes in environmental variables such as temperature, rainfall, and primary productivity; these changes influence mammalian feeding ecology, social behavior and timing of reproduction. Over evolutionary time, seasonal environmental variation can influence natural selection on mammalian life histories. Incremental deposition of tooth enamel records the seasonal variation in isotopic composition of water and diet ingested by mammals over time; hypsodont teeth of large herbivores can record an entire year. Intra-tooth resolution of unmixing along the growth axis of teeth thus tracks seasonal changes in the isotopic composition of drinking water as well as seasonal variation in diet due to vegetation availability or water stress. From a large sample of adult molars collected between 1975 and 2010, we evaluated the seasonal isotopic record of enamel in zebra and wildebeest from Amboseli National Park in Kenya, a semi-arid, seasonal savanna ecosystem. During the time of year inferred as the rainy season, the enamel record reflects the seasonal precipitation signal, becoming gradually depleted in δ18O as the season progresses due to the amount effect. Conversely, the dry season is represented in enamel by increasing δ18O values through time. Seasonal variation in δ18O is on average 2.1 per mil (n=10 individual teeth), which is characteristic of equatorial regions dominated by seasonality of rainfall rather than temperature. However, δ18O values of enamel are higher than in meteoric waters from eastern Africa in general, indicating that zebra and wildebeest in Amboseli are drinking from water sources influenced by evaporation. The average bulk oxygen isotopic composition of wildebeest enamel (32.42 ± 0.18‰) is significantly higher than zebra enamel (30.64 ± 0.04‰). There is no significant difference between the δ13C values of wildebeest and zebra, 1.28 per mil and -0.04 per mil, respectively. Carbon isotopic composition of enamel in both zebra and wildebeest signify...
a nearly exclusive C₄ diet, with low seasonal variation (1 per mil). δ¹³C values change inversely with δ¹⁸O values over the annual cycle for all individuals sampled. Decreasing carbon isotopic composition of tooth enamel could indicate a shift in dietary content from the wet to the dry season or a seasonal shift in δ¹⁸O values of the C₄ vegetation itself. Stable isotope studies on modern species provide fundamental insights for reconstructing the ecology of extinct mammals and discovering the influence of seasonal changes on Cenozoic mammalian lineages and faunas.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

A NEW RHOMALEOSAURID PLIOSAUR FROM THE SINEMURIAN (LOWER JURASSIC) OF LYME REGIS, ENGLAND

SMITH, Adam S., British Geological Survey, Nottingham, United Kingdom; ARAÚJO, Ricardo, Southern Methodist University, Dallas, TX, United States

An excellently preserved partial skeleton of a rhomaleosaurid pliosaur (Sauropterygia: Plesiosauria) from the Sinemurian (Lower Jurassic) of Lyme Regis, England, consists of a complete cranium, mandible, and articulated cervical vertebral column. The material is taxonomically distinct and its occurrence is noteworthy because pliosaurs are rare from this stratigraphic horizon. The new taxon is diagnosed by a single autapomorphy: a pronounced pit on the posterior margin of the dorsal ramus of the squamosal. It also possesses the following unique combination of characters: premaxillary rostrum short (length and width subequal), five teeth in the premaxilla, premaxilla-maxilla sutures parallel anterior to the external nares, frontals contact on the midline, prefrontal-frontal-suture convex and gently curved medially, mandibular symphysis region spatulate and short (length and width subequal), robust rod-like axis neural spine with a circular transverse cross section, and cervical neural spines with a laterally expanded apex. The taxon shares some characters with older (Hettangian) rhomaleosaurids (e.g. ‘Rhomaleosaurus’ megaaphephalus), and other characters with younger (Toarcian) rhomaleosaurids (e.g. ‘Rhomaleosaurus sensu stricto and Meyerasaurus’), and it is therefore morphologically and proportionally intermediate between these two groups.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A RECONSIDERATION OF THE STATUS OF THE UPPER JURASSIC PTERODACTYLOID PTEROSAUR MESA DACTYLUS ORNITHOPTEROS FROM THE MORRISON FORMATION OF COLORADO

SMITH, David K., Northland Pioneer College, Show Low, AZ, United States; HARRIS, Jerry D., Dixie State College, Saint George, UT, United States

Pterosaurian fossils from the Upper Jurassic Morrison Formation remain fragmentary and poorly known. In the 1980s, a small synsacrum from Dry Mesa Dinosaur Quarry, Mesa County, Colorado, was proposed for the holotype for the new pterodactyloid pterosaur species Mepadactylus ornithopterus. A number of disarticulated cranial and postcranial elements subsequently have been referred to the same taxon.

Although the referred postcranial material is certainly pterodactyloid, the synsacrum would constitute an extremely unusual element for a pterosaur. It consists of a series of fused sacral vertebrae with prominent, distally fused neural spines that dramatically decrease in height posteriorly. The vertebrae also become minute posteriorly, indicating that this animal could not have had an extensive or large tail. Micro-CT scans failed to recover any evidence of internal structure or pneumaticity. The holotype synsacrum has been extensively figured, a detailed description is lacking. It not have had an extensive or large tail. Micro-CT scans failed to recover any evidence of internal structure or pneumaticity.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DENTAL WEAR AND LAMELLAR FREQUENCY ANALYSIS TO CONTRAIN THE IDENTITY OF THE NORTH AMERICAN MAMMOTH SPECIES

SMITH, Gregory J., Penn State University, University Park, PA, United States; GRAHAM, Russell, Penn State University, University Park, PA, United States

A mammoth skeleton found at the Newton Site, a kettle lake 15 km southeast of Towanda, Pennsylvania, has been referred to M. columbi on the basis of its high, narrow skull. However, the specimen’s thin enamel (1.5 mm) and moderately high lamellar frequency (9 plates/decimeter) resemble some specimens of M. primigenius, as well. Maps from the Neotoma database show that a Columbian mammoth inhabiting the Towanda area would be a significant outlier from the general geographic range (western US and Gulf Coast area from Florida to Texas) for this species. This record would suggest that M. columbi inhabited a broader range of environments than previously presumed. However, if the specimen was in reality M. primigenius, its location, 50 km north of the Oleon drift border, would align well with the Woolly mammoth’s range.

To better ascertain the Newton mammoth’s identification, we examine herein the effects of dental wear on the morphology of mammoth teeth, especially enamel thickness and lamellar frequency. Sagittal sections of mammoth teeth reveal the tendency for enamel lophs to become more broadly spaced and enamel ridges to thicken towards the base of the crown. Thus, an older M. primigenius with extensively worn molars might display thicker enamel and a lower lamellar frequency, and might therefore appear to be a Columbian mammoth on the basis of dental morphology alone. Here, we conduct an analysis of numerous M. columbi and M. primigenius molars at various stages of dental wear to determine if this phenomenon has played a role in determining the species identification of the Newton mammoth.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

PROBLEMATIC IDENTIFICATION OF PROBOSCIDEANS AT THE MIDDLE PLEISTOCENE PALEONTOLOGICAL/ARCHAEOLOGICAL LOCALITY OF ELANDSFONTEIN (WESTERN CAPE PROVINCE, SOUTH AFRICA)

SMITH, Kathy M., Georgia Southern University, Statesboro, GA, United States; STYNDEER, Deano D., University of Cape Town, Cape Town, South Africa

Three proboscidean species inhabited Africa in the middle Pleistocene: Loxodonta atlantica, Loxodonta africana, and Elephas recki. L. africana can easily be distinguished from L. atlantica and E. recki by the broad, lozenge-shaped wear surfaces of its molars. L. atlantica and E. recki are more difficult to distinguish on the basis of molar characteristics. These two species rarely co-occur in the African fossil record, with L. atlantica in northern and southern Africa and E. recki in eastern equatorial Africa. Consequently, taxonomic assignment of isolated molars from these species may have been based, in some cases, on geography rather than morphology. Elandsfontein (EFT), a middle Pleistocene locality on the west coast of South Africa, has produced hundreds of skull elements referred to L. atlantica. Among these are 15 complete or nearly complete permanent molars, one of which is newly recovered and has not yet been referred to a species. The last taxonomic revision of EFT proboscidean material was done in the 1970s, and additional material has been recovered since then, so an updated assessment could yield new insights into the biogeography and evolutionary history of middle Pleistocene African elephants. With this goal in mind, standard molar characteristics (crown height, width, length, enamel thickness, lamellar frequency, number of enamel plates, and hypsodonty index) were recorded for EFT molars, and characteristics of M3s (n=5) were evaluated against diagnostic characteristics for L. atlantica and E. recki. EFT molars were in general more similar to L. atlantica than to E. recki, but they exhibited features of both species and could not definitively be assigned to one. Principal components analysis (PCA) was conducted to compare EFT M3s to those of E. recki and L. atlantica described in the literature. Variables used in the PCA were those not substantially affected by tooth incompleteness: height, width, enamel thickness, and average lamellar thickness (a measurable reflection of lamellar frequency). The first principal component sorted individuals by species and showed that the newly recovered M3 was more similar to L. atlantica than to E. recki, but species assessment based on PCA was unreliable because the distinction between species was unclear on the first or any axis. Qualitative criteria may be more useful for identifying species based on molars; for example, E. recki exhibits irregular enamel folding, usually not present on L. atlantica and not present on EFT molars. Overall, there is little reason to revise taxonomic assignment of EFT specimens or to refer the new molar to E. recki. However, if not for geographic differences and based on molar criteria, E. recki and L. atlantica might be described as members of the same genus.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

REGIONAL PATTERNS OF MODERN SYMPATRY IN NORTH AMERICAN QUATERNARY MAMMAL FAUNAS

SMITH, Michael R., Indiana University, Bloomington, IN, United States; POLLY, David, Indiana University, Bloomington, IN, United States

The temporal and regional responses of past faunas to Quaternary climate cycles provide important insights for how biotas respond to changing climates and environments. We used cluster analyses, digital range data for modern mammals, and digital climate data to determine whether faunal similarity from 27 Quaternary sites in North America was affected by site age, past climate, or biogeographic region. Cluster analysis using the Raup-Crick index was used to categorize sites based on the similarity of their mammalian faunas. Areas of maximum modern sympatry for the extant species at each site were quantitatively identified using the modern geographic. Areas of sympatry were found by counting the number of modern species shared at each 50 km grid point in North America. The climate associated with the areas of maximum sympatry were found using the climate envelopes were constructed for the points with maximum sympatry using the minimum and maximum values for MAT and total annual precipitation from those points. Faunas clustered into four groups, which separate first on regional basis and secondarily on a climatic basis. The first cluster contained sites whose extant species were largely sympatric in the area of the site, the second cluster contained sites whose extant species are today sympatric in the northeastern Great Plains or north of the Great Lakes, the third cluster was a mixture of species that are today sympatric in the great plains or greater midwest, and the fourth with species that are today sympatric in the inter-montane west. The extant component of the faunas were highly predictive of this pattern despite the wide variety of ages, paleoclimates, and proportions of extinct fauna at the sites. Local climate and/or other geographic range controllers were mixed in these continental scale patterns indicating a need for understanding faunal dynamics on a regional scale.
We analyzed aspects of Early Jurassic sauropodomorph faunal structure using phylogenetic methods. Previous studies posited that some Early Jurassic sauropodomorph regional faunas were phylogenetically overdispersed (i.e., taxa from any given fauna are more distantly related to each other than expected by chance). However, phylogenetic overdispersion was not found in a previous study of Early Jurassic sauropodomorph faunas from Antarctica. Here we report the presence of red pigments in the tooth enamel of a primitive Cretaceous mammal, A TRANSYLVANIAN CRETACEOUS MAMMAL WITH RED IRON PIGMENTS IN TOOTH ENAMEL.

Digital endocasts were rendered for 17 charadriiform species (15 extant and 2 flightless, extinct species). Mapping of character state changes onto a well resolved phylogeny for Charadriiformes resulted in the recognition of differences between the endocast anatomy of wing-propelled diving Pan-Alcidae and other charadriiforms, distinctions between flightless and volant pan-alcids, and identification of characters that differentiate terrestrial and aquatic charadriiforms. In comparison with other charadriiforms, pan-alcids displayed compressed semicircular canals, indistinct occipital sinuses, and indistinct cerebellar fissures. Flightless pan-alcids have relatively smaller optic lobes and more laterally expanded anterior wulsts than those of volant pan-alcids. Aquatic charadriiforms are differentiated from terrestrial species by the possession of more vertically oriented brains, wulsts that are more anteroposteriorly expanded, posteriorly positioned endosseous labyrinths, and anteriorly expanded, tapered cochlear ducts. Additionally, the brain of Rynchops niger is unlike that of any other sampled charadriiform, and may be related to the unusual foraging behavior of that species. Furthermore, charadriiform affinity of the enigmatic fossil taxon Halyornis was supported through comparisons with charadriiform and outgroup taxa. Finally, based on these new morphological data and comparisons of relative brain volume, evolution of hypotheses regarding charadriiform genome size and its relation to flightlessness, gregariousness, flight capability, and developmental strategy were facilitated.

The Early Jurassic Hanson Formation of Antarctica has yielded unprecedented insight into the evolution of high-latitude vertebrate faunas during the early Mesozoic. Our 2010/11 expedition collected additional material of the theropod Cryolophosaurus ellioti, and the sauropodphorom Glaciatorus hammeri, the two previously known dinosaurs from the Hanson Formation. Remains of two new species of sauropodomorph were also recovered. Sauropodphorom A is represented by a nearly complete juvenile specimen, and includes portions of the skull, axial, and appendicular skeleton. Sauropodphorom B is represented by three articulated vertebrae (2 dorsals, 1 dorsosacral), a left ilium, both pubes, and a partial ischium. New U-Pb zircon dates of 194.0 +/-1.6 Ma from 20 meters below the Mt. Kirkpatrick strata help constrain the age of this fauna. A phylogenetic analysis of 57 taxa and 353 characters recovers the three Antarctic sauropodomorph taxa as distantly related to each other, and both new species as more closely related to Stupuropoda than to Massospondylidae. Sauropodphorom A is recovered as the sister taxon to Ignawusaurus from the Early Jurassic of South Africa, with Sarazhusaurus from the Early Jurassic of North America forming the sister taxon to this diad. Sauropodphorom B is recovered as the sister taxon to the Early Jurassic Leonerasaurus from Argentina. Glaciatorus is recovered as a member of Massospondylidae in a polytomy with Coloradisaurus and Lufengosaurus.

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Previous studies posited that some Early Jurassic sauropodomorph regional faunas were phylogenetically overdispersed (i.e., taxa from any given fauna are more distantly related to each other than expected by chance), but such patterns have not been tested quantitatively. We analyzed aspects of Early Jurassic sauropodomorph faunal structure using phylogenetic comparative methods and a time-sliced dataset with several branch length estimations. The phylogenetic diversity (standardized for unequal species richness) represented in the Antarctic sauropodomorph fauna is as high or higher than that of the other five Early Jurassic regional faunas analyzed. We found no significant support for phylogenetic overdispersion of sauropodomorphs in Early Jurassic regional faunas, though analyses generally recovered Antarctica as having the most evenly dispersed fauna. These results provide additional support for biogeographic links and prevalent dispersal across Pangea during the Early Jurassic. The presence of three distantly related sauropodomorphs in Antarctica also implies that although endemism in Antarctic vertebrates increased from the Early Triassic to Early Jurassic, climatic and/or physiographic barriers did not prevent dispersal into Antarctica during the Early Jurassic.

Technical Session X (Friday, October 19, 11:00 am)

A TRANSYLVANIAN CRETACEOUS MAMMAL WITH RED IRON PIGMENTS IN TOOTH ENAMEL.

Red pigments in tooth enamel of living mammals are known in soricomorph insectivores and murid and castoriod rodents. They are of iron composition and thought to increase the resistance to bacterial colonization of the enamel and therefore, are ideal for investigating intracranial endocast variation, and potential links between endocast anatomy, phylogeny, ethology, and ecology. Furthermore, although osteological correlates of the transition to wing-propelled diving and flightlessness in charadriiforms have been previously documented, corresponding morphological changes in the sensory systems of these birds have not been studied.

Soripterodactylus is recovered as a member of Massospondylidae in a polytomy with Ceratosaurus nasicornis and Allosaurus fragilis. The two previously known specimens of the enigmatic species B. transylvanicus differ from Kogasornung ungureanui by the more convex M1 with only two cusps on the lingual row in state of three, the more square M2 in state of triangular, the P4 that has about the same width on all the length of the tooth whereas the P4 of K. ungureanui is much wider on the posterior border than it is on anterior border, the P2 that has no long posterior expansion. The new specimen presents a pattern of red pigment distribution more like in soricomorph insectivores than in rodents and importantly shows that B. transylvanicus had no ever-growing incisors.
A DEVONIAN 'IN-GROWING' FINSPIRE: PATHOLOGICAL DEFORMITY IN A GYRACANTH FISH
SNYDER, Daniel, Middle Georgia College, Cochran, GA, United States; TURNER, Susan, Queensland Museum Geosciences, Brisbane, Australia

Dental pathologies are not unusual, with fossil examples known even in microfossils. Most are the result of injury, some result from heterochrony, but occasionally there is a developmental cause. Because they are modified placoid odontodes, dental spines can be compared to teeth and they are formed primarily of a type of dentine called osteodentine. Dermal spines are found in sharks, acanthodians ('spiny sharks') and their relatives from the late Silurian onward. Fin spines sometimes show pathological damage, usually resulting from injury. Developmental or late-stage changes in keratinous structures are well known in mammals but few if any pathological changes in early vertebrate fin spines have been recorded. A unique deformed pelvic fin from a gyracanthid acanthodian, probably Gyracanthides sherwoodi Newberry, has been found in the Upper Devonian (Fameninian) Duncannon Member, Catskill Formation, at Red Hill, Clinton Co., PA, USA. The deformity has been determined by its position on the body; rather than growing dorsoventrally, the fin spine grew mediolaterally, and did not lengthen much further than its own area of insertion. Gyracanthids have no known descendants, so we review modern analogues. We conclude that injury in life is a sufficient explanation, that there is evidence of extreme trauma without breakage. Such injury supports the view of gyracanthids as fish that regularly rested, bumped and scratched against the bed of the waters where they lived, and may offer an explanation for variation seen in other, more poorly-known spine taxa (e.g., Oracanthus).

X-RAY MICRO-COMPUTED TOMOGRAPHY REANALYSIS OF THE UPPER TRIASSIC DIAPSID ELACHISTOSUCHUS HUENELI
SÖHRAL, Gabriela, Museum für Naturkunde Berlin, Berlin, Germany; MÜLLER, Johannes, Museum für Naturkunde Berlin, Berlin, Germany

The Upper Triassic reptile Elachistrosuchus hueneli from Germany has been considered as both a pseudosuchian archosaur and as a sphenodontid lepidosaur in early studies based on characters such as presence of an antorbital fenestra and tooth implantation. Part of the reason for this ambiguous taxonomic assignment is that it shows many plesiomorphic characters, much of the material is encased in matrix, and it has been largely ignored in recent literature. In an attempt to shed new light on its morphology and phylogenetic relationships, parts of the holotype and assigned materials were scanned using high-resolution micro-computed tomography. Results revealed internal structures of the skull and new elements within the matrix. One of the most striking features recovered is the presence of well-developed processes in the frontals forming a tube-like structure medially. A similar, but more subtle character is reported for basal lepidosauromorphs and archosauriforms, but is lost in derived members of the latter clade. Due to lack of information, presence and distribution of this character among basal taxa is difficult to assess. Presence of a lacrimal, although reduced, and sub-thecodont tooth implantation are incompatible for sphenodontids. The condition of the posterior ramus of the jugal indicates a partially open lower temporal bar. Malexial, pterygoids and vomers bear a shagreen of denticles. The splenial might be absent. These are characters more commonly found in derived neodiapsids. Presence of a suborbital fenestra discards it as a basal synapsid. Scans also revealed a T-shaped interclavicle with a broad plate, a character not usually found in coscuhians. Clavicyles are also present and partially articulated. Among assigned materials, a strongly dorsoventrally flattened juvenile skull was found. The parietals are not entirely ossified, showing a large dorsal fontanelle and the morphology of jugals also indicates the presence of an incomplete lower temporal bar. This new work suggests that Elachistrosuchus may well be a late surviving neodiapsid or basal coscuhan taxon and that it has a great potential to provide new information on the phylogeny and evolution of these clades.

REFFERAL OF MIACIS LATOURI TO NEW GENUS, AND A PHYLOGENETIC ANALYSIS OF THE EARLIEST "MIACIDS" (CARNIVORAMORPHA)
SOÉLÉ, Floréal, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Richard, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; COLLOT, Tiphaine, SFA – Institut International de Paléoprimatologie, Paläontologie Humain: Evolution et Paléoenvironnement (IIPHEP) – UMR 6046, Université de Poitiers, Poitiers, France; DE BAST, Eric, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SMITH, Thierry, Department of Paleontology, Royal Belgian Institute of Natural Sciences, Brussels, Belgium

Based on new collections from the earliest Eocene locality of Dormaal, Belgium, we almost entirely reconstructed the deciduous and permanent dentition of one of the earliest "miacids," Miacis latouri, previously known by only two teeth (M1 and M2). The 250 new specimens found in Dormaal illustrate almost all the loci and therefore give information on the dentition of the "miacid" species and its variability. Based on the dental features, we refer the species to a new genus. Indeed, this population shows a mixture of features that are typical of either Miacis or Vulparius, which implies that the two genera were already almost separated from the very beginning of early Eocene. We also present evidence that "Miacis latouri" was sexually dimorphic and describe its tarsal bones (calcaneum and astragali), associated with dental remains by indirect methods. They represent the oldest specimens known for the "Miacidae" and their morphology supports an arboreal capability for this species. In order to ascertain the position among "miacids," we performed a phylogenetic analysis of the earliest "miacids." The resulting cladogram defined three important groups: the Uintaconus-group, the Miacus-group – including "Miacis latouri" and the Ooedectes-group. These results also suggest a dispersal of two lineages of "miacids" (Miacis-group and Ooedectes-group) from Europe to North America around the Paleocene-Eocene boundary. Moreover, the topology of the phylogenetic tree supports a Paleocene radiation of the "miacids," which is presently poorly known. Finally, the morphological comparisons and the phylogenetic analysis allowed us to refer Miacis rundlei from Abbey Wood, England (MPB-9) to the genus Glaucochloris and Miacis exiguus from the Bighorn Basin, Wyoming (W2a-3) to the genus Vulparius.

MACROEVOLUTIONARY TRENDS IN BODY SIZE DURING THE THERAPSID-ARCHOSAUROMORPH TRANSITION
SOOKIAS, Roland B., GeoBio-Center, Ludwig Maximilian University of Munich, Munich, Germany; BENSON, Roger B., Department of Earth Sciences, University of Cambridge and Department of Earth Sciences, University College London, London and Cambridge, London, United Kingdom; BURLE, Richard J., GeoBio-Center, Ludwig Maximilian University of Munich, Munich, Germany

Many explanations for apparent trends in body size in the fossil record have been proposed. Two key questions concerning terrestrial tetrapod body size evolution are whether selection for larger body size has driven what appears to be an increase in the size of many clades over time ("Cope’s rule"), and whether environmental changes are responsible for large-scale patterns seen in body size, including the exceptional size of dinosaurs. We investigated both of these questions, focusing on the replacement of basal therapsids (stem-group mammals) by archosaurs, including dinosaurs, as the dominant large-bodied terrestrial fauna during the Triassic. We compiled and analysed a dataset of body-size proxies for more than 400 therapsid and archosauriform species spanning the Late Permian–Middle Jurassic. Maximum-likelihood analyses indicate that Cope’s rule (i.e. an active within-lineage trend of body-size increase) is extremely rare, despite a clear long-term pattern of increasing body size in archosauromorphs. Instead, non-directional processes of evolution predominated in taxonomically and ecomorphologically more inclusive clades, with stasis more common in less inclusive clades. In addition, we compared changes in three abiotic factors – oxygen, CO2 (as a proxy for temperature), and land area – with changes in the maximum size of Permian–Jurassic archosauriforms and therapsids (with data from Cenozoic mammals for comparison) using time series generalised least squares regression models. When serial correlation is removed we find no robust correlations, suggesting that these environmental factors did not consistently control tetrapod maximum size. We also examined the shape of maximum size growth curves for Permian–Jurassic data by comparing fits of Gompertz and logistic models. Gompertz models – i.e. exponentially decreasing size increase with larger sizes – fit maximum size curves far better than logistic models. Together this suggests biological limits such as reduced fecundity and niche space availability, not environmental limits, become increasingly limiting as larger sizes are reached. Limits to body size appear to be highly clade-dependent, based on the lack of environmental correlations with body size, the exceptional size of dinosaurs, and the fact that maximum size of Middle–Early Late Triassic archosauromorph predators exceeded that of contemporary herbivores, breaking a widely accepted ‘rule’ that herbivore maximum size greatly exceeds carnivore maximum size. Previously identified unique adaptations (e.g. skeletal pneumaticity, high growth rate) probably facilitated the exceptional size of archosaurs, but of these adaptations only rapid reproductive rate was likely important in facilitating opportunistic replacement of therapsids.

AERIAL ABILITY IN BASAL DEINOCYNOGLOSSA
SORKIN, Boris, Queensborough Community College, Bayside, NY, United States

The previously proposed hypothesis that non-volant derived members of the coelurosaur clade Deinocynoglossa (Dinosauria: Theropoda) evolved from volant ancestors is evaluated by reviewing relevant publications subsequent to that of the hypothesis. Comparative anatomy and computer and physical modeling indicate that basal members of Deinocynoglossa, microraptorine Microraptor and aneurine Balanorhinus, possessed substantial scapulocoracoid and aileron ability, the former being capable of both gliding and active flight that utilised long pennaceous feathers on both fore- and hindlimbs. This supports the hypothesis that the more derived non-volant Eudromaeosauria and the non-volant Unenlaginae more derived than Balanorhinus, evolved from volant ancestors. The phylogenetic positions of Tianyarsaptor and Mahakula within Dromaeosauridae indicate that fore- and hindlimb with the body size, the exceptional size of dinosaurs, and the fact that maximum size of Middle–Early Late Triassic archosauromorph predators exceeded that of contemporary herbivores, breaking a widely accepted ‘rule’ that herbivore maximum size greatly exceeds carnivore maximum size. Previously identified unique adaptations (e.g. skeletal pneumaticity, high growth rate) probably facilitated the exceptional size of archosaurs, but of these adaptations only rapid reproductive rate was likely important in facilitating opportunistic replacement of therapsids.

POSTER SESSION IV (Saturday, October 20, 4:15 - 6:15 pm)

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scansorial ability and capacity for gliding flight that utilized long pennaceous feathers on
fore and hind limbs in basal members of both Dromaeosauridae and Troodontidae suggests
that the most recent common ancestor of Deinonychosauria is also a scansorial four-winged
glider. Known morphology of basal avialans Pesolopenna and Archaeopteryx suggest that the
same is true of the most recent common ancestor of Paraves.

It has been previously proposed that adaptations for aerial locomotion present in the known
non-avialan clade Oviraptorosauria were indicative of evolution from a terrestrial ancestor, just as similar adaptations in other theropods are indicative of volant ancestry in
derived non-Deinonychosauria. The morphology and phylogenetic position of yet
unknown oviraptorosaurs whose future discovery would support or falsify this hypothesis are
speculated on.

Technical Session XVIII (Saturday, October 20, 3:30 pm)
A VIRTUAL ENDOCAST AND ENDOCRANIAL FEATuRES OF OODECTES
(MAMMalia: Carnivoramorpha)
SPaulding, Michelle, Carnegie Museum of Natural History, Pittsburgh, PA, United States;
Flynn, John J., American Museum of Natural History, New York, NY, United States

A virtual endocast of the basal carnivoramorph Oodectes herpestoides was constructed from
a high-resolution computerized tomography scan (CT scan) of an exceptionally
well-preserved specimen from the Bridger Formation of Wyoming, USA. This specimen is
essentially undeformed, and thus has generated the first undistorted full endocast
known from a middle Eocene carnivoramorph. Natural endocasts are known from the
contemporary Vulpavus and the late Eocene Procorax. Vulpavus has been found to
be the sister taxon to Oodectes in our recent phylogenetic analyses, and comparing
these two endocasts shows them to be more similar to one another than is that of
Procorax, but there are some key differences. Most notably Oodectes has a relatively
more expanded frontal pole with some contact with the olfactory bulbs, and a longer dorsal
neocortical sulcus. Both Bridgerian taxon endocasts possess straight neocortical sulci on
the cerebrum, with less cerebellum contact than in Procorax.

The endocranial morphology of Oodectes is also described, providing the first endocranial
morphology description for a basal carnivoramorph. Endocranial features, such as an
ossified tentorium and the morphology of the dorsal surface of the petrosal, have long
been incorporated in higher-level phylogenetic studies including carnivorans, but
the status of these characters in stem carnivoramorph taxa has been unknown. Oodectes
possesses an ossified tentorium, but this structure is not as extensively developed as it is in
crown carnivorans. The dorsal surface of the petrosal of Oodectes has an extremely large
subarcuate fossa and a sharp anterior projection – the apex partis petrosae. This latter feature is
typical of crown carnivorans, but the size of the subarcuate fossa is not.

Recent advances in CT scanning, and steadily increasing computing power for analyzing
these scans permit much faster generation and processing of high resolution CT scans than
previously available. A database of more than ten scans of basal carnivoramorphs is
currently being assembled and this capability for ‘virtual preparation’ is greatly expanding
the potential for incorporating the morphology of the endocranial space into phylogenetic
analyses focused on these Paleocene and Eocene stem carnivoramorph taxa. This will
enable enhanced understanding of basal conditions and evolutionary transformations within
Carnivoramorpha and across related groups (Ferae, Orestontoria).

POSTCRANIAL OSTEOLOGY OF EARLY ORNITHIScHIAN DINOSAURS AND
THE ANCESTAL BODY PLAN OF ORNITHIScHIA
SPencer, Marc R., University of Iowa, Iowa City, IA, United States

Ornithischians first appear in the Late Triassic, but their early fossil record is sparse. The
earliest known forms are relatively small, bipedal, and possess morphological features that
are associated with herbivory. Furthermore, the phylogenetic position of many of these early
ornithischians remains unresolved. Previous work has focused primarily on cranial anatomy
because ornithischians demonstrate elaborate solutions for herbivory (e.g., tooth
batteries) and possess more informative postcranial ornamentation (e.g., crests) that have
demonstrated the value of postcranial morphology when it is used in combination with the
study of cranial morphology to evaluate the general postcranial body plan of ornithischians. Several of the earliest known ornithischians (e.g., Lesothosaurus, Stenonychosaurus, Heterodontosaurus) have been described, providing insight into the functional morphology of early ornithischian dinosaurs and the ancestral ornithischian body plan. Postcranial morphology is an important aspect of the paleobiology of these dinosaurs, and its study can provide valuable insights into the diversity and evolution of this group. This talk will focus on the postcranial anatomy of early ornithischian dinosaurs and the implications for understanding the ancestral body plan of Ornithischia.

Technical Session II (Wednesday, October 17, 9:00 am)
A LIVING ANALOGUE TO THE FIN-LIMB TRANSITION: LOCOMOTION AND FIN USE OF AN AIR BREATHING FISH ON LAND
STANden, Emily M., Redpath Museum McGill University, Montreal, QB, Canada;
Larssson, Hans C., Redpath Museum McGill University, Montreal, QB, Canada

When aquatic vertebrates first moved onto land they had to overcome many new
physiological and biomechanical challenges. One major hurdle would have been
transitional from an aquatic mode of locomotion to a terrestrial mode of locomotion. In
this study, Polypterus senegalus, an anadromous fish, was used to test how fins in a
basal, relatively preserved neopterygian can be used to locomote on land. Fish
were filmed swimming and walking at 250 frames per second and video was analyzed to
capture kinematic variables. Both body oscillation and fin movements differed between walking and swimming. Qualitatively, fish used the
medial surface of their pectoral fins as the primary power surface during swimming and switched to
the lateral pectoral fin surface for support and during walking. Quantitatively, during swimming animals had significantly larger body motions compared with
swimming. Polypterus senegalus effectively locomote on land and do so with significantly different fin and body motions. This contrast in fin and body motion between walking and swimming suggests the pectoral fin ‘functional landscape’ is diverse. We hypothesize that it is this functional plasticity that allowed early aquatic vertebrates to co-opt their fins effectively for terrestrial locomotion.

Preparers’ Session (Thursday, October 18, 8:15 am)
FROM DISCOVERY TO PUBLIC OUTREACH: A NEW VISITOR ORIENTATED FOSSIL QUARRY AND FOSSIL PREPARATION LAB OPENS AT THE BEN REIFEL VISITOR CENTER AT BADLANDS NATIONAL PARK
Starch, Eilen, Badlands National Park, Interior, SD, United States; Benetton, Rachel, Badlands National Park, Interior, SD, United States; Householder, Mindy, Badlands National Park, Interior, SD, United States; Boyd, Clint A., South Dakota School of Mines
and Technology, Rapid City, SD, United States; PAGNAC, Darrin, South Dakota School of Mines and Technology, Rapid City, SD, United States

In May of 2010, a specimen of *Hoploneuron* was discovered by a visitor at Badlands National Park. The collected elements include a complete skull and five cervical vertebrae. This specimen is one of the most superbly-preserved examples of *Hoploneuron* collected from the White River Group, owing in part to the calcareous cement of the Middle Scenic upper sandstone interval of the Brule Formation. However, the mandible was incomplete, and the medial section of the left side was totally absent. Realizing the significance of this find, the park partnered with the South Dakota School of Mines and Technology to assist in the digital reconstruction of the mandible, including recreating the missing segment and adjusting the model to counter the effects of deformation. The resulting data were used to generate: 1) a rapid prototype of the skull, allowing study of the specimen without incurring damage to the original; and 2) the mass production of scaled casts. The importance of this specimen was realized during preparation, when several puncture wounds in the skull were observed, consistent in size and depth with that of another nimravid. This new knowledge motivated a preliminary survey of the area, producing a fairly diverse faunal list, including a marsupial (*Herpetotherium*), a leporid (*Palaeolagus*); rodents (*Eumys, Ichthyromys*); perissodactyls (*Mesohippus, thscierodont*); artiodactyls (*Merycoidodon, Leptometes*); reptiles; and trace fossils. The diversity and unique preservation of these fossils led the park to open both a visitor-oriented research quarry and an interactive, fossil preparation lab, inside the adjacent Ben Reifel Visitor Center in June of 2012. Inserting a fossil preparation lab into a historic structure, utilized daily for interpretive education and visitor outreach, presents unique challenges. Concerns related to noise levels, safety, and preservation of the historical structure all had to be carefully addressed while ensuring that specimens are handled, prepared, and secured according to the highest standards. Since construction of a traditional viewing lab was impractical, a workstation was fabricated in an area designated for specimens to be viewed by the public while also providing a sealed work space to contain fossil preparation byproducts. For the first time in park history, visitors will be able to observe and interact with scientists at a fossil quarry, a fossil preparation lab, and a visitor center, all in an easily accessible area. With continued excavation and research, via expanded paleontological facilities and partnerships with universities, Badlands National Park plans to continue alternative, non-destructive methods of preparation and cast reproduction, in hopes of further preserving fossils for future generations.

Technical Session II (Wednesday, October 17, 11:30 am)

**A NEW FOSSIL CHAR (** _Salvelinus_ **) FROM MIOCENE LAKE SEDIMENTS IN STEWART VALLEY, NEVADA**

STEARLEY, Ralph F., Calvin College, Dept. of Geology and Geography, Grand Rapids, MI, United States; CAVEN, Robert P., Ohio State University, Department of Evolution, Ecology and Organismal Biology, Columbus, OH, United States.

During middle Miocene time, between 18 and 9 Ma, the Walker Lane region of western Nevada was a high-altitude plateau undergoing transpressional disassembly. Intermittent N-S drainage connections formed between adjacent downfaulted basins, possibly extending northward to southeastern Oregon. To the east, in eastern Nevada and western Utah, a rugged highland served as a drainage divide. Geologic data, including mapped ignimbrites extending across the present crest of the Sierra Nevada, indicate probable drainage connections between western Nevada and the Pacific Ocean. In Stewart Valley, Mineral County, Nevada, lacustrine sediments, the Savage Canyon Formation, reveal the presence of a lake which occupied the basin approximately 15 million years ago, as determined by potassium-argon dates, plant-, and mammalian biostratigraphy. During the 1970’s through early 1990’s, University of California crews recovered fossils of a large (30+ cm), well-toothed eusalmonine from these lacustrine sediments. Non-cranial features of this eusalmonine include a small adipose fin, 58-60 vertebrae, and numerous small scales, typical characteristics of modern *Salvelinus* species. A review of this material has presented as prime examples of extinct animals possessing woven bone matrix show a strong birefringence in longitudinal plane. This optical feature is identical with that of the circumferential lamellar bone generally observed in transversal sections of poikilothermic ectotherm long bones, the presence of which is thought to be a reliable indicator of a slow growing bone tissue. The antiquity nature of primary cortical bone in longitudinal sections is consistent with recent texture analyses on sauropod bone illustrating a preferential longitudinal orientation of the long (c) axis of the fluorapatite crystals. This suggests that highly organized fibre orientation in a bony matrix does not necessarily limit growth rates; an observation that has significant implications for the interpretation of the historical indicators of growth rates (Amprino’s rule) and evolution of growth strategies. The longitudinal arrangement of crystallites reflecting the original alignment of the collagen fibres is likely an adaptation to biomechanical requirements of the long bones of sauropods. Based on these results, the very presence of woven bone in non-embryonic and non-pathologic long bones of sauropods is hereby contested. We hypothetize that the mistaken isotropy observed in most commonly used transversal sections is most likely the result of the random orientation of the a and b axes of the crystallites along their c axis. These results again call for awareness of the three dimensional character of bone when drawing far reaching conclusions based purely on two dimensional histological thin slice images.

**DRIVERS OF JAW SHAPE IN ** _Neotoma_ **: MANDIBULAR GEOMETRIC MORPHOMETRICS AND IMPLICATIONS FOR MORPHOLOGICAL PARTITIONING**

STEGER, M. A., U.C. Berkeley, Berkeley, CA, United States; FERRER, Elizabeth, U.C. Berkeley, Berkeley, CA, United States

The modern biodiversity crisis has generated interest in the response of species to climate change in the past. *Neotoma* is one of the most common taxa in Neogene North American fossil deposits; these woodrats are paleoecologically important because they collect bone-laden carnivore scats and raptor pellets in their middens, providing a major source of Quaternary fossil material. However, it is potentially difficult to identify Neotoma fossils to the species level. Body size ranges overlap across most species, and body size within species is strongly correlated with climatic variables. Although teeth are often diagnostic to species in mammals, in *Neotoma* interspecific tooth variability among species is low, whereas within species it is high. Nevertheless, because *Neotoma* species partition their environment, knowing which species are present in fossil deposits is important for understanding the environmental implications of turnover and abundance changes. We analyzed extant *Neotoma* jaws using geometric morphometrics to determine (1) if we could identify toothless mandibles to species, and (2) if climate and/or phylogeny correlates with jaw shape of modern mandible blond views of 445 right mandibles (all individuals were adults with similar degrees of tooth wear) from nine species of *Neotoma* found in the Western US, and conducted a Procrustes analysis on two landmarks and four curves (60 semilandmarks). We performed a Canonical Variates Analysis (CVA) to explore the morphological relationships among species, and made pairwise Hotelling’s T2 test comparisons (permutation test with 1000 resamplings, Holm p value adjustment) to determine which species could be differentiated based on mandible shape. Though most species were morphologically too similar to distinguish, we found that several, including *N. cinerea* and *N. lepida*, could be identified in some pairwise comparisons. We also tested for a correlation between mandible shape and both climate variables and body size (nasal length as a proxy for size) using multiple linear regression. There is no correlation between jaw shape and body size, so we were able to rule out allometric effects. Phylogenetic signals were assessed using generalized least squares (GLS). Shape was significantly correlated with local temperature across species, but within species, mandible shape depends more on intraspecific competition—this is strong morphological confirmation for the observation that, when several species of *Neotoma* are present in the same region, they partition dietary resources.

**NO FIBROS (WOVEN) BONE IN SAUROPOD FILOBAMMELLAM BONE?**

STEIN, Koen, Steinmann Institut fuer Geologie, Mineralugie und Palaeontologie, Bonn, Germany; PRONDVAI, Edina, Hungarian Academy of Sciences – Eotvos Lorand University “Lendulet” Dinosaur Research Group, Budapest, Hungary

Fibrolamellar bone is defined as a composite tissue consisting of a rapid growing woven fibro bone matrix in which primary vascular canals are embedded in a space with a growing infilling of lamellar bone. This tissue is widely recognized in mammals, non-avian dinosaurs and birds. Here we provide histological evidence that the bone matrix hitherto interpreted as isotropic woven fibro bone in transverse sections of sauropod limb bones actually has a lamellar to parallel-fibred anisotropic nature in longitudinal sections. Thin sections of long bones of well known sauropod taxa (e.g. *Alamosaurus, Apatosaurus* and *Camarasaurus*) presented as prime examples of extinct animals possessing woven bone matrix show a strong birefringence in longitudinal plane. This optical feature is identical with that of the circumferential lamellar bone generally observed in transversal sections of poikilothermic ectotherm long bones, the presence of which is thought to be a reliable indicator of a slow growing bone tissue. The antiquity nature of primary cortical bone in longitudinal sections is consistent with recent texture analyses on sauropod bone illustrating a preferential longitudinal orientation of the long (c) axis of the fluorapatite crystals. This suggests that highly organized fibre orientation in a bony matrix does not necessarily limit growth rates; an observation that has significant implications for the interpretation of the historical indicators of growth rates (Amprino’s rule) and evolution of growth strategies. The longitudinal arrangement of crystallites reflecting the original alignment of the collagen fibres is likely an adaptation to biomechanical requirements of the long bones of sauropods. Based on these results, the very presence of woven bone in non-embryonic and non-pathologic long bones of sauropods is hereby contested. We hypothetize that the mistaken isotropy observed in most commonly used transversal sections is most likely the result of the random orientation of the a and b axes of the crystallites along their c axis. These results again call for awareness of the three dimensional character of bone when drawing far reaching conclusions based purely on two dimensional histological thin slice images.

**A NEW TAXON OF DIAMANTOMYS FROM THE LATE OLOCONEGRO NSUNGWE FORMATION, RUKWA RIFT BASIN, SOUTHWESTERN TANZANIA**

STEGES, Nancy L., Ohio University, Athens, OH, United States; O’CONNOR, Patrick M., Ohio University, Athens, OH, United States; ROBERTS, Eric M., James Cook University, Townsville, Australia

*Diamentomys* *leanderiti* (Mammalia: Rodentia: Hystricognathi) was first described from localities of mid-late Miocene age in what is now Namibia, based on a lower jaw preserving three molar teeth. In the original description, the extreme distinctiveness of this taxon was remarked upon, with an arrangement of crests and cusps resembling no other rodent taxon. Hundreds of additional specimens recovered from the Miocene of southwestern and eastern continental Africa have subsequently been ascribed to the taxon. Yet discoveries from late Oligocene and early Miocene sites in eastern Africa have begun to reveal substantial early diversity in the clade, with the emergence of a handful of novel species attributed to the genus in recent years. Here we describe a new species of *Diamantomys* representing the largest of the *Nsungwe Formation* rodents, with mesiodistally elongate and distinctly crestiform molars generally consistent with members of the genus *Diamantomys*, yet highly size distinctive and preserving more elaborate crenating on the lower molars together with a posterior cingulid. The morphology of late Oligocene micromammals
from the Rukwa Rift Basin of Tanzania suggests that the Nsungwe fauna may provide bridge between well-documented early and mid Cenozoic hystricognath rodents. Rodent fossils from the late Oligocene interval on continental Africa are critical for linking the richly diverse early Paleogene faunas of Saharan Africa and Oman with the better-sampled Miocene faunas of Afro-Arabia and beyond.

Technical Session I (Wednesday, October 17, 8:30 am)

A MULTI-ELEMENT HISTOLOGICAL ANALYSIS OF THE JURASSIC TYRANNOSAURUROID GUAULONG WCUCI

STIEGLER, Josef B., The George Washington University, Washington, DC, United States; CHONIERE, Jonah N., American Museum of Natural History, New York, NY, United States; NU, Xing, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; CLARK, James M., The George Washington University, Washington, DC, United States

While knowledge of skeletal development in Cretaceous coelurosaurians continues to grow, relatively little is known about ontogeny in their Jurassic counterparts. The basal tyrannosauroid Guaulong wucui from the Upper Jurassic Shishugou Formation of Xinjiang, P.R.C. is known from two penecontemporaneously fossilized individuals of differing size and ontogenetic maturity. We produced histological sections from core samples of the right humerus, femur, and tibia from the larger holotype specimen, as well as whole-element sections from the humerus, femur, tibia, and fibula of the smaller referred specimen. In addition, we examined fibular thin sections of both specimens that were produced for a previous study.

Both individuals exhibit a fibro-lamellar complex with sub-plexiform vascular organization in all examined elements, although localized fields of reticular vascularization are present, especially in the smaller individual. The frequency of longitudinally oriented primary osteons increases approaching the periosteal surfaces of hind limb elements in both specimens (consistent with a slowed rate of growth). Double and triple lines of arrested growth (LAGs) are visible in the interior cortex of the tibia in the holotype. Multiple spaced LAGs have been previously ascribed to stressful life-history events and this pattern may be measurable by the interpreted seasonal activity of the Shishugou Formation. An external fundamental system (EFS) is present in hind limb elements of the large specimen with varying numbers of LAGs in each, but no EFS is visible in the humerus, perhaps indicating significant allometric change in limb proportions during ontogeny.

Several features indicate substantial lateral migration and remodelling of the fibula and relative stationarity of the tibial medullary cavity during ontogeny in the smaller specimen: (1) a marked lack of concentricity of growth lines in the fibula; (2) osteoblastic and osteoclastic activity on the lateral and medial peristeal surfaces of the fibula, respectively; (3) numerous secondary osteons and large erosion rooms in the medial region of fibular cortex; and (4) the presence of extensive endosteal lamellar bone in the tibia with little evidence of peri-medullary haversian systems, Howship’s lacunae, or resorption lines. Similar patterns of fibular remodelling and migration, and/or tibial stationarity can be seen in published histological sections of Cretaceous tyrannosaurids (e.g., Tyrannosaurus, Daspletosaurus and Raptorex). These findings reveal potential biases associated with age estimates derived from fibulae, and emphasize the utility of multi-element histological studies for accurate ontogenetic assessment.

THE EVOLUTION OF RHINO ARTHRITIS IN THE CENOZOIC

STILSON, Kelsey T., University of Oregon, Eugene, OR, United States; HOPKINS, Samantha S., University of Oregon, Eugene, OR, United States; DAVIS, Edward B., University of Oregon, Eugene, OR, United States

The family Rhinocerotidae provides a natural system for understanding the evolutionary underpinnings of arthritis, because osteological evidence of arthritis increases in frequency through their evolutionary history. The severity and prevalence of arthritis in Rhinocerotidae increases substantially from 50 million years (Ma) to the present: early rhinocerotids and their relatives have arthritis rates similar to those of other mammals, but individuals of all five extant species of rhinoceros develop extensive arthritis in all of their distal limb bones before they reach maturity. Through this interval, rhinos increased dramatically in size, evolving from animals like Hyrachyus, which was about the size of a large dog (150 kg), to the one-ton, stout-limbed megafauna of today. Despite this order of magnitude increase in mass, rhinos consistently displayed cursoriality (the habit of running) throughout their evolutionary history. These competing factors of increasing size and consistent cursoriality provide a possible driver for the prevalence of arthritis in living members of the clade. We have examined specimens of Hyrachyus and the extinct rhinos Trigonias, Diceratherium, Menoceras, Aplbelaps, Teleoceras, as well as all five species of extant rhinos on the population level. Using 2700 specimens from 12 species of rhinos, we have been able to trace the history of articular development in the rhino lineage, finding that arthritis changes immensely through the history of the rhinocerotid lineage, from 20% of the bones in Hyrachyus to 50% of the early Miocene Menoceras to almost 100% of skeletal elements in modern rhinos. As it increases, it goes from a phenomenon localized mostly in the feet to one found throughout the skeletal system, showing the impact of the forces experienced by the skeleton over an ever-increasing proportion of the animal’s body. The severity of arthritis also seems to increase, as indicated by indicators of greater severity of arthritis in individual joints. The frequency of articular development is related to increasing body size, but that there are clearly other evolutionary effects controlling its prevalence, in particular ongoing evolutionary changes in locomotion. Our results suggest arthritis was a pathology that was ‘allowed’ to develop in lineages of rhinos in the face of more pressing adaptations. The persistence and rise of arthritis in rhinocerotids suggests that the resolution to this evolutionary tradeoff may include a surprising degree of accommodation.

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SPATIAL AND TEMPORAL SHIFTS IN PALEOGENE CROCODYLIFORM DIVERSITY AND A NEW GLOBIDONT ALLIGATOROID FROM THE MIDDLE EOCENE OF WEST TEXAS

STOCKER, Michelle R., The University of Texas at Austin, Austin, TX, United States; BROCHU, Christopher A., University of Iowa, Iowa City, IA, United States; KIRK, E. C., The University of Texas at Austin, Austin, TX, United States

Most of our knowledge regarding the loss of diversity within Crocodyliformes in the Middle and Late Eocene comes from specimens from the central Western Interior. However, crocodylians from the Middle Eocene Devil’s Graveyard Formation (DGF) of West Texas provide additional information from southern North America during that period of faunal reorganization. Here we describe a new taxon of alligatoroid from the middle member of the DGF based on the most complete alligatoroid material known from Tertiary deposits outside of the Western Interior. The precise age of the new taxon is unclear because of a lack of associated fauna or datable tuffs. However, the holotype was recovered from a stratigraphic horizon between the Late Uintan Purple Bench locality and the Duchesnay Skyline Channels localities. The new taxon is similar to alligatorine material from the Uinta Formation of Utah and shares the presence of nearly spherical tooth crowns with previously published mandibular fragments from lower in the DGF stratigraphic section. However, the new DGF taxon can be distinguished from the Uinta Formation material and all other alligatorines on the basis of several caiman-like features, including a prominent, notched, descending lamina of the pterygoid posterior to the choana and a long descending process of the exoccipital that makes contact with the basioccipital tubera. Additionally, autapomorphies of the new taxon include rounded anterior processes of the palatines and a prominent, anteriorly extending crest on the dorsal surface of the skull anterior to the orbit. Although the posterior maxillary teeth are bulbous (a feature shared with basal alligatorines), the posterior alveoles are smaller than the fourth and fifth maxillary alveoli, which is a feature shared with Alligator and another new species from the Uinta Formation. Our morphological phylogenetic analysis indicates that the new DGF taxon has potential affinities with Alligatorinae. This new taxon adds to the diversity of specialized globidontians in the Paleogene and represents the southernmost known occurrence of a blunt-toothed alligatoroid in the Paleogene of North America. Other crocodylians known from the DGF include a pristichampsine and Boreasuchus. Crocodylians are not identified from this formation, suggesting slightly lower crocodyliform diversity in West Texas than in Uintan deposits further north.

Preparators’ Session (Thursday, October 18, 9:00 am)

METHODOLOGY AND RESULTS OF A COMPREHENSIVE SPECIMEN CONSERVATION CONDITION SURVEY OF AN ACTIVE BONE BED AND STORAGE COLLECTION AT THE MAMMOTH SITE OF HOT SPRINGS, SD, INC.

STORCH, Paul, Museum Science Consultants, Saint Paul, MN, United States; WILKINS, William J., Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; POTAPOVA, Olga, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States; AGENBROAD, Larry, Mammoth Site of Hot Springs, SD, Inc., Hot Springs, SD, United States

The Mammoth Site of Hot Springs, SD (MSSH) poses unique challenges for collections management, conservation, and preservation in that it is both an active, on-going paleontological excavation site and a research collection. Discovered in 1974, the development of the site and the museum has paralleled the growth and development of the field of museum conservation. Over the past two decades the MSSH has applied conservation methods and materials used in the stabilization and preservation of the specimens. The museum has also undergone various assessments of its operations, developed a long-range conservation plan, and acted on the recommendations of the assessors. The comprehensive specimen condition survey, an object by object survey, is the most detailed conservation assessment available. The assessment consists of visual and tactile observations of individual specimens and recording ordinal numerical rankings of specimen and matrix condition and treatment priority. The ranking system was developed by the conservator (Storch) in collaboration with the MSSH staff (Potapova and Wilkins). The amount of time in hours required for conservation treatments (e.g. stabilization, cleaning, reversing improper treatments, etc.) were also estimated. The bone bed and collections storage specimens were assessed in two on-site visits of ten days each. Eighty-three and thirty individual bones were assessed and results tallied for the three metrics mentioned above. Condition assessment reports were filled out for each specimen and will be added to the more detailed collections specimen records. Images of representative conditions for each ranking were taken and are included in the final project report. In the bone bed, 12% of the specimens are in the poor to fair condition categories, 68% in good, and 20% rated as excellent. The condition of the “poor/fair” specimens, and many of the elements in the “good” ranking, is due to the presence of darkened and aged cellulose nitrate and polyvinyl butyral polymer resins applied as preservatives and consolidants to the bone surfaces and matrix. Results are similar for the specimens in storage. The final project report summarizes the results within a conservation risk assessment framework of ten agents of deterioration including disassociation, or the separation of provenience information from the specimen. The project also applied the condition rankings to the specimen location information in ArcGIS for the site as an additional mapping layer so the in-situ exhibit information can be highlighted by condition ranking for identification and preservation work planning.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

MYRMECOPHAGOUS MAMMAL MICROWEAR STRAIT, Suzanne G., Marshall University, Huntington, W.V, United States

Faunivorous mammals eat an extensive array of food items that vary substantially in their physical properties and offer different foraging challenges. Therefore, it is not surprising that there are equally diverse adaptations for feeding on these foods including two morphological extremes. Small-bodied primate, bat, insectivoran, and marsupial insectivores tend to hunt and feed primarily on individual coleopterae, leptopteran, and orthopteran. Microfaunivory typically they have triturating crests and high dental complexity values relative to frugivores. On the other extreme are the myrmecophagous mammals from many groups (anteaters, tamandua, armadillos, echidna, aardvark, pangolin, nimbuts, sloth bears, and aardwolves) that have evolved to prey upon on colonial insects (hymenopterans and isopterans). The true specialists of this group have convergently evolved reduced dentitions and dentaries. Additionally, many other modern mammals include large quantities of colonial insects in their diets but do not demonstrate the extreme masticatory system reduction of species such as anteaters and pangolins. The question explored in this study was whether there is a dental microwear signal correlated to ant and termite feeding that could be used to identify fossil taxa that regularly eat colonial insects regardless of whether or not they demonstrate masticatory reduction.

Scanning electron micrographs at 500X magnification of lower molars were analyzed for microwear feature size and density on the only myrmecophagous mammals that have retained enamel-covered teeth: Proteles cristatus (aardwolf), Melursus ursinus (sloth bear), and Myrmecobius fasciatus (numbat). These data were compared to earlier work on other faunivorous mammals and data from the literature for frugivores and folivores. Results indicated that feature size and density is probably the microwear signal most suggestive of the type of faunivory, with faunivores have much higher feature densities than either frugivores or folivores. Additionally, although terme/ant feeders tend to have same high feature density range as previously reported for other types of faunivorous diets, they can be distinguished from these by lower pit frequencies. These data suggest that the microwear signal of myrmecophagous mammals is unique and can potentially be identified in the fossil record.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RE-EXAMINING THE AFFINITIES OF MOSASAURUS GRACILIS – IS IT TRULY A MOSASAURUS?

STREET, Hallie P., University of Alberta, Edmonton, AB, Canada; C allure, Michael W., University of Alberta, Edmonton, AB, Canada

In 1822, the genus Mosasaurus, based on remains from the Maastrichtian of the Netherlands, became the first named taxon of mosasaur, followed in 1829 by the addition of the specific epithet to the specimen of “hoffmanni”. Mosasaurus missouriensis (originally described as M. maximillimani) from the Upper Cenomanian of North America was the second described species of Mosasaurus, followed in 1849 by the description of M. gracilis from very fragmentary remains from the Middle to Upper Turonian (Upper Chalk) of the southeast English Coast. The type material of M. gracilis includes an associated pair of right and left dentaries, an isolated vertebra, and three articulated vertebral fragments, all from the Middle to Upper Turonian sections of the Olhund Pit, near Lewes; and a right dentary originally described as a maxillary fragment from the Chalk at Dorking. Examination of the type specimens of M. hoffmann and M. missouriensis, with comparisons to M. gracilis, reveals that the latter taxon does not share any generic-level anatomical features with either the generic type, or these two other species of Mosasaurus. In fact, M. gracilis exhibits more shared characters, such as a short rostrum on the dentary anterior to the first tooth, with russellosaurine mosasaurs. In addition, M. gracilis is known from Turonian-aged deposits, while other species belonging to Mosasaurus are Upper Campanian to Maastrichtian in age. Based on the evidence of shared characters and contemporaneity, we suggest that M. gracilis be removed from Mosasaurus because it shares more affinities with russellosaur-like mosasaurs.

AGE AND PALEOECOLOGY OF MOSASAURS AND PLEISOSAURS FROM THE LATE CRETAECIOUS SOUTH ATLANTIC MARGIN AT BENTIABA, ANGOLA

STRANGAN, Christopher, Southern Methodist University, Dallas, TX, United States; FERGUSON, Kurt M., Southern Methodist University, Dallas, TX, United States; JACOBS, Louis L., Southern Methodist University, Dallas, TX, United States; POLCYN, Michael J., Southern Methodist University, Dallas, TX, United States; MATEUS, Octávio, Universidade Nova de Lisboa, Caparica, Portugal

The geology of coastal Angola reflects the rifting of Africa and South America and the development of the South Atlantic Ocean. This study utilizes stable carbon isotopes derived from foraminiferal shells to constrain the age of mosasaur and pleisosaur teeth recovered from a single horizon, and uses carbon isotopic values derived from tooth enamel to refine the marine vertebrate niche partitioning. The vertebrate-bearing horizon is near the top of a marine section unconformably overlain by continental syn-rift deposits. A basal flow intercalated within the marine sequence is dated at 84.5 Ma (Santonian), and reflects a widespread magmatic interval along the South Atlantic margin. The age of the basal beds is constrained by the last occurrence of C. carnifex in the English Chalk and Tunisia. Low in the section is a 4% positive excursion interpreted as Oceanic Anoxic Event 2 at the Cenomanian-Turonian boundary (93.5 Ma), indicating the sediments were deposited from
the Late Cenomanian to Early Maastrichtian. The δ13C values derived from mosasaur and pliosaur tooth enamel range from -5 to -16‰, showing a negative trend with increasing body size. This pattern is similar to that observed in modern marine mammals, in which more negative δ13C values correlate with deep diving behavior and foraging habitats distant from the shoreline. Specimens of the mosasaur Globidens implicated values more negative than expected for their body size and are interpreted as reflecting long diving durations required by their durophagous feeding behavior. Pliosaurus specimens yielded δ13C values between -5 and -14‰. The large range in values reflects taxonomic variation or habitat partitioning among individuals. The diversity of niches utilized by large bodied marine amniotes implied by these results suggests a high level of productivity during the Late Cretaceous across a range of habitats along the coast of Angola.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

LATE CRETAEOUS FISH OTOLITHS FROM NORTHEAST MISSISSIPPI: IMPLICATIONS FOR NORTH AMERICAN TELEOSTEAN EVOLUTION AND DISTRIBUTION
STRINGER, Gary L., University of Louisiana at Monroe Museum of Natural History, Monroe, LA, United States

Well-preserved and relatively abundant fish otoliths from the Late Cretaceous Ripley Formation at the Blue Spring Site (MS 73.035) in southeast Union County in northeastern Mississippi (USA) have contributed to a better understanding of teleostean evolution and distribution in North America. Extensive leaching of Cretaceous strata often destroys the aragonitic fish otoliths and limits otolith occurrence to primarily clays and marls. Fortunately, highway construction exposed a large area of the Ripley Formation, which included the Coon Creek beds that contain aragonitic remains. Ten collections were acquired from the aragonitic clay beds through bulk sampling and surface collecting. These collections resulted in approximately 800 fish otoliths for study. The number of specimens from the Blue Spring Site is quite significant in that many previous North American Cretaceous otolith studies have been based on 100 to 300 otoliths. Bulk samples were taken at four measured sections at the site with seven samples ranging from 11.5 to 25 kilograms (total of 102 kilograms). Bulk samples produced 446 otolith specimens, while three surface collections supplied an additional 355 otoliths. Statistical analysis for abundance was limited to the bulk sample otoliths.

The majority of the otoliths were sagitta, but there were lapilli from several arid taxa (marine catfish). Some of the otoliths exhibited crenulated and lobated margins, which was an indication of their excellent state of preservation. The abundance and preservation of the fish otoliths contributed to the first North American Cretaceous occurrence of several taxa. Furthermore, the larger sized otoliths from the surface collections made it possible to identify several taxa with greater specificity than previously possible based on smaller, immature specimens. Otolith specimens that compare favorably with the synodontids (lizardfishes) Saurida and Synodus are reported for the first time from the Cretaceous in North America. Also, a small serrated otolith was identified as most likely belonging to Centropristis and represents the first Centropristis otolith from the North American Cretaceous. The specimen is especially significant in that it provides additional evidence for the presence of perciforms in the Cretaceous. Perciforms were long believed to be restricted to the Cenozoic, but otoliths studies from North America and Europe have clearly shown their presence in the Mesozoic. Well-preserved, larger otoliths from the surface collections made it possible to more precisely identify several forms. The otoliths previously identified as Polyxinae indeterminate appear to be closely related to Polyxina, and "genus Trachichthychiurum" oscians may be in the genus Hoplostethus.

POSTER III (Friday, October 19, 4:15 - 6:15 pm)

COMPUTER TOMOGRAPHY INVESTIGATIONS INTO CRANIAL PNEUMATIZATION IN A SMALL OLIGOCENE SULID (STEGANOPODES:SULIDAE)
STUBBS, Alyssa E., North Carolina State University, Raleigh, NC, United States; KSEPKA, Bruce M., University of Kansas, Lawrence, KS, United States; WANG, Kebai, Zhucheng Museum, China; WANG, William, University of New Hampshire, Durham, NH, United States; BOWRING, Samuel, Massachusetts Institute of Technology, Cambridge, MA, United States; CHINNERY, Brenda, University of Texas, Austin, TX, United States

Sulidae are a family of coastal seabirds known for their ability to plunge-dive from great heights into the water. The cerebrum of the fossil sulid, the extant Sula leucogaster, was recently described from an isolated metatarsal to the new putative species "Tyrannosaurus zhuchengensis". Although these finds are taxonomically indeterminate, more diagnostic tyrannosaurid material has recently been collected and is being studied by our research group. An associated maxilla and dentary comparable in size and gross morphology to the corresponding elements in the Mongolian species Tarbosaurus bataar were recently described by some of us as a new large tyrannosaur, Zhuchengyuanmus magnus. Z. magnus is distinct from T. bataar in important details of the maxilla, including the lack of a subcutaneous flange, the presence of a horizontal shelf on the lateral face of the ascending process, and the shape and position of the maxillary fenestra. A second tyrannosaurid maxilla and dentary are known from the same quarry, and disarticulated postcranial bones and teeth have also been collected from the Zhucheng site. The second maxilla is distinct from that of Z. magnus in many respects, including all three features mentioned above, but could be referable to T. bataar despite minor differences from previously described maxillae of that taxon. It is clear that two very large tyrannosaurine species coexisted in what is now the Zhucheng area during the Late Cretaceous, an unusual situation that presumably required some form of niche partitioning. The second tyrannosaurid dentary shows clear pathological features, including a swolen, medially thickened overall shape and a more-liking prominence on the medial surface below the foramen inanum/branchialis oralis. CT scans suggest that the prominence represents the surface expression of a dental abscess, from which an osteomyelitic infection probably spread diffusely and altered the shape of the entire dentary. Although a dental abscess has previously been documented in a hadrosaurid dinosaur, the presence of this type of
pathology in a theropod is novel. Dental abscesses appear to have been uncommon in dinosaurs, but in rare cases they clearly did occur. The abscess in the dentary from Zhucheng would certainly have interfered with feeding and been detrimental to the animal’s overall health.

Preparators’ Session (Thursday, October 18, 10:15 am)

USING A GLYCEROL-WATER SOLUTION TO CONTROL RELATIVE HUMIDITY IN A CLOSED ENVIRONMENT

SUPPLEE, Jeffrey, East Tennessee State University, Johnson City, TN, United States; COMPTON, Brian, East Tennessee State University, Johnson City, TN, United States

Glycerin is a tri-liquid alcohol that is water-soluble, viscous, and hygroscopic. Consequently, it has many industrial uses in areas such as pharmaceuticals, food and beverages, textiles, paper and printing, among others. The hygroscopicity of glycerin (also called glycerol) is its ability to take moisture from the atmosphere and hold it. In order to achieve a desired relative humidity in an enclosed environment, a given amount of water can be added to a glycerin solution which achieves evaporative equilibrium with the enclosed atmosphere. To slowly dry fossils, we utilized glycerol’s properties to incrementally lower the relative humidity over extended time periods. Prior to this use of glycerol solutions, wet Pleistocene fossils from Saltville, VA were tested using other methods to control the rate of water evaporation. The fossils were dried at different rates (quick dry, 1 month, 3 months, and 6 months), attempting to control the rate of drying by slightly opening or adding damp towels to closed containers housing the fossils. We had remote sensors that recorded temperature and relative humidity inside each of these closed containers. A uniform decrease in relative humidity from 75% to 40% was found to be the optimal drying rate. We calculated to use as a standard for each of these time frames. Trying to match this calculated rate of drying without using glycerin was very difficult. The original method resulted in large variations in relative humidity, while the glycerol method enabled us to precisely control the relative humidity of the environment. We used a food grade glycerol product (vegetable glycerin 99.7%) for a three-month test. Glycerol placed in a beaker with no added water in a closed container equilibrated to a relative humidity of about 20% after several days. We then added water to create a solution that equilibrated with the closed atmosphere to a relative humidity of 98%. At this point we added the wet fossil to the container and incrementally added glycerol in order to reproduce the calculated three-month drying curve. Use of glycerol solutions has been successful in controlling the rate of drying inside the containers housing the Saltville fossils.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

MECHANISM OF THE CRUROTASAL JOINT

SUZUKI, Daisuke, Department of Anatomy, Sapporo Medical University, School of Medicine, Sapporo, Japan; CHIBA, Kentaro, Natural History Sciences, Hokkaido University, Sapporo, Japan

The movable astragalus-calcaneum joint is a key feature diagnosing crurotarsan archosaurs. The movement in the astragalus-calcaneal joint while changing from dorsiflexion to plantar flexion (approximately 145 degrees). In addition, three formalin fixed crocodylian specimens (Crocodylus porosus, and Losia crocodilus) were dissected to observe their macroscopic morphology. The dissected specimens show that the calcaneal tuber projects posterolaterally, which is thought to produce a large moment arm during plantar flexion at the ankle by sagittal movement. This morphology of crurotarsan ankles may affect their posture and locomotor system, but the detailed mechanisms of this joint have not been investigated. In this study, six crocodile specimens (three Crocodylus porosus, two C. siamensis, and one Tomistoma schlegelii) were used to study the ankle joint mechanism of crocodiles, the sole survivor of the crurotarsans. These specimens were CT scanned at five different positions, from maximum dorsiflexion (approximately 65 degrees) to maximum plantar flexion (approximately 145 degrees). In addition, three formalin fixed crocodilian specimens (two Caiman crocodilus, one C. porosus) were dissected to observe their macroscopic morphology. The dissected specimens show that the calcaneal tuber projects posterolaterally, and possesses a pulley-like central groove. The tendon of the gastrocnemius passes through the groove, and partially enters onto the medial surface of the calcaneal tuber. The analysis of the CT images shows that the horizontal movement is larger than the sagittal movement at the astragalus-calcaneum joint creating propulsion and generates crurotarsan semi-erect or fully-erect posture. This mechanism, however, may be less effective than the dinosaurian mesotarsal joint mechanism with fully-erect posture, in that the sagittal movement could propagate the power effectively in erect postures.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

PARAMETRIC COMPUTATIONAL FLUID DYNAMICS SIMULATION OF THE RESPIRATORY HEAT LOSS IN SAUROPODORM DINOSAURS: THE ROLE OF LONG TRACHEA

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High metabolic rate in sauropodomorphs has been proposed and discussed in the literature. Due to the high volume to surface ratio of large sauropodomorphs, the temperature control using respiratory system gains importance. Previously measured respiratory heat and water loss and our recent computational fluid dynamics simulations of breathing cycle in domestic fowl showed that the evaporative respiratory heat loss takes place mainly in the trachea. In the present study we test the hypothesis that the remarkably long neck of some sauropodomorphs facilitate an effective system of evaporative cooling able to sustain high metabolic heat production of these extinct species. To this end we select several sauropodomorphs, for which both the neck length estimates and body mass estimates are available based on the fossil material. We consider smaller sauropodomorphs (Plaurosaus and Shanosaurus) with estimated body masses under 5 tons and large sauropodomorphs (Brachiosaurus, Diplodocus, Mamenchisaurus) with estimated body masses above 10 tons. For the dimensions of the trachea and respiratory parameters (tidal volume, respiration rate, and inspiration time) we use allometric relationships from avian data. The tidal volume values are obtained in two different ways: based on the allometric relationship for the tidal volume and derived from the allometric oxygen consumption rate as the amount of air that contains enough oxygen to sustain the body weight. We use these data and generate three different computational fluid dynamics models as simplified representations of the respiratory system of sauropodomorphs and simulate a breathing cycle. The tracheal diameter is varied for each model to reach the heating and humidification of air at the caudal end of trachea for different body temperatures. Our results show that allometric relationships have limitations for the determination of the geometry of the trachea of long-necked sauropodomorphs as well as for the estimation of the tidal volume, which plays an immediate role in predicting the heat loss in the system. The estimation of the tidal volume based on oxygen consumption, which takes into account the large dead space due to the long trachea, seems more meaningful and produces more realistic results. Computational fluid dynamics simulations and parametric analysis present a powerful tool for the understanding of the function of the respiratory system in temperature control due to convective and evaporative cooling, especially when the information on geometry and physiology of the system is lacking. We conclude that even though the present study relies essentially on the accuracy of the mass estimate of the extinct animals, it still gives an insight into the physiological constraints compatible with life.

Diagnosis and Paleoenvironmental Changes in Neogene Fossils and Environments from Panama: Evidence from REE Proxies

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Previous studies have shown that vertebrate taxa have undetectable amounts of rare earth elements (REEs) in their skeletal structures during life; little has been reported about fossil vertebrates. So far as is known, after death and during the early stages of diagenesis, REEs are quickly incorporated into the mineral lattice of the bones and teeth, and as reported here, shells and otoliths. The REE uptake in fossil specimens potentially can be used to determine the diagenetic environments of these fossils. The present study was designed to evaluate the REE uptake in samples taken from 69 specimens collected from the Culebra, Cucaracha, Gatan, and Chagres formations, and late Miocene strata in Darien Basin of Panama. Our overall goals were to use REE analyses to understand patterns of diagenesis and changes in terrestrial and oceanic environments in South America during the Miocene. The speci mens were sampled using a rotary drill. We therefore used data from the University of Florida Department of Geosciences’ laboratory protocol. The samples were analyzed for their bulk REE concentrations on an Inductively Coupled Plasma Mass Spectrometer (ICPMS). Because REEs can be correlated to the REE of the pore waters in which the fossils were fossilized, ratio analysis of La/Sm compared to La/Yb either confirmed paleo-depths of previous studies, or provided new evidence from the other poorly known localities. The plots of the vertebrate tooth and bone specimens from the five formations showed higher REE concentrations than those of the invertebrate plots, confirming a greater degree of porosity and relative diagenesis. The data also demonstrate that the Cucaracha and some Culebra samples were diagenetically altered in a terrestrial environment due to a continental signal, the Gutran sharks were altered in coastal environments, and the Darien and Chagres samples were altered in an oceanic environment. In contrast to the vertebrate bone samples, the Gutran small Stroblerina sp., and Gatan otoliths display different REE patterns, with concentrations declining from La to Lu. These differences in the other REE plots due to their different aragonitic composition. The Gatan echinoid, Epitetraps, and oyster Hyotissa, both showed lower REE uptake indicating relatively little diagenesis. Our study demonstrates that REE analyses of fossils composed of hydroxyapatite or calcite are a useful proxy to determine early fossil diagenesis and paleoenvironment.

Additional Material of the Type Specimen of the Tapiroidea Colodon Kayi (Hough) from the Sage Creek Basin, Montana

TABRUM, Alan R., Carnegie Museum of Natural History, Pittsburgh, PA, United States

Carnegie Museum of Natural History specimen (CM) 9561, a right maxilla with P3-M3 (P3 and P4 not supported by bone), is the holotype specimen of the tapiroid Colodon kayi. This specimen was collected in 1939 from late Uintan beds exposed in the Sage Creek
Bassin of southwestern Montana and is one of several specimens from the same small locality assigned the field number 18/39. Two additional maxilla fragments of Protoreodon also collected in 1939 and assigned the field number 18/39. The two "new" maxilla fragments of C. kai present the right P2 and roots of right P1, and (2) somewhat eroded left P1-P3. The right P2 of one of the "new" maxilla fragments tightly contacts the right P3 of CM 9561; hence, the two "new" maxilla fragments clearly pertain to the type specimen of C. kai. Furthermore, a pair of lower jaws of C. kai, CM 12088, was also collected in 1939 and bears the field number 18/39. Based on similarities in preservation, dental wear stage, and fairly tight occlusion between the right upper cheek teeth of CM 9561 and the right lower cheek teeth of CM 12088, the lower jaws of CM 12088 seem almost certain to represent the same individual as CM 9561, the type specimen of C. kai.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

THE FIRST RECORD OF A HESPERORNITHIFORM FROM JAPAN

TANAKA, Tomonori, Hokkaido University, Sapporo, Japan; KOBAYASHI, Yoshitsugu, Hokkaido University, Sapporo, Japan; KANO, Mamoru, Mikasa City Museum, Sapporo, Japan; KURIHARA, Kenichi, Mikasa City Museum, Sapporo, Japan

Hesperornithiformes are marine foot-propelled diving birds and one of the most widely distributed group of birds in the Cretaceous. Here, we report the first record of a hesperornithiform from the Upper Cretaceous Kashima Formation (Coniacian to Santonian) of the Yezo Group, Japan. In 1996, a calcareous concretion was collected from silstone-dominant marine deposits of the formation in Kumaosaizawa Creek in Mikasa City of central Hokkaido. It contained a partial, semi-articulated skeleton of a hesperornithiform and the ammonites Polyptychoceras pseudoglautinum and Damesites kayi, which suggest that the age of the horizon is early Santonian. The skeleton is represented by three cervical and three dorsal vertebrae, distal ends of left and right femora, and a middle part of left fibula. All of the preserved vertebrae are heterocercal with saddle-shaped articular surface. The foramen transversarium of the cervical vertebrae is large. The fibular condyle of the femur is expanded laterally as seen in many diving bird taxa (hesperornithiforms, gaviiforms, and pinnipediforms). The concavitas lateralis of the dorsal vertebrae is deep, which is present only in hesperornithiforms. The combination of the characters in the dorsal vertebrae and the femur indicates that this specimen belongs to Hesperornithiformes. Prior to the Santonian, all of hesperornithiforms were reported from Cretaceous deposits in North America, except for Enaliornis from Albian of England. During the latest Santonian to Maastrichtian, hesperornithiforms appear to have radiated widely into Europe (Sweden, Russia, Ukraine, and Kazakhstan) and Asia (Mongolia). This Japanese hesperornithiform is the first report from the eastern margin of the Eurasian Continent and the oldest record outside of North America for the Cretaceous, except for Enaliornis. It also implies that the distribution of hesperornithiforms was expanded to Asia in, or prior to, the Santonian age.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)


TANAKA, Yoshihiro, University of Otago, Dunedin, New Zealand; FORDYCE, Robert E., University of Otago, Dunedin, New Zealand

The history and relationships of the Ganges River dolphin Platanista (Odontoceti, Cetacea) have been contentious since Flower’s pioneering studies of “river dolphins” in the mid 1800s. Do living “river dolphins” – Platanista, Iniata, Pontoporia and Lottipotes - form a clade, or does the Platanista excide the latter three genera? Recent osteological, palaeontological and molecular studies have not yet reached consensus. We are now reassessing the cladistic relationships of fossils in the odontocete families Waipatiidae, Allodelphinidae, Squidodontidae and Squidodelphinidae, to see which, if any, belong to Platanista excide than in to stem Odontoceti. The study includes some new marine fossils from Oligo/Miocene rocks in New Zealand, with a total of 14 taxa (Zygoryzha, Aegoryzha, Alloglophya, Waipatia, Squidodon, Platanista, Zarhachis, Preptomophilus, Squidophylus, Notocetus vanhoveni, “N.” marplei, un-named Notocetus-like OU 22306, Kogia and Mesopodoun), and 123 characters from previous studies by direct study of specimens (originally scored states, presence/absence for palaeontographical, and phenetic-based phylogenetic analyses) and phenetic-based algorithms of PAUP 4.0b produced following tree, in which 17 characters support monophyly of Platanista excide (sensu Muizon), with this order of families: (Mesopodoun +Kogia (Squidodelphinidae (Squidodontidae (Waipatiidae (paraphyletic “Squidodelphinidae” (Platanistidae)))). If correct, this result indicates a higher diversity for Platanista excide in the past than now, and deep (Late Oligocene) origins. Of note, “Squidophylus” excide appears as a paraphyletic cluster immediately stem-ward of Platanista excide, with the species of Notocetus being paraphyletic. The addition of more fossil putative plataniids from New Zealand may better resolve the relationships of the Squidodelphinidae and Platanistidae.

Technical Session III (Wednesday, October 17, 1:45 pm)

EAR MORPHOLOGY OF CAENOMERYS AND RELATIONSHIPS OF CAINOTHERIDS

THEODOOR, Jessica L., University of Calgary, Calgary, AB, Canada; DREGER, Sonya, University of Calgary, Calgary, AB, Canada; WIOG, Jacqueline, University of Calgary, Calgary, AB, Canada; RUF, Irina, Steinmann-Institut für Geologie, Mineralogie und Paläontologie, Bärental, Bonn, Germany

The phylogenetic relationship of cainotheriods to other cetartiodactyls has been difficult to resolve, with recent analyses placing them either within Tylopondia or as basal ruminants. Previous description of a skull of Cainotherium showed several features which may bear on the question of cainotheriid relationships, but additional data on other cainotheriids was lacking.

Micro-CT investigations of the ear region of two specimens of Caenomeryx show that the preserved morphology is very similar to Cainotherium, including a greatly enlarged cancellous auditory bulla. The prominent ridge separating the endocranial cerebral and cerebellar faces of the periotic sinus among ruminants and protoceratids is lacking. The pars canaliculata of the periotic contains a massive, anteriorly directed subarea fossa, which faces more anteriorly than in Cainotherium. The subarea fossa contains a deeper mastoid fossa within it. As in Cainotherium, the foramen acusticum superius (leading into the facial canal) and internal acoustic meatus are separate, not set into a submastical depression as in other known cetartiodactyls, suggesting that this separation of these foramina is synapomorphic for at least the Cainotheriinae, if not Cainotheriidae. On one specimen of C. kayi, a rare ventral to these foramina the subarea fossa has a subtle flange bordering the lateral wall of the petrosal canal. This feature is similar to, but less well-marked, the condition in Cainotherium, and is not preserved in the second specimen. The sinus venosus temporalis is present, but appears to be mediolaterally compressed relative to that of Cainotherium.

The morphology of Caenomeryx based on these two specimens indicates that cainotheriid ear morphology is relatively consistent and is likely to be phylogenetically informative. The separation of the foramen acusticum superius form the internal acoustic meatus appears to be autapomorphic for at least the cainotheriines; additional data for the oxaracrine cainotheriids is necessary to verify the status for Cainotheriinae as a whole. The enlarged subarea fossa of C. kayi contains a deep mastoid fossa share with a number of tylopodan taxa, including extant lamnids, Bumonurus, anoplotheres and xiphodontids, but is known also among basal mammalian taxa such as hypertragulids. The ventral flange bordering the petrosal canal appears to be poorly marked overall in cainotheriids and clearly differs from the overhanging condition in camels and Bumonurus. The overall morphology is more similar to that observed in camels, xiphodontids, and anoplotheres, but additional data will be needed to resolve the polarity of these characters.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

ASSESSING THE DIFFICULTIES OF GENUS-LEVEL DIAGNOSES OF FOSSIL RODENTS

THIES, Monte L., Sam Houston State University, Huntsville, TX, United States; TUTALO, Richard, Sam Houston State University, Huntsville, TX, United States; LABBE, Micky D., Sam Houston State University, Huntsville, TX, United States; LEWIS, Patrick J., Sam Houston State University, Huntsville, TX, United States

When accurately identified, the fossil remains of rodents and other small mammals can often provide detailed ecological and environmental insights about the past. In many small mammal fossil deposits, the maxillae, mandibles and dentition are the best preserved and most abundant fossil elements. As such, these specimens are commonly used in the identification of rodent taxa in the fossil remains. Previous research at various fossil sites throughout southern and eastern Africa has yielded taxonomic lists with species-level identifications based on cup patterns of cheek teeth. However, accurate species-level identifications seem unlikely due to a lack of consistent and identifiable dental morphologies. Our research, involving an examination of 16 genera of extant rodents collected in association with an extensive sample of small mammal fossils from a cave in Ngamiland Province of northwestern Botswana, has attempted to address this problem. Since fossil remains of small mammals often lack complete sets of dentition due to various taphonomic processes, using the extant members of each taxon (via barn owl pellets, live trapping, and museum specimens) allowed for the best assessment of the diagnostic dental morphologies present in each genus. Once the dental apomorphies of each extant genus were identified, those characteristics could then be applied in the identification of the fossil taxa. Using both molar cup and alveolar patterns, comparisons were made between and among the sixteen taxa to determine which tooth/ alveolar patterns were the most diagnostic for genus-level identifications. Generally, alveolar patterns were not specific enough to warrant a single identification, although they are useful for eliminating certain taxa. Additionally, the upper and lower M1s are the most diagnostic teeth while the upper and lower M2s and M3s are the least diagnostic for genus-level identification. For most taxa, a complete set of both maxillary and mandibular dentition was necessary for a genus-level identification. Nonetheless, the rarity of complete sets of teeth in fossil deposits presents a potential problem in the identification of fossil rodent specimens.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SEARCHING FOR EVIDENCE OF FOSSIL FEATHER COLOR WITH SPECTROSCOPY

THOMAS, Daniel B., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; JAMES, Helen F., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; CARRANO, Matthew T., National Museum of Natural History, Smithsonian Institution, Washington, DC, United States; MADDEN, Odile, Museum Conservation Institute, Smithsonian Institution, Washington, DC, United States
Fossilized melanin-bearing organelles (melanosomes) have recently given insight into the original coloration of fossil feathers in both extinct birds and their non-avian dinosaur relatives. Although melanin contributes part of the color palette to Neornithes, the full spectrum of modern feather color is achieved with a more diverse array of biochemicals. Therefore, expending the color palette of fossil feathers may require analyses from a set of complementary techniques. Spectroscopic methods provide a good supplement to the existing morphological approach as they can rapidly differentiate each of the modern feather pigments without destruction of the original sample. We have explored the descriptive potential of Raman spectroscopy for analyses of modern and fossil feathers. Each of the reported feather pigments could be differentiated by in situ analyses of modern feathers, and existing approaches as they can rapidly differentiate each of the modern feather pigments. Fossilized melanin-bearing organelles (melanosomes) have recently given insight into the coloration of modern feathers. The presence or absence of fossil feather pigments may be rapidly determined, and potentially provide color descriptions from point to point, or inform about the benefit of subsequent destructive analyses.

NO ENVIRONMENTAL PARTITIONING OF CERATOPSIDS WITHIN THE LOWER DINOSAUR PARK FORMATION (CAMPIAN) FAUNAL ZONE OF WESTERN CANADA
TOKARYK, Timothy T., Royal Saskatchewan Museum, Eastend, SK, Canada; RYAN, Michael J., Cleveland Museum of Natural History, Cleveland, OH, United States; EVANS, David C., Ontario Museum, Toronto, ON, Canada
The Dinosaur Park Formation (DPF) of Alberta, Canada, is one of the best sampled Late Cretaceous dinosaur-bearing units in the world, and has produced hundreds of articulated skeletons and skulls of more than 40 taxa. It also preserves the last terrestrial sediments of the Belly River Group before the transgression of the Western Interior Seaway (WIS) deposited the marine Bearpaw Formation across the western interior of Canada. Limited exposures of the DPF occur in southern Saskatchewan (SK). The most northern exposures occur near the village of Unity, SK, while the most western outcrops are near Diefenbaker Lake, SK, approximately 300 km to the east of the primary DPF exposures in Alberta. A vertebrate fossil locality from approximately the middle portion of the DPF at Diefenbaker Lake represents the proximal-most occurrence of the formation to the WIS in North America. It preserves a multitaxic bone bed dominated by the disarticulated, fragmentary cranial elements of a caenorhynch ceratopsid that closely resemble those of Centrosaurus apertus from the DPF of Alberta, and is probably congener with it; unfortunately, no diagnostic parietal material has been collected. Of note is a small, adult-sized, ceratopsine nasal (Royal Saskatchewan Museum P9990.6) with a modified nasal horn core that is collected from near Unity. Although the complete nasal horn core is not preserved, it is reduced in size and shape to a thin, laterally compressed, forwardly projecting spine. There is no indication of broken bone surface, healed injury, or other surficial texture abnormalities to account for this unusual morphology; however, it does closely resemble the nasal horn core preserved on Canadian Museum of Nature 8795, a complete C. apertus skull with diagnostic parietal ornamentation. The only chasmosaurine, ‘Mesoceratops perfinia’, identified from Saskatchewan was collected from the Diefenbaker Lake locality, but it is now considered a junior synonym of Chasmosaurus russelli, well known from the DPF of Alberta. The available material from the DPF of Saskatchewan indicates that both C. apertus and C. russelli appear to be ubiquitous throughout the geographic range of the lower to middle portions of the DPF (Dinosaur Park faunal zone 1) and can therefore not be inferred to have a preference for nearshore or more inland environments. The DPF does record replacement of dinosaur taxa between each of its three successive faunal zones that appears to be correlated to the transgression-shoreline sequence; however, the changes in fossil assemblages between each of the three DPF faunal zones a hypothesis can be made that at any given time at least some dinosaur distributions were not limited by the position of the transgressing shoreline of the WIS.

A NEW GENUS OF THE FAMILY OCHOTONIDAE (LAGOMORPHA, MAMMALIA) AND LAGOMORpha FAUNAL CHANGES AT THE AOERBA N AREA IN CENTRAL INNER MONGOLIA, CHINA
TOMIDA, Yukimitsu, National Museum of Nature and Science, Tsukuba, Japan
An international research team, composed of paleontologists from China, USA, and Japan, performed extensive fieldwork in the Miocene deposits of the Aoerban area, central Inner Mongolia from 2004 to 2008, and collected numerous small mammal fossils. Ochotonid identified from Saskatchewan was collected from the Diefenbaker Lake locality, but it is now considered a junior synonym of Chasmosaurus russelli, well known from the DPF of Alberta. The available material from the DPF of Saskatchewan indicates that both C. apertus and C. russelli appear to be ubiquitous throughout the geographic range of the lower to middle portions of the DPF (Dinosaur Park faunal zone 1) and can therefore not be inferred to have a preference for nearshore or more inland environments. The DPF does record replacement of dinosaur taxa between each of its three successive faunal zones that appears to be correlated to the transgression-shoreline sequence; however, the changes in fossil assemblages between each of the three DPF faunal zones a hypothesis can be made that at any given time at least some dinosaur distributions were not limited by the position of the transgressing shoreline of the WIS.

Technical Session II (Wednesday, October 17, 1:45 - 6:15 pm)
ANATOMY OF ARCHOSAUR PELVIC SOFT TISSUES AND ITS SIGNIFICANCE FOR INTERPRETING HINDLIMB FUNCTION
TSAI, Henry P., University of Missouri, Columbia, MO, United States; HOLLYDAY, Casey M., University of Missouri, Columbia, MO, United States
Reconstructing joint anatomy and function of extinct vertebrates is critical to understanding their posture, locomotor behavior, ecology, and evolution. Major changes occurred in hip joint morphology during archosaur evolution, resulting in a spectrum of postures. However, the presence of soft tissues in modern birds makes inferences of joint function difficult. Previous studies showed that bony articulation alone is insufficient for producing lifelike locomotor postures in archosaur hip joints. Moreover, the apparent incongruence of the bony acetabulum and femoral head of many extinct archosaurs suggests large volumes of missing soft tissue. This study describes the microstructure of crocodilian and avian hip joint and epiphyseal structures and documents osteological correlates for these structures in extinct archosaurs. Circumference and depth of the femoral head and the acetabulum were measured in basal and derived archosaurs to quantify the amount of missing soft tissues. The alligator proximal femur exhibited distinct regions of hyaline and fibrocartilaginous structures which are associated with different areas of joint contact during locomotion. A prominent bony ridge marks the junction between the metaphysis and epiphyseal cartilage in fossil archosaurs. The ligamentum capitis is avascular and similar in microstructure and topology to capsular ligaments. In theropods (i.e., Allosaurus), this ligament attaches to the fovea capitis, whereas in suchians it has a cartilaginous attachment on part of the medial protuberance of the femur, which also leaves a shallow fovea on the calcified cartilage. The acetabular labrum attaches ventromedially to the bony supracacetabular crest in alligators, whereas in birds, the labrum comprises the dorsal border of the acetabulum, and is continuous with the antitrochanter. This suggests that supracacetabular structures can be variably ossified at different regions of the acetabulum, perhaps in response to the primary directions of loading. In fossil archosaurs such as Postosuchus, Poposaurus, and Coelophysis, the bony supracacetabular crest appears to constrain abduction and dorsocranial dislocation of the proximal femur during parasagittal locomotion. On the other hand, the cartilaginous supracacetabular labrum was likely present in derived theropods to articulate with the facies articularis antitrochanterica (FAAN) of the femur, as substantial portions of FAAN lies outside of the acetabulum during reconstructed hip joint articulation. These data suggest major evolutionary transformations in the position and shape of the femoral head, acetabulum, and FAAN in different clades of archosaurs which impact our hypotheses of homology and function.
The body mass of several Paleogene land mammals was estimated. The estimated body masses are consistent with those by previous studies that used head-body length and long limb bones. For example, the body mass of the largest terrestrial mammal that ever lived, ‘Baluchitherium,’ was estimated to be about 10–15 metric tons. Therefore, the regression equations by this study using the astragali are useful for estimating body masses of fossil land mammals and have the potential to be widely applied to quantitative ecological and physiological studies of ancient land mammals.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

RECONSTRUCTION OF MUSCULAR AND PNEUMATIC SYSTEMS IN THE NECK AND ANTERIOR TRUNK OF ABELISAURIDAE: INSIGHTS FROM MAJUNGASAURUS CRENATISSIMUS (DINOSAURIA: THEROPODA)

TSUJII, Takanori, The University of Tokyo, Tokyo, Japan; O’CONNOR, Patrick M., Ohio University, Athens, OH, United States

Abelisaurid theropods are characterized by specialized morphology of the cervical axial skeleton. The cervical pneumatic system and axial musculature were reconstructed based on two well-preserved, nearly complete presacular series of Majungasaurus crenatissimus. By using the location of pneumatic features to hypothesize the distribution of pneumatic soft tissues (i.e., diverticula), the attachment sites of axial muscles may be better constrained. Detailed identification of osteological correlates was possible for several axial muscles and the cervical pneumatic system. For example, cervical pneumatic diverticula are here modeled as tubular projections that extended anteriorly to the level of the axis. The limited distribution of pneumatic features around the periphery of the vertebrae represents relatively simple diverticular organization. Regarding musculature, a tubercle on the postero-dorsal corner of the neural spine in the trunk represents the attachment for the tendon of insertion of the m. semispinalis of the m. transversospinalis group. Similar to the condition observed in extant crocodylians, this tubercle shifts ventrally in the anterior dorsal through postcranial cervical regions and eventually disappears. The notability low cervical neural spines suggest that the medial part of the m. transversospinalis system was not well-developed. In contrast, the relatively large epiplasticus suggests that lateral portions of this system (m. tendinoaicularis / m. ascendens cervicallis) was emphasized, likely serving as the main extenders, lateral flaxors, and stabilizers of the neck. Moreover, the large surface of the neural arch lateral to the prezygapophyseal lamina provided a large attachment area for the m. longissimus dorso-lateralis. A strong rugosity on the m. serratus posterior in the trunk represents the attachment for the tendon of insertion of the m. semispinalis dorsalis. Such土豆 indicate the “paraxial” specialization can strengthen bone-cracking capability, and this phenomenon may serve as a logical foundation to explain a gradient of adaptations in other carnivores and non-carnivorous mammalian clades.

Technical Session XIV (Saturday, October 20, 9:00 am)

CRANIAL ANATOMY, PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF BUNOSTEGOS AOKAENANIS (PARAREPTILIA: PAREIASAURIDAE)

TSUJI, Linda A., University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States

Bunostegos aokanensis is a pareiasaur reptile known from the Upper Permian Moradi Formation of northern Nigeria. Recently collected cranial material permits a re-description of the taxon in addition to inclusion of new information in a phylogenetic analysis of pareiasauriforms. Bunostegos is highly autapomorphic, with diagnostic cranial features including the presence of two or three hemispherical bosses located at the anterior end of the snout, an elongate, laterally projecting supraorbital ‘horn’ formed by an enlarged prefrontal, and a hemispherical supratemporal. The remarkable degree of specialization likely reflects a divergence from other parareptilian taxa, whose most plesiomorphic features are retained in Bunostegos. These features reflect the morphology of the cranial sculpture and the size and placement of the tabulars appear to be more similar to more derived pareiasaurs such as Arganaceras from Morocco and Elginia from Scotland, but the most parsimonious tree topology indicates that these features evolved independently in Bunostegos. The relationships of velosaurian pareiasaurs, including Anodon, Nanoparia, and Scutosaurus, were consistent with those of previous analyses.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)

ESTIMATING BODY MASS OF FOSSIL LAND MAMMALS USING THE ASTRAGALUS

TSUBAMOTO, Takehisa, Hayashibara, Setouchi, Japan

In mammalian skeletons, astragali are a compact and easily handleable bone, and its fossil remains have relatively higher chances to be discovered as undamaged specimens. Astragalar fossils have been well studied as an indicator of the functional morphology and phylogenetic relationships of mammals. On the other hand, body mass of animals strongly correlates with their ecology and physiology and is used in paleoecological studies. Therefore, the body mass of fossil taxa has been extensively estimated by several methods. However, only a few studies have investigated the relationship between astragalar size and body mass. The previous studies have shown the relationship between astragalar size and body mass were intended only for a few selected taxonomic groups.

To expand the application of the astragalar to more extensive groups of mammals in estimating body mass, we examined the allometric relationship between body mass and astragalar size in an extensive sample of extant land mammals (11 orders, 48 species, 80 individuals; body mass ranging from 18 g to 3.4 metric tons) using regression analysis. The results indicate that the best body mass estimator for extensive land mammals is the tibial trochlea size rather than the total size of the astragalus. For example, the body mass is estimated using the medio-lateral width of the tibial trochlea by the following formula (R² = 0.985; %SEE = 42.0; %PE = 28.8): log(body mass [g]) = 2.789 X log(width of tibial trochlea [mm]) + 2.078.

Using the results, the body masses of several Paleogene land mammals were estimated. The estimated body masses are consistent with those by previous studies that used head-body length and long limb bones. For example, the body mass of the largest terrestrial mammal that ever lived, ‘Baluchitherium,’ was estimated to be about 10–15 metric tons. Therefore, the regression equations by this study using the astragali are useful for estimating body masses of fossil land mammals and have the potential to be widely applied to quantitative ecological and physiological studies of ancient land mammals.

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structure markedly different from roughly contemporaneous areas, and supports the theory that central Pangaea was geographically isolated from the rest of the supercontinent by desert-like conditions.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

ARTIODACTYLS FROM THE LATE MIOCENE (HEMMPHILLIAN) WYMAN CREEK LOCAL FAUNA, KEWA PAHU COUNTY, NEBRASKA

TUCKER, Shane T., University of Nebraska State Museum, Lincoln, NE, United States; FORBYES, Michael R., University of Nebraska State Museum, Lincoln, NE, United States

The biostratigraphic record of the central Niobrara River Valley is well represented by strata younger than 4.5 million and older than 9 million years. An un-named intraformational channel fill in the uppermost portion of the Merritt Dam Member of the Ash Hollow Formation partially fills this regional gap in the rock record. Volcanic ash clasts incorporated into these unconformities provide fossils vital for the identification of a new species. New material of pectoral, pelvic, dorsal, anal fins and the endoskeletal shoulder girdle from the Red Hill site and Metzger’s Quarry (late Famennian Catfish Formation: Duncannon Member, Rugosopora flexuosa—Grandisporina cornuta palynophor zone (Fa2c substage)) of Clinton and Lycoming counties in central Pennsylvania gives a clear picture of the early elements of a large sirenian fish, Gyracanthides sherwoodii, which lived in non-marine conditions in the eastern Laurentian rivers and deltas. Like its contemporaries in Gondwana (Gyracanthides spp. in South Africa and Gyracanthides murrayi in southern Australia), it was mainly cartilaginous, and most probably a filter-feeder that swam and lived by facing into the swift currents and, as demonstrated by the wear on the ventral surfaces of the spines, sometimes used its pectoral fin spines for rigid support by inserting them into the substrate. Growth series of G. sherwoodii show that this taxon attains over a meter in length with families acquiring some of the pectoral skeletal elements very early. As yet we have found no evidence of scales in this species. Gyracanthid acanthodians might have lived like other large non-marine, primarily cartilaginous fish such as freshwater sharks, catfish or sturgeon and attained wide distributions in similar ways due to a possible marine phase in their life histories. At all stages of their growth they would have been prey for the cohabiting predators such as Hyperpeton or Hyneria at the Red Hill site. Despite their primitive cartilaginous skeleton, an ornamented pectoral fin is present in the pectoral fin assembly in Gyracanthides sherwoodii. The endoskeletal pectoral girdle in G. sherwoodii, and in closely related Late Devonian to Early Carboniferous specimens, supports the placement of gyracanthid fishes within the Acanthodii although recent work is questioning the monophyly of this group of ‘spiny sharks’.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

NEW SPECIMENS OF MIDDLE EOCENE WHALES (CETACEA, PROTOCETIDAE) FROM NEW JERSEY

UHLEN, Mark D., George Mason University, Fairfax, VA, United States

The Family Protocetidae was first delimited by Stromer to include the genera Proctoetus and Eocetus, the only two protocetid genera known at that time. Both are from the middle Eocene (Lutetian and Bartonian respectively) of Gebel Mokattam, Egypt. The pace of discovery of protocetids was extremely slow until the 1990s with only three genera (Pappocetus, Indocetus, and Babiacetus) added to the family. Since 1990, an additional 16 genera have been added to the family, greatly expanding our knowledge of their diversity, anatomy, behavior and biogeography. These additions to the family have been in Indo-Pakistan, Egypt and North America, as additional fossils of protocetids thought to be related to Eocetus are probably better interpreted as early basinsaurid. Protocetids have yet to be described from Oceania or anywhere in the Pacific Basin or Antarctica.

Here, several protocetid teeth are described from eastern New Jersey, U.S.A. These specimens represent the northernmost discovery of protocetids in the world. These specimens were collected from the basal beds of the Kirkwood Formation (Ashy Park Member). While this unit is considered Aquitanian (= early Hemingfordian, or early Miocene) in age, these protocetid teeth, along with characteristically middle Eocene shark teeth are believed to have been eroded out of the underlying Bartonian (middle Eocene) Squankum Member of the Shark River Formation and were then incorporated into the basal beds of the Kirkwood Formation during the Aquitanian transgression represented by the basalt Kirkwood. Several of the specimens described here were collected by avocational paleontologists, while others were discovered in museum collections misidentified as entelodonts, squalodonts, or indeterminate mammals. The specimens described here represent both molars and incisors of protocetids. They are similar to other contemporaneous protocetids from North America, Egypt, and Indo-Pakistan, and they lack the well-developed accessory denticles of more derived basinsaurids. Additional prospecting in the Middle Eocene deposits of the mid-Atlantic of North America may yet provide more complete specimens for more in-depth phylogenetic analysis.

Romer Prize Session (Thursday, October 18, 11:45 am)

ENAMEL MATURATION AND INTRATOOTH STABLE ISOTOPE PROFILES IN ELEPHANT (LOXODONTA AFRicana) MOLARS: A NEW TOOL FOR EVALUATING SEASONALITY IN TERRESTRIAL PALEOVENVIRONMENTS FROM PROBOSCIDEAN TEETH

UNO, Kevin T., University of Utah, Salt Lake City, UT, United States

Multi-year stable isotope records from serially sampled fossil teeth are potential archives of an individual’s life history and the environment in which it lived. Carbon isotopes in enamel are a tool for evaluating shifts in diet resulting from seasonal vegetation change, whereas oxygen isotopes provide information about physiology and seasonality of precipitation. Proboscidean molars are attractive as archives of past environments because a single molar plate may contain up to a decade of information, and due to their large size and thick enamel, they are often well preserved in the fossil record. The formation of tooth enamel entails a protracted maturation period, leading to an attenuated and temporarily shifted isotope record. Sampling geometry adds further complexity, limiting serial enamel isotope records to parameters that include the growth rate of molar plates, initial enamel density, and enamel thickness. The formation of tooth enamel entails a protracted maturation period, leading to an attenuated and temporarily shifted isotope record. Sampling geometry adds further complexity, limiting serial enamel isotope records to parameters that include the growth rate of molar plates, initial enamel density, and enamel thickness.
maturation length along a plate. Bomb-curve 14C dating of the last lower molar (m3) in two elephants reveals plate growth rates of 1.3 to 1.6 cm/yr; molar histology suggests similar rates. Micro-CT data show the initial enamel matrix is ~65% of the density of mature enamel. Coupled micro-CT and histological data indicate a maturation length of 7.6 ± 0.7 cm. The forward and inverse models are validated using remote sensing data, precipitation and oxygen isotope data sets, and by comparing synchronous, high-resolution molar and tusk isotope records in two elephants. The updated models for enamel formation in elephant molars provide a new technique for quantitatively assessing seasonality and proboscidean life history. Extension of this technique to fossil proboscidean teeth, particularly from the Neogene, will enable the study of seasonality in terrestrial paleoenvironments such as East African hominin sites or sites that bracket the late Pleistocene megafaunal extinction events. It will also be useful for studying key periods of proboscidean evolution.

Technical Session VI (Thursday, October 18, 3:00 pm)

NEW INFORMATION ON THE ANATOMY AND RELATIONSHIPS OF TITANOSAURIFORM SAIROPODS FROM THE CRETACEOUS OF EAST ASIA
UPCHURCH, Paul, University College London, London, United Kingdom; D’EMIC, Michael D., Georgia Southern University, Statesboro, GA, United States; MANNION, Philip D., Imperial College London, London, United Kingdom; BENSON, Roger B., University College London, London, United Kingdom; PANG, Qing, Shijiazhuang University of Economics, Shijiazhuang, China

There are approximately 90 valid, or potentially valid, species of titanosauriform sauropod. A significant proportion of these taxa (27%) come from East Asia, with this region yielding 17 new forms since 2000. However, many of these new taxa have received only brief preliminary descriptions; consequently their evolutionary relationships within Titanosauriformes remain problematic. First-hand examination of seven Cretaceous titanosauriforms from China (Baotianmansaurus, Borealosaurus, Gobititan, Huabeisaurus, Huanghetitan ruangyensis, Ruyangosaurus and Xianshanosaurus) enables revision and strengthening of their diagnoses and a clarification of their phylogenetic positions. For example, Huabeisaurus possesses autapomorphies such as a tubercle on the anterodorsal part of the lateral surface of the coracoid and relatively short haemal canals in anterior chevrons. Moreover, some derived states occur in more than one taxon and are potentially phylogenetically informative (e.g., absence of ribs from caudal 10-11 onwards in Huabeisaurus and Alamosaurus, lateral projections at the distal ends of haemal blades in Gobititan and Huanghetitan ruangyensis). Preliminary phylogenetic analyses (based on two data sets) suggests that all Cretaceous East Asian taxa are somphospondylans, but their precise relationships are sensitive to taxon/character sampling and treatment of quantitative characters. There is growing evidence for a group within Somphospondyli that includes Erketu ruyangensis. Huabeisaurus and several other Cretaceous East Asian taxa, characterised by derived states such as deep U-shaped bifurcation of presacral neural spines and strongly ventrally deflected cervical parapophyses. Most tree topologies suggest that several Early and mid-Cretaceous sauropods formed a monophyletic clade that was endemic to East Asia, suggesting that this region was physically and/or environmentally isolated at this time. Other taxa display unexpected similarities with derived South American saltasaurines, including the presence of somphospondylans tissue structure in the neural arches of anterior caudals and steeply reclined neural spines in anterior and middle caudal vertebrae. This indicates that some of the Early and mid-Cretaceous East Asian titanosauriforms might also hold clues to the origins of one or more of the advanced titanosaur clades of the Late Cretaceous.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

MICROSTRUCTURE OF THE SERRATED MARGIN OF EXTANT AND FOSSIL SHARKS WITH ORTHODENTINE AND OSTEODENTINE
USHIMURA, Eri, University of Hyogo, Tatsuno, Japan

Serrated tooth margins have arisen a number of times throughout the evolution of carnivorous vertebrates, however, little is known about their formation. Shark teeth may provide ideal models to study serrae formation, since shark teeth are continuously replaced and both immature and mature teeth can be found in a single specimen. In this study I examined two extant and fossil shark species: the first type (the tiger shark, Galeocerdo cuvier) and the silvertip shark, Carcharhinus albimarginatus has orthodentine, in which dental pulp is localized at the center of the tooth. The second type (the great white shark, Carcharodon carcharias) has osteodentine, in which the dental pulp diverges irregularly. I also studied teeth from the fossil tiger shark G. aduncus from the Miocene of Aurora, North Carolina, US, and the great white shark C. carcharias from the Shimosa Group, Middle Pleistocene. Microstructure of serrae was examined with ground sections of teeth and high-resolution micro-CT. I measured sections of jaws of the fetus of the tiger shark and the silvertip shark, isolated odontoblasts were also found in the enameloid in a serra. Furthermore, before the stage of mineralization in the silvertip and great white sharks, the inner enamel epithelium was found to make folds that probably correspond to the outline of the future serrae. In surface etched teeth in extant tiger shark, banded bundles were found associated with the serrations as in the fossil carcharhiniform and lamniform sharks.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

PINNIPED TURNOVER IN THE SOUTH PACIFIC OCEAN: NEW EVIDENCE FROM THE PLOI-PLEISTOCENE OF THE ATACAMA DESERT, CHILE
VALENZUELA-TORO, Ana M., Universidad de Chile, Santiago, Chile; GUTSTEIN, Carolina S., Universidad de Chile, Santiago, Chile; VARAS-MALCA, Rafael M., Museo de Historia Natural - UNMSM, Lima, Peru; SUÁREZ, Mario E., Museo Paleontológico de Caldera, Caldera, Chile; PYENSON, Nicholas D., Smithsonian Institution, Washington DC, DC, United States

Modern pinnipeds distributed along the coasts of continental South America consist almost entirely of otariids (sea lions and fur seals). In contrast, phocids (true and elephant seals) are present only on the southernmost extreme of Chile. This recent biogeographic pattern is consistent with the zoogeocentral model, but it is incompatible with the pinniped fossil record during the Neogene. From the middle Miocene to the Pliocene, true seals exclusively dominated pinniped assemblages, and they were only replaced by the fur seals and sea lions sometime after the Pliocene. Here, we describe pinniped material collected from two new localities in the Atacama Desert, northern Chile, that clarify this marine mammal faunal turnover. Specifically, these finds provide records of the first occurrence of Otariidae and the last occurrence of Phocidae in Chile, which in turn, these records constrain the timing of this turnover to the early Pliocene through to late Pleistocene interval. The stratigraphic context of these findings provide new insights into hypotheses that explain this faunal turnover in South America, and we briefly discuss them in the context of turnover events within other marine vertebrates throughout the Southern Hemisphere.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

THREE-DIMENSIONAL GEOMETRIC MORPHOMETRIC ANALYSES OF URSIDAE ARE ABLE TO PREDICT FUNCTIONAL ADAPTATIONS OF FOSSILS
VAN HETEREN, Anneke H., University of Roehampton, London, United Kingdom
Limited work has been done on reconstructing the diets of Ursus, Ursus minimus and U. eurystyius, because only few and fragmentary fossils are available. Three-dimensional geometric morphometrics might be able to determine the position of rare fossils in the morphospace of more abundant species, from which their diet may be inferred. To test this, the mandibular morphology of the eight extant Ursidae species, fossil U. arctos, U. spelaeus and U. deningeri was analysed using 3D geometric morphometrics and the positions of Ursus, U. minimus and U. eurystyius determined relative to the extant morphospace. Landmarks for 3D digitisation of the mandible were chosen to reflect functional morphology relating to the temporalis muscle. Extant and extinct Ursidae, were digitised with a Microscribe G2. Generalised Procrustes superimposition was performed on the raw coordinates and allometric effects removed by regressing the Procrustes coordinates onto the natural logarithm of centroid size pooled per species. Principal component analysis (PCA) was conducted on the regression residuals, and analysis of variance (ANOVA) conducted. Subsequently, Ursidae phylogeny was overlain on the PCA graphs, allowing for dietary predictions for Ursus, U. minimus and U. eurystyius. PCA of mandibular landmarks differentiates between known dietary niches in extant Ursidae. ANOVA indicates that the most important food item in the diet has a highly significant effect on PCs 1 and 2. The positions of the nodes and the directions of the branches of the Ursidae phylogeny indicate that Ursus may have been adapted to increased amounts of invertebrates in its diet relative to its carnivorous ancestor Cephalogale. The diet of U. minimus is predicted to have consisted of greater intake of vertebrates relative to Ursus and U. eurystyius is predicted to have smaller invertebrate intake relative to U. minimus.

These results are consistent with analyses of individual teeth and two-dimensional geometric morphometrics from the literature. This indicates that overlaying a phylogeny onto morphospace can provide valuable information on taxa that are rarely or incompletely preserved in the fossil record.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

CERVICAL FUSION IN ANKYLOSAURI: ANATOMY AND FUNCTION
VAN NUREN, Collin S., University of Toronto, Toronto, ON, Canada; ARBOUR, Victoria M., University of Alberta, Edmonton, AB, Canada; EVANS, David C., University of Toronto, Toronto, ON, Canada

Fusion of the anterior cervical vertebrae occurs convergently in extant f ossorial, arboreal, and marine mammals. In non-avian dinosaurs, fusion of the anterior cervical vertebrae occurs convergently in extant fossorial, arboreal, and marine mammals. In non-avian dinosaurs, fusion of the anterior cervical vertebrae occurs convergently in extant fossorial, arboreal, and marine mammals.
Syncravers are known in two nodosaurids (Edmontonia, Panoplosaurus) and one ankylosaurid (Saichania). Cervical fusion in ankylosaurs occurs between the first and second cervical vertebrae in all three taxa. The atlas forms a hemispherical cup-shaped cotyla that forms a ball-and-socket union with a sphenoidal occipital condyle, which would have increased mobility at the cranio-cervical joint. The atlantal neural arches are fused ventrally to the centrum and posteriorly to the axial neural arches but are not fused to each other. Fusion of the single-headed atlantal rib and double-headed axial cervical rib to their respective vertebrae occurs in all three ankylosaur taxa.

Currently, understanding the evolutionary patterns of the ankylosaurian syncraval is problematic because of poor phylogenetic resolution within this clade. However, the atlas-axis complex remains unfused in the nodosaurid Sauropteryx and the ankylosaurids Ankylosaurus, Euoplocephalus, and Shuaxia and suggest that cervical fusion evolved at least twice in Ankylosauroidea, although the anterior cervical is not known in most taxa.

The morphology of the ankylosaurian syncraval closely resembles that of ceratopsians in the ball-and-socket crano-cervical joint and the morphology of the neural spine. The ceratopsian syncraval is often linked with the evolution of a massive head. Despite the convergence of ankylosaurian and ceratopsian synapomorphies, no functional hypotheses for cervical fusion in ankylosaurs has been proposed for cervical fusion in ankylosaurs. However, the head-support hypothesis can be rejected because the ankylosaurs with syncraval lack enlarged heads compared to other closely related taxa with unfused cervicals (e.g., Sauropteryx and Ankylosaurus). These results question the head-support hypothesis in ceratopsians, and suggest that the cervical fusion in these taxa may have evolved in response to ecological or behavioral factors, perhaps related to feeding or head-to-head combat behavior, and stresses the need for more comparative studies of cervical fusion in extant taxa (e.g., mammals, hornbills) within an ecological context.

Poster Session I (Wednesday, October 17, 4:15 - 6:15 pm)
THE NEOCERATOPSID HORIZONTAL SHELF IS NOT HORIZONTAL, AND OTHER NEW INFORMATION ABOUT THIS STRUCTURE
VARRIALE, Frank, King’s College, Wilkes-Barre, PA, United States
The “horizontal shelf” is a conspicuous structure located on the labial side of the dentary in many non-cretaceous neoceratopsians, resulting from the incomplete shear of dentary teeth past their maxillary counterparts. The shelf was originally described based on the dentition of Leptoceratops gracilis; subsequent workers have noted the horizontal orientation of this structure, its possible function in grinding food, and its significance as a synapomorphy of Leptoceratopsidae. However, examination of Archaeoceratopsidae, Lioaceratopsidae, and Protoceratopsidae (all non-cretaceous neoceratopsians), as well as the ceratopsians Ceratopsinops, Leptoceratops, and Prenoceratops reveals that the shelf is neither limited to leptoceratopsids nor uniformly horizontal. All taxa show a common morphology among shelves, suggesting in turn a common genesis of this structure.

When present, shelves in labial view most often take the appearance of a scalene triangle. The legs of the triangle represent distinct mesial and distal occlusal surfaces. The contribution of each surface varies across the dentition. If a single dentary tooth occluded equally with two maxillary counterparts, then the shelf has a near equilateral shape. The mesial and distal occlusal surfaces are not planar but concave in appearance, supporting a semicircular, palinal model of mastication. The labial distance that a shelf extends from the side of a dentary tooth is also variable both within a single individual and among taxa, its size a result of the amount of time since tooth eruption.

Dental microwear was recovered from shelves in both Ceratopsinops and Leptoceratops, and both taxa show a similar pattern. Fits are a common feature, as would be expected of a grinding surface. The orientation of the scratches does not support the traditional strict orthal model of grinding mastication and also indicates that food on the labial side of the denition moved rostromesially, presenting circumstantial evidence for a containing structure to prevent loss of food from the mouth.

The distinct lack of a universal horizontal orientation in the shelf supports abandoning the use of this descriptor; simply “labial shelf” is favored here. The common pattern in genesis of the labial shelf across many non-cretaceous neoceratopsians necessitates a reexamination of the coding of this character in phylogenetic analysis. The appearance of a labial shelf in taxa as basal as Lioaceratops suggests that the character may be a neoceratopsian synapomorphy that is lost in Ceratopsiidae, and not limited to Leptoceratopsidae as previously thought.

Symposium: Cretaceous Faunas of Appalachia: Systematics, Paleocology and Taphonomy: A Symposium Dedicated to the Memory of Donald Baird (Thursday, October 18, 10:30 am)
LATE CRETACEOUS (SANCTORI-MAASTRICHTIAN) VERTEBRATE FAUNAS FROM THE ARCTIC OF APPALACHIA
VAVREK, Matthew J., Royal Ontario Museum, Toronto, ON, Canada; LARSSON, Hans C., Redpath Museum, Montreal, QB, Canada
Although fossil vertebrates were first discovered in the Canadian Arctic over 150 years ago by crews in search of the lost Franklin Expedition, the region has remained relatively poorly known in relation to more southerly parts of North America. We have begun a project to collect and describe fossil vertebrates from the Late Cretaceous of the eastern Canadian Arctic, and have discovered a much more diverse fauna than initially suspected. At present, we have identified seven chondrichthyan fishes, an ostechthyan fish, a turtle, a mosasaur, a plesiosaur, a hadrosaurid, three non-avian theropods, and a hesperornithid bird from Santonian-Maastrichtian deposits on Bylot Island, Nunavut. Although some of the material is generally indeterminate, it nonetheless is a very important data set to estimate species distributions and biogeographic patterns of diversity. The eastern Canadian Arctic has a complex geographic history and a very diverse fossil vertebrate fauna. Late Cretaceous faunas were very diverse and the fauna on Bylot Island is intermediate between the faunas from Appalachian and Laramide, and provides some of the best large-scale ecological pattern in North American Late Cretaceous marine chondrichyans.

Symposium: Vertebrate Paleontology in the Northern Neotropics: Cradle and Museum of Evolution across Geological Time (Wednesday, October 17, 9-45)
PALEOGENE VERTEBRATE FAUNAS FROM THE GREATER ANTILLES
VELEZ-JUARBE, Jorge, Laboratory of Evolutionary Biology, Department of Anatomy, Howard University, Washington, DC, United States; DOMING, Daryl P., Laboratory of Evolutionary Biology, Department of Anatomy, Howard University, Washington, DC, United States
The origins of the Greater Antillean vertebrate faunas have been a topic of extensive research. Here we focus on the Paleogene faunas which include the middle Eocene of Jamaica and the early Oligocene of Puerto Rico. The fossils studied come from exposures of the middle Eocene Guys Hill Formation at Seven Rivers, Jamaica and from exposures of the early Oligocene San Sebastian and Juana Diaz formations in northwestern and southwestern Puerto Rico, respectively. The Seven Rivers fauna includes elasmobranchs, ostechthyan, pelomedusoid turtles, varanid and polychrotid lizards, crocodylids, sirenians and rhinocerotids. This fauna includes some of the earliest sirenians, as well as some terrestrial taxa that share affinities with coeval North American taxa. The early Oligocene fauna of Puerto Rico so far includes elasmobranchs, osteichthyan, pelomedusoid turtles, gavialoid crocodylids, megalonychid sloth, and caviomorph rodents. Whereas the fish fauna (osteichthyans and elasmobranchs) is very similar between the islands the terrestrial and semiterrestrial fauna are not. The Jamaican fauna reflects a more Holarctic origin, which differs from later faunas from the region, including the Oligocene ones from Puerto Rico, which are almost exclusive of South American affinities. These differences reflect the diverse geotectonic history of the islands constituting the Greater Antilles.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)
SPECIES DELIMITATION BASED ON THE LIMITS OF CLIMATE AND MORPHOLOGY IN PALEONTOLOGY: A GEOMETRIC MORPHOMETRIC ANALYSES OF CHRYSEMYS PICTA PLASTRONS
VERMILLION, Wesley A., Indiana University, Bloomington, IN, United States; POLLY, P. D., Indiana University, Bloomington, IN, United States
Aquatic turtles have great promise as paleoclimatic indicators. Their ectothermic physiology gives them sharp geographic boundaries defined by winter cold, and their freshwater environment and diet give the isotopic signature in their bones a clear relationship to the signature of precipitation within their environment. The North American pond turtle, Chrysemys picta, originated in the Miocene and persists to the present day, with its northern boundary following isothermic lines around New Brunswick, along the northern Great Lakes, and into southern Saskatchewan and Manitoba. This species is not homogenous; however, it is divided into four subspecies C. picta picta (Atlantic seaboard), C. p. marginata (Midwest), C. p. bellii (upper Great Plains and northwests), and C. p. dorsalis (southern Mississippi River drainage). The latter group has an entirely different climatic regime and has been considered a distinct species by many authors.

The possibility of distinguishing these four phylogeographic groups, especially, C. p. dorsalis, based on its shell, was examined in this study. Seventeen landmarks were taken on the plastrons of individuals within each of the four subspecies. A Principal Component Analysis of the Procrustes superimposed landmarks shows morphological variation within C. picta is determined by subspeciation. Differentiation of subspecies accounts for ~8% of the total morphological variation. C. picta picta was determined to be marginally more similar to C. dorsalis than to the other subspecies. Compared to morphological differentiation between subspecies, there is considerable within group variation. While there are phenotypic differences between subspecies, a reasonable sample size is necessary to distinguish them. Future work tracing the differentiation of C. picta in relation to the climatic transition from Miocene to Quaternary will have to be based on more than individual specimens.
Australopithecus afarensis has a dense and geographically widespread fossil record that spans nearly 700,000 years. This taxon has been found in heterogeneous environments and generally does not show a preference for any habitat type (open grassland, woodlands, bushlands etc.). Analyses of dental microwear suggest that during its history the material properties of the foods eaten by A. afarensis did not change. To understand the context in which A. afarensis succeeded we avoided major adaptational changes through time, this project explores the question of stability in the community structure within A. afarensis localities through time and space. To reconstruct these communities, guild structure was compared in localities where A. afarensis has been recovered. Mammalian genera (~1 kg) were categorized into guilds based on broad dietary, locomotor, and size classes (defined in the Evolution of Terrestrial Ecosystems Database). To compare guild structure across space, the proportion of guilds from the Sidi Hakoma Member in the Hadar Formation, Ethiopia (n=62 genera) were compared to the proportion of guilds in the Tulu Bor Member of the Koobi Fora Formation (n=19 genera) in East Turkana, Kenya, both dated to ~3.4 Ma. Guild structure was compared between all geological members of the Hadar Formation (the basal (n=31), Sidi Hakoma (n=94), Dener Dora (n=105) and Kada Hadar Members (n=83)) to examine change through time (3.4-2.95 Ma). A chi-squared test was used to determine whether guild structure was significantly different between pairs of geological members. No differences exist between geological members through time at Hadar, despite a trend toward the environment becoming more arid and seasonal. Significant differences were found across space, however, in that the lower Sidi Hakoma Member was significantly different in guild structure from the lower Tulu Bor Member (~0.01). This study differs from other paleoecological studies by focusing on community dynamics rather than habitat reconstruction. The results of this study highlight the fact that A. afarensis is found pre-adapted for many different ecological niches within the Hadar Formation as contrasted to the Koobi Fora Formation.

A NEW MARINE TURTLE FROM THE MAASTRICHTIAN OF ANGOLA

VINEYARD, Diana P., Southern Methodist University, Dallas, TX, United States; MATEUS, Octávio, Universidade Nova de Lisboa, Monte de Caparica, Portugal; JACOBS, Louis L., Southern Methodist University, Dallas, TX, United States; POLICYN, Michael J., Southern Methodist University, Dallas, TX, United States; SCHULP, Anne S., Naturhistorisk Museum Maastricht, Maastricht, Netherlands

Well preserved skull, jaw and associated postcranial material of a new marine turtle was recovered from the mid Maastrichtian (Late Cretaceous) Mucuo Formation, Benga, Angola, during the 2010 Project Paleo Angola expedition. Preliminary analysis was performed showing that the new material represents a sister-taxon of Eucteles based on synapomorphies such as extensive secondary palate, shovel-like mandible, low toroidal ridge, and broad skull, and places the new Angolan specimen as the most basal Eucteles. This new taxon, plus Angolochelys abaeus, and at least two other distinct taxa show a diversity of marine turtles previously unknown in the Cretaceous of Africa.

VARIATION IN COMPLEX SYSTEMATIC PROBLEMS: A CASE STUDY

TITEK, Natasha S., The University of Texas at Austin, Austin, TX, United States; BURROUGHS, Robert W., The University of Texas at Austin, Austin, TX, United States

Levels of variation in one population that exceed interspecific levels known to be expressed between sister species can make species identification within a clade problematic. The situation is further complicated by the fact that, while levels of variation within many species remain poorly understood. Box turtles of the extant genus Terrapene exemplify this problem. The clade is currently split into six species and ten subspecies. Morphological variation has been noted in many of these taxa, but remains poorly characterized. The situation presents a circular problem; characterizing variation across the temporal and geographic range of the clade remains intractable until lineages can be separated and studied individually, but lineages remain unidentifiable on an evolutionary level, due to a lack of understanding of variation. In systematics, this problem can translate into poor understanding of apomorphies and a lack of resolution in phylogenetic analyses. We used Pleistocene and recent specimens of Terrapene as a test case to approach the problem of variation and systematic resolution in phylogenetic analyses that include fossils. We used specimen-level phylogenetic analyses to explore whether variation between specimen-level terminals still allowed for species-level resolution. We scored multiple specimens of extant species of Terrapene as well as multiple fossils from several localities. We hypothesized that specimens would cluster in polytomous assemblages by species, if variation had a minimal effect on resolution. However, in our analysis not all specimens clustered together into species assemblages. Examination of character distribution indicated that coding specimen-level, as opposed to species-level, terminals caused signal from
intraspesific variation to overwhelm potential apomorphies that were traditionally used to separate species. We then collapsed recent specimens into species-level terminals and fossil specimens into locality-level terminals. That approach resulted in traditionally recognized clades. Our results indicate that the complement of species- and specimen-level analyses provides a starting point for elucidating different sources of variation that affect systematic resolution. In this case, we find that currently recognized apomorphies for species of *Terrapene* are insufficient to support species-level discrimination of 4% of intraspecific variation. In this context, reliable, apomorphy-based identification of isolated specimens in the fossil record is currently impossible. Adding extinct ‘species’ known from only single specimens to an analysis presents a comparable situation. Some currently recognized species and subspecies are not immune to this problem.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

**INSIGHTS FROM A NEW SPECIMEN OF THE GAVIALOID CROCODYLIAN *THORACOSAURUS NEOCESARIENSIS* FROM THE MAASTRICHTIAN-DANIAN HORNERSTOWN FORMATION, SEWELL, NJ**

VOEUGELE, Kirsten K., Drexel University, Philadelphia, PA, United States; PATEL, Athena K., Drexel University, Philadelphia, PA, United States; ULLMANN, Paul V., Drexel University, Philadelphia, PA, United States; SCHEIN, Jason P., New Jersey State Museum, Trenton, NJ, United States; LACOVARA, Kenneth J., Drexel University, Philadelphia, PA, United States

A recently discovered specimen of the gavialoid crocodylian *Thoracosaurus neocesariensis* from the Inverness Company Glencombite pit in Sewell, NJ, yields new phylogenetic and ontogenetic information about this rare taxon. Collected from the end-Cretaceous Main Fossiliferous Layer (MFL) thanatocoenosis of the Hornerstown Formation, these fossils represent a disarticulated but associated subadult individual, roughly half the size of those previously published. This new specimen includes a nearly complete lower jaw and the first well preserved articular, tibia, and ischium for *T. neocesariensis*. Novel taxonomic insights from the lower jaw include: 1) the angular-surangular suture passes broadly along the ventral margin of the external mandibular fenestra; 2) uniform size of teeth alveoli in the dentary posterior to the 4th alveolus; 3) anterior processes of the surangular are unequal in length; 4) surangular does not extend posteriorly to the tip of the retroarticular process of the articular; and 5) presence of a dorsovertically oriented suture between the articular and surangular anteriorly. The later three features are synapomorphic with congeneric *T. macrocephalus*. With respect to previously published larger *T. neocesariensis* specimens, this individual possesses two unique features: 1) a linear frontoparietal suture between the supratemporal fenestra instead of a concavocorvex suture, and 2) the 3rd and 4th dentary alveoli are not confluent and are equal in size, instead of separated with the 4th alveolus larger than the 3rd. The linear frontoparietal suture of this specimen is similar to that of *T. macrocephalus*. In addition, the lingual foramen for the articular artery and alveolar nerve is solely on the articular in this individual, while for close phylogenetic relatives, including *T. macrocephalus*, the lingual foramen is on the surangular entire. These differences may reflect ontogenetic variation within *T. neocesariensis* and possibly independent evolution among gavialoids in the case of the location of the lingual foramen.

**POSTER SESSION II**

**THE IMPACT OF CORAL REEFS ON FISH DIVERSIFICATION**

WAINWRIGHT, Peter, University of California, Davis, Davis, CA, United States

Coral reefs harbor spectacular organismal diversity in a wide range of metazoan groups. Perhaps nowhere is this more conspicuous than teleost fishes where one in every six species lives on reefs and a stunning range of ecotypes and morphological specializations are found. But, did this diversity accumulate on reefs or have reefs been the site of this evolutionary creativity? We set out to explore the impact of reefs on ecomorphological diversification in two major reef radiations of tetazoids. Over 500 of the approximately 600 labrid species live on reefs, and the group includes spectacular ecological diversity, including detritivorous parrotfishes, cleaner wrasses, coral mucous feeders, zooplanktivores and a wide range of generalized invertivores. Patterns of diversification in the iconic labrids were contrasted with Haemulidae, which, although an important component of New World reef faunas, is actually more species rich in non-reef habitats and shows modest trophic diversity on reefs. Using an analysis pipe-line that accounted for phylogenetic relationships among species, the time available for diversification and model uncertainty we compared the rate of evolution of functional morphological traits associated with feeding and locomotion in reef and non-reef lineages. We found that reef labrids occupy 68.6% more trophic morphospace than non-reef species and have rates of trait evolution that are on average twice as fast as non-reef lineages. Remarkably, when we remove species representing niches only found on reefs we get about the same difference in rates of trait evolution. Such a pattern might be expected in the quintessential radiation of reef fish, but we find an even stronger pattern in Haemulidae where trophic traits evolve up to 12 times faster in reef lineages, in spite of the fact that there are no niches unique to reef species that have evolved in this group. In haemulids, locomotor traits evolve faster on reefs, but the difference is not as pronounced as we find in trophic traits. Together these analyses present a strong signal that reef habitats cause a higher rate of morphological diversification in fishes. Exactly why this is cannot yet be determined, but the extremely high physical and biological complexity on reefs may offer tremendous ecological opportunity that drives diversification.

**Poster Session III (Friday, October 19, 4:15 - 6:15 pm)**

**ASYMMETRIC VANES OF LIVING AND FOSSIL BIRD FEATHERS INDICATE MECHANICAL FUNCTION RATHER THAN FLIGHT ABILITY**

WANG, Xia, University College Dublin, Dublin, Ireland; DYKE, Gareth, University of Southampton, Southampton, United Kingdom

In modern bird feathers, vane asymmetry is caused by the rachis lying towards the leading edge, which is thicker, narrower and stiffer. Asymmetry is thus found in feathers with leading edges in close contact with the airflow in flight. A great deal of attention has been directed at the aerodynamic function of vane asymmetry, and it has been suggested that degree of asymmetry is related to flapping flight. The mechanical role that vane asymmetry plays has never been explored.

We measured vane asymmetry (trailing-vane width: leading-vane width) at 25%, 50% and 75% of feather length from first or second primaries in the wings of 38 living species. Species were grouped by different flight styles, wing beat frequency, and plumage stiffer. ANOVA was conducted to determine if these parameters can be predicted from asymmetry. Results show that neither vane asymmetry (mean asymmetry value of the three points) nor vane asymmetry at any of the three points we measured is significantly different in birds classified with different flight styles (P=0.13) or wing beat frequency (P=0.64). However, mean vane asymmetry and vane asymmetry at the 25% point do differ significantly between birds that have markedly different feather stiffer.

This research does not support the long-held dogma, “*Archaopteryx* must have been a flapper because it has asymmetric feathers”; alternatively, data suggest that the less asymmetric feathers of this fossil bird, compared with those of modern birds, indicates that *Archaopteryx*’s feathers were relatively more flexible. Because direct correlations between flight style and vane asymmetry cannot be established, conclusions about dinosaur flight capabilities from the vane asymmetry of fossils should be treated with caution.

**Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)**

**EXPLORING UNCERTAINTY IN THE CALIBRATION OF THE MOLECULAR CLOCK**

WARNOCK, Rachel C., University of Bristol, Bristol, United Kingdom; JOYCE, Walter G., Institut für Geowissenschaften, University of Tübingen, Tübingen, Germany; PARHAM, James F., Alabama Museum of Natural History, University of Alabama, Tuscaloosa, AL, United States; LYSON, Tyler R., Department of Geology and Geophysics, Yale University, New Haven, CT, United States; DONOGHUE, Philip C., Department of Earth Sciences, University of Bristol, Bristol, United Kingdom

Calibration is a critical step in every molecular clock analysis but it has been the least considered. Bayesian approaches to divergence time estimation make it possible to incorporate the uncertainty in the degree to which fossil evidence approximates the true time of divergence.
We explored the impact of different approaches in expressing this relationship, using Testudines as an example for which we established novel calibrations. We demonstrate that the parameters distinguishing calibration densities have a major impact upon the prior and posterior of the divergence times, and it is critically important that users evaluate the joint prior distribution of divergence times used by their dating programs. We also show that the inclusion of informative fossil taxa increases concordance between raw palaeontological and molecular estimates of divergence times – however, the timescale always remains sensitive to the choice of calibration priors. This highlights the urgent need for innovative ways of incorporating palaeontological knowledge into molecular clock analyses.

Poster Session IV (Saturday, October 20, 4:15 - 6:15 pm)

DINOSAURIAN OOFUAN FROM THE UPPERMOST CRETACEOUS NEMEGT FORMATION IN MONGOLIA

WATABE, Mahito, Hayashibara Museum of Natural Sciences, Setouchi, Japan; TSOGTBAAATAR, Khishigjav, Mongolian Palaeontological Center, Ulaanbaatar, Mongolia

Dinosaur eggs and nests are abundant in Cretaceous beds, especially in the Upper Cretaceous. The oofuans from these beds are widely diverse, especially in China and North America. The uppermost Cretaceous Nemegt Formation (Maastrichtian) yields many dinosaur bone fossils and has been intensively studied for dinosaur eggs and nests. These eggs and nests were carefully collected from the ground surface, and detailed geologic and geographic records were made. The surveyed dinosaur fossil localities of Nemegt are: Bugin Tsav, Gurvilt Tsav, Khachin Ula I, Tsagaan Khusbhu, Ulaan Khusbhu, Altan Ula II, III, and IV, and Khermeen Tsav (Upper White Beds with Nemegtiian dinosaur fossil assemblage).

The dinosaur bone fauna of the Nemegt Formation is represented by: theropods (Tarbosaurus, Gallimimus, alvarezsaurids, the oviraptorid Nomingia, and Avimimus), sauropods, hadrosaurids (Saurolophus and Barbsoldia), an ankylosaurid (Tarchia), and a pachycephalosaurid. The dinosaur ichnofauna (footprints) from the formation is characterized by: variably-sized bipedal forms (small to large theropods), large to medium-sized bipedal ornithopods, and medium and large-sized quadrupedal forms (sauropods and a possible ankylosaurid).

The dinosaur oofuana of the bed contains: denuroolithid (varially-formed forms), spheroolithid, elongattoothil (varially-sized forms), and laevisoolithid (thin-shelled forms) eggs. Other egg groups belonging to the dinosauroid basic type, faveoololithid (usually assigned to sauropods), and ovaloolithid (ornithopods) eggs are absent, in spite of the need for sauropods in the associated bone fauna. Eggs assigned to ankylosaurids have not yet been reported.

More intensive and careful searching for, and collecting of, dinosaur eggs is necessary in order to collect sedimentologic and geographic data associated with those eggs. Additionally, morphological variations in egg ultrasturctures between individuals and within the same egg need to be understood as a basis for further comparisons and the erection of new ostea. Such careful methods will provide a concrete basis for bone-egg-footprint correspondence among the Nemegt dinosaurs.

Technical Session IX (Friday, October 19, 11:15 am)

THE ONTOGENY OF CRANIAL MORPHOLOGY IN CROCODILIANS AND ITS PHYLOGENETIC SIGNIFICANCE: A GEOMETRIC MORPHOMETRIC APPROACH

WATANABE, Akinobu, Florida State University, Tallahassee, FL, United States; SLICE, Dennis E., Florida State University, Tallahassee, FL, United States

The degree to which ontogenetic data can facilitate our understanding of phylogenetic relationships has long been a subject of contention in evolutionary biology. In vertebrate palaeontology the availability of fossil specimens at multiple developmental stages has permitted studies on the ontogeny of extinct taxa, a topic of growing interest in the field. However, morphological changes associated with ontogeny are generally considered a hindrance for resolving phylogenies in palaeontological studies due to their confounding effects on taxonomic identification and the tendency of juvenile individuals to exhibit plesiomorphic features. Nevertheless, whether the patterns, or trajectories, of ontogenetic changes are phylogenetically informative remains to be tested. Here, I used extant members of Crocodylia to investigate whether the trajectories that describe the morphological changes associated with ontogeny contain significant phylogenetic signal. Using three-dimensional landmark-based geometric morphometric methods, I digitized the cranial and postcranial elements of alligators and crocodiles for each sampled species to test whether the similarities in the orientation of these trajectories correlate with phylogenetic relatedness. Crucial to this study was the availability of molecular phylogenies that provided phylogenetic reconstructions independent from morphological data, with which the phylogenetic signal of these trajectories could be tested. I employed a suite of methods, including (1) the K-statistic; (2) a likelihood ratio test based on Pagel’s lambda; (3) permutation regression analysis; (4) topological comparisons between the dendrogram constructed from a clustering method and the molecular phylogeny; and (5) a Mantel test. All tests produced a non-significant result, indicating that the shape changes associated with growth are not phylogenetically informative. Interestingly, the topology of the dendrogram constructed from a clustering algorithm also differs markedly from the topology of published morphological trees, which suggests that the underlying signal in these trajectories is largely uncorrelated with similarities in adult cranial morphologies. The results of this study counter the assumption that patterns of morphological changes that occur throughout ontogeny contain significant phylogenetic signal and give caution to the use of ontogenetic data for phylogenetic inference.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

A REGIONALLY EXTENSIVE LANCIAN SEISMITE SERVES AS A TIME SYNCHRONOUS STRATIGRAPHIC MARKER FOR MAPPING DINOSAUR BONEBEDS IN NORTHEASTERN WYOMING

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The Lance Formation in northeastern Wyoming and other correlative Upper Cretaceous deposits in the region are notoriously resistant to stratigraphic studies. The beds can change character completely over a few meters, and it is not unusual to find an entire change in sediment character evident at a single location. In informal stratigraphic look at the Lance Formation leaves the impression that prominent sandstone ledges could serve as stable marker beds, but these are secondarily cemented with carbonate, and they can disappear and reappear at a higher or lower stratigraphic position without consistency. Without a dependable stratigraphic framework, it is difficult to correlate remote bone outcrops with the main quarry area. In the past, the most useful stratigraphic marker had been the major bonebed which is exposed for several hundred meters. The persistence of the bonebed suggested to us that a stratigraphic framework was possible. During the 2011 season, we identified a prominent seismic in the region of our quarries that is traceable across the extent of the quarries. The seismic is a ten, fine-grained, immature sandstone which exhibits distorted, undulating to crumpled bedding features and overlies an undisturbed sandstone. A flat, undisturbed sandstone lies above the seismic. We have thus far been able to map the seismic over an area of 50 square kilometers and we are presently working to ensure the seismic is everywhere a single event and to extend the seismic as far as possible. Using this time synchronous bed as a mappable horizon, we have been able to tentatively establish the relationship between the thirteen quarry sites we have worked. The majority of the quarries (eleven) occur in the main bonebed at a horizon 27 meters below the seismic. A microfault is 15 meters below the seismic and a unique bonebed is 37 meters below the seismic. While the eleven quarries are plesuspecific Edmontosaurus sites, the unique bonebed is remarkable in that excavation thus far (500 bones, teeth and mappable fragments) has revealed no Edmontosaurus remains, but bones and teeth from most other taxa of dinosaurs reported from the Lance (Pachycephalosaurus, Triceratops, Nanotyrannus, Tyrannosaurus, Dromaeosaurus, Nodosaurus, Struthiomimus, and several not yet identified) as well as remains of turtles, lizards, frogs, crocodiles and mollusks. We now know the stratigraphic relationship of this bed to the main bonebed, and we are now working to piece together a more comprehensive taphonomic model for the entire site.

Preparers’ Session (Thursday, October 18, 11:15 am)

LOST AND FOUND: THE CHALLENGES, OPPORTUNITIES AND SIGNIFICANCE OF A FOSSIL RHINOCEROS SPECIMEN FOUND DURING A STORAGE CLEANING EVENT

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Museums and other institutions frequently have specimens hiding in field jackets for decades on back shelves in storage rooms. The collection facilities at the University of North Dakota (UND) are no exception, but have some extra challenges to overcome. First, UND has no staff fossil curator, which means this responsibility falls to the main paleontology professor and student volunteers. Second, is the lack of space for large vertebrate fossils, both in terms of cabinet space and jacket storage. As a result, specimens are stored in numerous places throughout the building. Third, UND has a history of hiring invertebrate paleontology faculty, which can result in vertebrate fossil specimens receiving less attention. These factors led to the peculiar situation of an Oligocene rhinoceros (UND-PC 16162), collected in 1966, being rediscovered in the North Dakota Geological Survey (NDGS) Wilson M. Laird Core and Sample Library in 2012. UND-PC 16162 is from the Brule Formation, White River Group, Stark County, North Dakota. Some elements of the specimen were collected with partial field jackets, while other elements were simply wrapped in newspaper. The specimen was placed into two wooden crates, brought back to UND and never prepared. The specimen was moved to the NDGS Core Library during the mid-1980s. The specimen remained in storage, with no record of the move, until 2012, when the crates were rediscovered in a cleaning effort at the NDGS Core Library. Once rediscovered, the search began for any field notes in order to determine the specific geographic location and stratigraphic horizon of the specimen. During this time, preparation of the fossil was undertaken with limited vertebrate fossil preparation equipment. To overcome the lack of equipment, a local orthopedic clinic was contacted and a surgeon volunteered the use of a spare cast cutter. A few UND paleontology students prepared the specimen and were able to involve one of the orthopedic doctors from the clinic in the process. Once prepared, the goal is to create a display with the specimen at the orthopedic clinic in order to promote paleontology, and positive interactions between the public and the paleontology program at UND. The rediscovery of the rhinoceros specimen is fortuitous in that the specimen represents Diceratherium tridactylum, which prior to this study was known in North Dakota only from specimens from the Arkaroola Formation. UND-PC 16162 is the first D. tridactylum specimen recovered from the Brule Formation of North Dakota and could assist with refinement of the biostatigraphic zonation of the Brule Formation in North Dakota.
lamellar bone late in ontogeny, it rarely characterizes much of their growth. In this respect, marsupials do not resemble primates, murine rodents, or large-bodied ungulates, but do resemble some xenarthrans. Highly vascularized woven bone has yet to be shown in any ectothermic, slow-growing, or bradymetabolic taxon, but histological characters traditionally associated with slow growth (LAGs, lamellar bone, avascularity) are more common in mammals (including placentals) than previously appreciated. These characters cannot by themselves be used to diagnose extant taxa as bradymetabolic, ectothermic, or even as slow growers, so their interpretation in extinct taxa must be cautious. 

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A REANALYSIS OF CM 11162, A SKULL OF APATOSAURUS (SAUROPODA: DIPLODOCIDAe)

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Although relatively common by sauropod dinosaur standards, few diplodocid skulls have received thorough description in the post-war era. One of the first specimens to benefit from a modern treatment was Carnegie Museum (CM) specimen 11162, a nearly complete skull assignable to Apatosaurus louisae. With the recent resurgence in interest in diplodocid evolution and ecology, this specimen is of great significance: it is the most complete described skull of Apatosaurus, and is a primary source of information regarding the facial skeleton of flagellicaudatans other than Diplodocus and Dicraeosaurus. Here, we revisit this specimen following additional preparation and the recent publication of several descriptions of diplodocid skulls that have highlighted new characters and regions of interest.

We identify or confirm six size-independent cranial character states that distinguish Apatosaurus from Diplodocus. We confirm that Apatosaurus lacks a basipectoral ridge, and that the basipectoral processes are autapomorphically flared distally, as previously published. We also confirm the presence of globular basal tubera, as opposed to the sheet-like tubera of Diplodocus; we further observe that the tubera of Apatosaurus face posteriorly, not laterally as in Diplodocus. In lateral view, the squamosal and quadratojugal of Apatosaurus do not appear to closely approximate each other as they do in Diplodocus. Finally, the supraoccipital crest of Apatosaurus is massive, prominent, and flanked by deep nuchal fossae, unlike the relatively low crest and shallow fossae of Diplodocus. We are unable to confirm the absence of a sharp-lipped fossa surrounding the prearticular fenestra; this fossa has been proposed as an autapomorphy of Diplodocus, but the poor preservation of this region of CM 11162 obscures the condition in Apatosaurus.

In addition, we document the presence in CM 11162 of two character states that were previously identified as autapomorphies of Diplodocus: no contact between the vomer and premaxillae; and pterygoid at least partially medial to ectopterygoid on transverse suture. The presence of these character states in Apatosaurus suggests that they are synapomorphies of a more inclusive diplodocid clade, probably Diplodocidae.

Technical Session XVI (Saturday, October 20, 11:15 am)

THE ISOTOPIC RECORD OF LAGOMORPHS AT HALL’S CAVE

WICKS, Travis Z., The University of Texas at Austin, Austin, TX, United States; SHANAHAN, Timothy M., The University of Texas at Austin, Austin, TX, United States; MAUPIN, Christopher R., The University of Texas at Austin, Austin, TX, United States; GORMAN, Meaghan K., The University of Texas at Austin, Austin, TX, United States; BELL, Christopher J., The University of Texas at Austin, Austin, TX, United States

The isotopic values of tooth enamel often are used to make paleoenvironmental interpretations. Perhaps the most common way in which these data are employed is in the reconstruction of vegetation; specifically, the carbon isotopic values in the teeth of herbivores are used as proxies for the relative proportions of C3 and C4 photosynthesizers. C3 records from soil organic matter in various localities in Texas reveal noticeable fluctuations in the ratio of C3 and C4 vegetation since the Last Glacial Maximum. Generally speaking, C3 productivity decreased drastically multiple times during the late Pleistocene and gradually increased since then, peaking at approximately 6 ka. Hall’s Cave in central Texas contains a well-dated sedimentary record that spans the last 20,000 years, encompassing the interval during which these changes took place. The cave is also extremely fossiliferous and allows us to test predictions derived from dietary models of lagomorphs. We compare our isotopic data to the well-documented diet of modern lagomorphs (from laboratory and field data) as a reflection of the relative proportions of C3 and C4 productivity. Lepidops appear to be good proxies for a proxy of local vegetation because of their small home ranges, ever-growing cheek teeth, varied diet, and abundance in the fossil record. This is as opposed to many large herbivores, such as Equus and Bison, which are used as proxies specifically for grass. Here we indicate that although vague trends can be seen, leporid C3/C4 is insensitive to changes in relative C3/C4 productivity, when compared our record of C3/C4 records from soil organic matter. This is likely due to dietary preferences of individuals. Despite the observation that leporids are generalist herbivores, an individual may exhibit strong preferences for one type of plant or another. This is clearly exhibited in our dataset, which contains specimens with nearly all C3 diets and specimens with nearly all C4 diets occurring at the same stratigraphic level. Although several factors make lepidops appear to be good for paleoecological reconstructions, comparison with soil organic C3/C4 records reveals that individual diet preferences overemphasize the generalist herbivorous tendencies of the group as a whole. We emphasize the need to use caution when using vertebrate isotopic records to reconstruct paleoenvironments due to biases in the diet of the taxon used as proxy.
A RE-EVALUATION OF TOROSAURUS UTAHENSIIS: IMPLICATIONS FOR MAASTRICHTIAN CERATOPSIAN DIVERSITY IN WESTERN NORTH AMERICA

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There is considerable ongoing debate about taxonomy and ontogeny of late Maastrichtian chasmosaurine ceratopsids from western North America (e.g., Triceratops and Torosaurus latus). However, recent studies have all but ignored another coeval taxon, Torosaurus utahensis from the North Horn Formation of central Utah. We conducted a comprehensive re-analysis of ceratopsid specimens from the North Horn Formation; five diagnostic specimens were identified as Torosaurus utahensis, and three others are assignable to Torosaurus sp. We conclude that T. utahensis is a valid taxon based on two autapomorphies and a unique combination of character states. Autapomorphies for T. utahensis are proximally “waisted” postorbital horncores and with an anterior margin situated anterior to the orbit. In addition, T. utahensis preserves a unique combination of character states including the presence of epiparietal P2, and the shape of the squamosal. Synapomorphies that are shared with T. latus include: five epiparietals on each side of the parietal; dorsalventrally thin and rostrocaudally broad transverse parietal bar; subcircular parietal fenestrae; and a C-shaped cross section of the median portion of the midline parietal bar. A recent hypothesis suggests that Torosaurus latus is the adult ontogenetic stage of Triceratops, based on specimens from the northern part of western North America. In the north, well-sampled assemblages such as the Hell Creek Formation produce abundant Triceratops remains, whereas assemblages with similarly-sized samples from other Basin states preserve exclusively Triceratopsid remains. In contrast, diagnostic ceratopsid specimens from the North Horn Formation are assignable only to Torosaurus, a relative abundance which would be aberrant if it were simply an adult of Triceratops. This could be an artifact of low sample size; however, the probability of finding only eight Torosaurus specimens from a Hell Creek-like relative abundance distribution of Triceratops and Torosaurus is ~<0.001, indicating that the North Horn assemblage is significantly different from that of the Hell Creek. Two possible hypotheses could explain these data: first, T. utahensis is an adult of Triceratops, and only old adult animals are preserved in the North Horn Formation; or, T. utahensis and T. latus are valid and sister taxa, and the lack of Triceratops specimens in the North Horn Formation is a real biogeographic difference. We suggest the latter hypothesis is more likely.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

A PALEONTOLOGICAL AND NEONTOLOGICAL INVESTIGATION OF THE CLAIM THAT THE PTEROSAUR SCAPHOGNATHUS CRASSIROSTRIS SURVIVED INTO THE SEVENTEENTH CENTURY

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In an attempt to discredit evolutionary theory by “proving” that humans and pterosaurs coexisted until recently, some young-Earth creationist (YEC) authors claim that a skeleton exhibited in Italy in the seventeenth century was that of a recently-killed pterosaur, specifically Scaphognathus crassirostris. It is important that paleontologists not simply dismiss such claims but instead investigate them and publish the results of the investigations. This is because YEC literature shows that the YEC community generally accepts the results of such investigations and drops falsified claims (e.g. alleged human footprints in Cretaceous limestone near Glen Rose, Texas) from its arsenal of anti-evolution claims. The skeleton in question was exhibited, and an anatomically detailed drawing of it was published in 1685, in which it was claimed that the specimen was a dragon that had recently been killed in the marshes near Rome. According to recent YEC literature, the winged skeleton’s cranial crest and long tail diagnose it as the pterosaur S. crassirostris. We compared the skeleton to that of S. crassirostris and note that its skull shape, dentition, hindlimb morphology, and tail vertebrae differ markedly from those of S. crassirostris and all other known pterosaurs. Furthermore, S. crassirostris has no crest; the YEC claim that it is crested is based on misidentification of an uncrusted frontal bone on a juvenile S. crassirostris fossil. Osteological comparison with extant animals reveals that the skeleton that was originally exhibited is a taxidermic composite. It combines the skull of a dog; the mandible of a second, smaller dog; and the tail of an eel. It’s “hindlimb” is actually the forelimb of a small bear. Faux cloacal covers and conceals junctions between bones of different animals. The wings are fake and do not resemble pterosaur wings in shape. The claim that S. crassirostris survived until three centuries ago can therefore be put to rest, thanks to a combination of paleontological and neontological investigation of osteology. This piece of anti-evolution “evidence” is therefore invalid.
region experienced periods of drought. In addition, the fact that all of the turtle mass death assemblages from the Hell Creek of North America (N=6) are predominantly made up of baenid turtles indicates that these freshwater aquatic turtles were not well adapted for such environmental stresses.

Technical Session XIII (Friday, October 19, 2:30 pm)

NEW DISCOVERIES OF PRIMATES FROM THE EARLY PALEOCENE NACIMIENTO FORMATION (TORREJONIAN NALMA), SAN JUAN BASIN, NEW MEXICO: A WINDOW ON THE FIRST PRIMATE ADAPTIVE RADIATION

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Primates were one of several mammalian orders that underwent a rapid period of diversification in the Paleocene. As a consequence of this pattern, it appears that the order was present by the Late Paleocene, even though it is not known for certain. One of the most striking aspects of this pattern is the relative paucity ofEarly Cretaceous primates. Although this order first appeared in the mid-earliest Cretaceous, the first primate remains are from the late Albian. This order first appeared near the Cretaceous-Paleogene boundary, it is not until the Torrejonian (the second North American Land Mammal Age [NALMA]) of the Paleocene that a diversity of families began to emerge. One of the critical places to study this first primate adaptive radiation is the San Juan Basin (SJB), which extends from northwestern New Mexico into southwestern Colorado, and includes deposits that range from the Late Cretaceous to the early Eocene. Of particular importance to the study of early primate evolution are fossils from the Nacimiento Formation, dated to between 64.5 and 62 mya, which comprise the type fauna for the Early Paleocene Puerca and the Torrejonian NALMAs. Although there are currently no primates known from the Puerca deposits, Torrejonian fossils previously described from the formation represent 6 different species of “paleochidion” and paromomyid pleiadiforms. However, all of these species are known from very limited material—prior to this report the total number of primate specimens described from the Nacimiento Formation of the San Juan Basin was less than 25.

The current report increases the sample of primate specimens more than fivefold. Included is the first picodontid pleiadiform specimen from the Torrejonian of the SJB, referable to Picrodon calgarensis. Also included in the new sample is the first paromomyid specimen complete enough to allow for a species level taxonomic assignment, which represents a new species of Paromomys. With respect to the “Paleochidionidae”, the current report includes the first new specimens attributed to Pleistoles nectinem and Anzausia williamsoni, and large collections pertaining to Torrejonia wilsoni and Palaeothon woodi. These collections demonstrate previously unknown morphological variants, including the presence of a metaconid on the p4 of some specimens of T. calgarensis, which supports previous inferences about a close relationship to Pleistoles problematicus. This new sample considerably enhances our knowledge of the poorly understood “Paleochidionidae”, and about the biotriatigraphy, biogeography, and early evolution of North American primates. In particular, the rarity of paromomyids, the continuing absence of purgatorid, pleiadapid and carpolesid pleiadiforms, and the presence of a number of endemic “paleochidion” species in the SJB are all contrasts with contemporaneous deposits to the north. These contrasts suggest that already by the latter part of the Early Paleocene primates had developed not only an impressive diversity, but patterns of regional endemism.

Poster Session III (Friday, October 19, 4:15 - 6:15 pm)

AGE AND GROWTH IN MYLEDAPUS BIPARTITUS, A LATE CRETACEOUS FRESHWATER GUITARSHIF FROM ALBERTA, CANADA

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The freshwater guitarist, Myledapus bipartitus, is commonly represented by teeth and vertebral centra in the Late Cretaceous (Campanian, 75 Ma) deposits of North America. The species was first described in 1876, but until now, very little was known about its ecology. We analyzed the age and growth of 117 centra (74 hemisectioned) from the Oldman and Dinosaur Park formations of southern Alberta. The estimated maximum age was 16 years. Radial distance (RD) at the estimated asymptotic growth was calculated, and average RD at birth and 3 years were compared with two modern Rhinobatos species (R. productus and R. rhinobatos). Birth ring size ranged from 0.9–1.8 mm RD, which is smaller than those of R. productus (2.0–3.2 mm RD) and plot outside 95% C.I. At age 3, centroid of R. bipartitus ranged from 2.8–4.6 mm RD, which is smaller than those of R. productus and R. rhinobatos (5.0–6.6 mm RD) and plot outside the 95% C.I. For both species, Myledapus approached “asymptotic” growth at 7.8 mm RD; extant species examined reached “asymptotic” sizes at a RD greater than 11 mm. The growth trajectory of Myledapus has a similar slope to the Rhinobatos species. Rhinobatos rhinobatos was also longer lived than Myledapus by 8 years. This study is the first to quantify age and growth of Myledapus bipartitus and it shows that modern Rhinobatos spp. can live longer and have larger centrum sizes at age to suggest a longer total length (TL).

Technical Session X (Friday, October 19, 11:45 am)

A PARTIAL SKULL OF DIDELPHODON VORAX FROM THE LANCIAN-AGE HELL CREEK FORMATION OF SOUTHWESTERN NORTH DAKOTA, U.S.A.

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Late Cretaceous mammals from North America are known mostly from large collections of isolated teeth and dentulous jaw fragments. Though considerable data about the taxonomy, phylogeny, community structure, and ecomorphology of these mammals have been gleaned from these collections, fossil skulls and postcranial elements would provide a complementary and, by some accounts, more phylogenetically informative source of data to illuminate this critical interval of mammalian evolution.

A partial cranium of the stagodontid metatherian Didelphodon vorax (NDGS 431) was recovered from a sandstone unit in the Hell Creek Formation near Marmarth, North Dakota. This unit has also produced a typical Lancian vertebrate microfossil assemblage. NDGS 431 includes a partial rostrum that preserves parts of the zygomatic arches, maxillae, palate, and P3 through M4. The braincase, basiocciput, and petrosal morphology are also preserved, although some aspects of the skull are badly crushed, and not all parts are preserved on both the left and right sides. The semicircular canals of the inner ear are complete on the right side only. Based on dentition, NDGS 431 represents a small individual of a young adult.

Didelphodon vorax is among the largest mammals of the late Cretaceous of North America. Dental morphological traits have led to interpretations of D. vorax as a facultive and possibly a scavenger with specializations for feeding on hard objects. Dental similarities with pinnipeds and analyses of postcranial elements questionably attributed to D. vorax have led to hypotheses that it was semiaquatic. NDGS 431 provides new anatomical details. For example, in the inner ear, the cochlea completes approximately one and three-quarters turns, and the anterior semicircular canal is largest among the three canals in terms of length and arc radius of curvature. The aspect ratio of the anterior canal arc is larger than the other two canals, although the course of the anterior canal is distorted along its midsection. These and other data can be used to newly address the paleoecology of this important late Cretaceous metatherian and shed light on the phylogeny and morphological transformations of early Marsupialiforms.

Technical Session XI (Friday, October 19, 4:00 pm)

SMALL THEROPOD DINOSAURS FROM THE LATEST CRETACEOUS OF INDIA

WILSON, Jeffrey A., University of Michigan, Ann Arbor, MI, United States

Records of small theropod dinosaurs from southern landmasses are rare, but such remains have been known from India for nearly a century. Excavations by Charles Matley in Upper Cretaceous (Maastrichtian) sediments at Bara Simla, central India in 1917 and 1919 produced vertebral and limb elements that historically have been separated into at least six species (Compsosuchus solus, Laeviuschus indicus, Jubbulpuria fenestra, Coelurosaurus largus, Ornithomimosauridae, O. barabensis) or left as indeterminate ‘coelurosaurians.’ Relatively recent discoveries of the small theropod species Noasaurus leali and Masiakasaurus knopflei from contemporaneous rocks in South America and Madagascar, respectively, and advances in basal theropod systematics have led to a revised interpretation of several of these small theropod specimens as noasaur abelisaurids. Here we present a revision of some of the small theropods from the latest Cretaceous of India, based on study of the Matley collection at the Indian Museum (Kolkata) and newly collected material from Psidura, central India. Remains attributed to Laeviuschus and Jubbulpuria are approximately the same size, bear diagnostic features, and differ in features attributable to intracolumnar variation. It is likely that they are the same or closely related species, but the current absence of morphological overlap between them precludes testing that hypothesis. Compsosuchus, Coelurosaurus, and Ornithomimosauridae pertain to individuals slightly larger than Laeviuschus/Jubbulpuria. The latter two are morphologically distinct from Laeviuschus/ Jubbulpuria and share autapomorphies with another suggesting that they can be grouped together as Coelurosauridae, the first-named of the two genera. The new remains collected from Psidura include a partial dentary that bears the characteristic procumbent dentition of Masiakasaurus, which appears to be absent in the Noasaurus maxilla. Likewise, the syntopic cervical vertebrae of Laeviuschus indicus more closely resemble those of Masiakasaurus than Noasaurus. These data imply that the Indian and Malagasy noasaurids are more closely related to each other than either is to the South American form. The Bara Simla sediments were deposited during chron 29R, and the Psidura sediments during chron 30N–29R. To date, no small theropod remains have been reported from relatively rich localities in western India (chron 30N), where hundreds of sauropterygian and theropod bones have been collected, nor among the numerous bones recovered from Late Cretaceous Pale Formation in Balochistan, Pakistan, whose precise age relative to the Indian localities is unknown.

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change dynamics and habitat occupation and its potential to contribute to inferences about of cichlids (East Africa) and 40 species of notothenioids (Antarctica). By examining extant of shape data we collected on opecules of representatives for two extant species flocks, to quantified using outline-based geometric morphometrics on 2D images. We examined ecological settings over a short evolutionary time scale. Herein, opercule shape was is of particular interest because among 'model' extant teleosts such as sticklebacks its craniofacial bone supporting the gill cover, across representatives of the genus. The opercule adopted. Herein we examine the evolution of shape change in the opercule, a prominent fish genus fundamental issue in reconstructing the evolutionary history of clades and has implications Understanding the dynamics of species diversification in the wake of extinction is a

**Technical Session XVII (Saturday, October 20, 2:45 pm)**

**THE EFFECTS OF CLIMATE AND BEHAVIOR ON AVIAN BONE MICROSTRUCTURE: A COMPARATIVE OSTEOMORPHOLOGY STUDY OF HESPERORNITHIFORMS FROM THE LATE CRETACEOUS WESTERN INTERIOR SEAWAY**

WILSON, Laura E., University of Colorado, Boulder, Boulder, CO, United States

Bird microstructure patterns in *Hesperornis* femora and tibiotarsi from Kansas and the Canadian Arctic are compared to determine if migration or Late Cretaceous polar climate affected avian bone growth. Osteomorphological differences of these birds has led to speculation about their life histories, including whether they endured polar winters or migrated to more temperate climates. Consequently, the distribution of *Hesperornis* fossils in Late Cretaceous Western Interior Seaway deposits presents a unique opportunity to test the hypotheses that the energy expenditure required of long-distance migration or the limited food resources available during polar winters would cause a decrease in bone growth rate and be reflected in bird bone structure. Restricting the analysis for comparison of phylogenetically close individuals with similar functional adaptations within an ontogenetic framework, leaving environment and/or behavior as likely explanations for variation in bone microstructure.

Histologic analysis reveals no notable differences in vascular canal patterns or zonation between high- and mid-latitude *Hesperornis* specimens. The lack of histologic differences prompts two working hypotheses: (1) *Hesperornis* migrated, but migratory behavior does not leave a record in their bone microstructure; (2) *Hesperornis* did not migrate, but overwintering in the Cretaceous Arctic did not leave a record in their bone microstructure. To determine how migration and climate influence bone growth, a broad range of modern birds was examined. Comparisons among *Pygocephalus* penguin (Adélie, Chinstraps, Gentoos) bone microstructure reveals no histologic evidence for growth rate changes attributable to migration. Adélie and Chinstrap (both migratory species) bones show no zonation or changes in microstructure different from expected ontogenetic patterns, suggesting that migration is not necessarily recorded in avian bone microstructure.

Additionally, Gentoos (a sedentary species) show evidence of rapid bone growth possibly associated with increased chick growth rates in higher latitude populations, suggesting that the effects of polar climate do not always lead to a marked decrease in bone growth rate. These patterns may be explained by plasticity in bone growth of taxa, overestimates of the physiological strain of migration or polar environments on bone growth, and/or the attainment of skeletal maturity within one year in most birds. Ultimately, this study emphasizes the lack of clear evidence for migration or polar seasonality in avian bone microstructure, and leaves the question of long-distance migration in *Hesperornis* unresolved.

**Poster Session I (Friday, October 19, 4:15 - 6:15 pm)**

**PATTERNS OF CRANIOFACIAL SHAPE CHANGE IN THE EXTINCT SPECIES FLOCK OF THE ACTINOPTERYGIAN FISH GENUS SAURICHTHYS: PALEONTOLOGICAL AND PALEOECOLOGICAL IMPLICATIONS AND A COMPARISON WITH EXTANT SPECIES FLOCKS**

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Understanding the dynamics of species diversification in the wake of extinction is a fundamental issue in reconstructing the evolutionary history of clades and has implications for modern day attempts to assess the impact of biodiversity loss. The actinopterygian fish genus *Saurichthys* reached a near worldwide distribution in the Early Triassic, a time following the most devastating extinction event in earth history. The morphological diversification of *Saurichthys* is poorly understood because diagnostic features are limited and have been only partly examined and a quantitative approach has rarely been adopted. Herein we examine the evolution of shape change in the opercle, a prominent craniofacial bone supporting the gill cover, across representatives of the genus. The opercle is of particular interest because among ‘model’ extant teleosts such as scomblikeb its development is well documented and it has been shown to change shape under varying ecological settings over a short evolutionary time scale. Herein, opercle shape was quantified using outline-based geometric morphometrics on 2D images. We examined shape change between representatives of six species, comprising 167 specimens and including newly preserved material of the Middle Triassic deposits from Monte San Giorgio (Switzerland), a key locality from which four species have already been described from abundant, well-preserved fossils. Our results show a diversity of opercle shape, and importantly provide key indicators of species-specific shape changes in the anterior margin, which will be used to aid delimitation of unidentified materials, and for reconstructing the palaeobiology of *Saurichthys*. These results are compared, and discussed in the light of shape data we collected on opercles of representatives for two extant species flocks, to elucidate patterns of shape dynamics and assess the comparative magnitude of disparity in the context of an adaptive speciation model. Our comparisons for extant species were based on the same morphometric protocol and comprised representatives from 61 species of chondrichs (East Africa) and 40 species of notothenioids (Antarctica). By examining extant models in tandem with *Saurichthys* we are able to consider the relation between extant shape change dynamics and habitat occupation and its potential to contribute to inferences about the palaeoecology of *Saurichthys*.

**Technical Session III (Wednesday, October 17, 3:45 pm)**

**HABITAT STRUCTURE AND HINDLIMB FUNCTIONAL MORPHOLOGY IN AN EARLY MIOCENE EQUID FROM PANAMA**

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Paleoenvironmental conditions of the Las Cascadas Formation of Panama are relatively unknown but are integral to understanding the evolution of the oldest terrestrial assemblage of vertebrates (middle-late Arikareean) in southern Central America. Here, we describe postcrania of an abundant equid taxon from the Las Cascadas assemblage and apply a morphology-based proxy to infer habitat structure during the early Miocene of Panama. The Las Cascadas equid is tentatively identified as a small (45-55 kg via regression analysis of limb dimensions), primitive parahippine based on dental morphology. Postcranial elements discovered in a single quarry include a scapula, proximal radii, femora, tibiae, astragali, calcanea, a third metatarsal, and several phalanges. Qualitative comparisons with the well-studied, time-averaged population of “Parahippus” leonensis from the Hemingfordian of central Florida reveal functionally-relevant dissimilarities between the taxa: 1) the femoral head and neck are rotated more anteriorly relative to the long axis of the femur, 2) the astragalar neck is shorter and more perpendicular to the axis of the trochlea, 3) reduced lateral and medial ligamentous attachments sites on the astragali, and 4) a more posterior translation of the hindlimb relative to the pelvis. These features suggest a more flexed neutral posture of the hindlimb in the Las Cascadas equid as well as a reduced lateral component of ligament-mediated stability during locomotion. Our paleoenvironmental proxy, measured using three-dimensional geometric morphometric (3DGM) techniques, is built on the observed correlation between mammalian tarsal morphology and substrate complexity, which differs between open and closed habitats. 3DGM analysis of Miocene equid astragali shows the Las Cascadas equid outside the morphospace occupied by predominantly closed-habitat, early Miocene morphotypes but within the region occupied by mixed open/closed habitat horses from the late Miocene. These results, combined with abundant volcanoclastic of the Las Cascadas Formation, suggest a mosaic of open and closed habitats created by intense volcanic disturbance of tropical forests during the early Miocene of Panama.
high browsers) such as Brachiosaurus, lack any neural spine bifurcation. Recently it has been proposed that neural spine bifurcation in Diplodocoidea is ontogenetic, suggesting that the origination of bifurcation in Diplodocus is a response to the increasing weight from the horizontally extended cervical column. As there are no terrestrial vertebrates with massive, horizontally extended necks alive today, extant forms with large cranial masses were examined for the presence of neural spine bifurcation. Here we demonstrate and report on for the first time, the soft tissue surrounding neural spine bifurcation in a terrestrial quadruped through the dissection of three Ankole-Watusi cattle. With horns weighing up to a combined 90 kg, the Ankole-Watusi is unlike any other breed of cattle in terms of horn weight and presence of neural spine bifurcation. Specifically, in regards to the soft tissue, the preservation of bifurcated neural spines is most vividly expressed in the form of a highly modified and specialized nuchal ligament. Inferring from the information attained from the Ankole-Watusi, it would appear that neural spine bifurcation is critical when supporting a large mobile weight positioned off of the shoulders, which may explain the presence and absence of bifurcation within Diplodocus and Brachiosaurus. During this study neural spine bifurcation was also observed in several additional families of sauropods, within several other clades of avian and non-avian dinosaurs, and within numerous extinct and extant species of mammals. Contrary to the previous hypothesis that neural spine bifurcation was a basal feature that was evolutionarily lost in many clades, bifurcation should now be recognized as a critical anatomical component for potentially any terrestrial vertebrate with a large, mobile weight positioned off of the shoulders.

Technical Session XV (Saturday, October 20, 9:45 am)

PALEOBIOLeGICAL IMPLICATIONS OF GROWTH HISTORY AND HISTOVARIABILITY IN A POPULATION OF THE HADROSaurID DIsoRn MAiAsaUra PeeBLEsORUM

WOODWARD, Holly N., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; HORNER, John R., Museum of the Rockies and Department of Earth Sciences, Montana State University, Bozeman, MT, United States; FARLOW, James O., Indiana Purdue University Fort Wayne, Fort Wayne, IN, United States

Forty-eight tibiae of the hadrosaurid dinosaur Maiasaura peeblesorum were used in a histologic analysis to assess the ontogenetic and individual variation present within a non-avian dinosaur taxon. Tibial measurements reveal strong relationships (R^2 > 0.9) between tibia length and diaphyseal circumference, cortical area, and bone wall thickness, and histology shows woven tissue was present throughout ontogeny, indicating growth was rapid until skeletal maturity was attained. A switch in vascular arrangement between lines of arrested growth (LAGS) similar to that recently described in Arctic Edmontosaurus was also found between LAGs at Maiasaura's most basal two years of age and older: immediately following a LAG, vascular canals were relatively small and longitudinal, and then became reticular, laminar, or plexiform for the majority of the zone. The presence of this vascular pattern in a taxon found far from the Arctic Circle casts doubt on a correlation with polar endemism. Apposition rates and growth curves illustrate that approximately half of the 7 m adult body length was attained within the first year of growth. Adult size, signified by the presence of an external fundamental system, was attained between 9–10 years of age by three individuals. Ontogenetic growth rates of Maiasaura were directly compared with the ontogenetic growth rates of skeletally mature captive reared mallard alligators by scaling the annual cortical growth of each taxon. Annual cortical increase is low and constant for the alligators, while Maiasaura cortical increase is very high early in life and steadily decreases to skeletal maturity. By directly comparing the taxa, it becomes evident that even alligators raised in optimal conditions never attain the elevated growth observed in Maiasaura, providing additional evidence that the presence of LAGs in non-avian dinosaurs is not an indicator of ecotomomy or reduced growth rates. Additionally, both standard and scaled Maiasaura growth curves demonstrate that there is considerable variation with regard to body size each year, which is often a lurking variable within ontogenetic studies of dinosaur taxa due to inadequate sample sizes. Finally, the age-size frequency distribution of tibiae suggests a high mortality rate for yearlings and those individuals approaching skeletal maturity. In fact, over half of the sample is from individuals a year or less in age, suggesting that even forty eight specimens are not sufficient to fully assess the histovariability present within this taxon. Regardless, this detailed population histovariability analysis contributes to the already well-studied hadrosaur Maiasaura, making the ontogenetic history of this taxon one of the best understood of all non-avian dinosaurs.

Technical Session XVI (Saturday, October 20, 9:15 am)

3D BIOMECHANICAL MODELLING OF MARSUPIAL AND PLACENTAL SABRE-TOOTH: A DIFFERENT KINDE OF BITE FOR AN EXTREME POUNDED PREDATOR

WROE, Stephen, University of New South Wales, Kensington, Australia; CHAMOLI, Uphar, University of New South Wales, Sydney, Australia; PARR, William, University of New South Wales, Sydney, Australia; RIDGELY, Ryan C., Ohio University, Athens, OH, United States; WITMER, Lawrence M., Ohio University, Athens, OH, United States

Questions surrounding the striking morphology of sabre-teeth and the presumably deadly purpose to which it was put have long excited the attention of paleontologists. Among the dozens of known sabre-toothed species, the iconic North American placental, Smilodon fatalis, and the bizarre South American marsupial, Thylacoleo croustoi are the most specialised forms. The two are prominent in discussions of convergent evolution. Here we apply a 3D computational approach to determine the extent of convergence in terms of mechanical performance. Both jaw closing and neck depressing musculatures were simulated. We found that, in many respects, the marsupial and placental were more similar to each other than to a living conical-toothed cat. Predicted bite forces were relatively low particularly at wide gaps and in simulations where jaw muscle forces were scaled to the maximum bite forces expected given that sabre-tooths’ skulls showed high stresses. Simulations involving head depressing musculature adjusted for size differences revealed relatively low stresses in both. Although broadly comparable in these respects our study also demonstrates differences that were likely reflected in the modus operandi of the kill. Jaw adductor driven bite forces were extremely weak in the marsupial and its skull was even better adapted to resist stress induced by neck driven muscles. Considered together with the fact that the centre of the arc described by the canine teeth was close to the jaw joint in S. fatalis our results are consistent with the hypothesis that both jaw closing and head depressing musculature played a role in prey dispatch for the placental. However, for T. croustoi the jaw adducting muscles probably played no major part in the killing bite and we suggest that the marsupial presents a more complete commitment to the already extreme sabre-tooth lifestyle.
NEW INFORMATION ON SEXUAL DIMORPHISM AND ALLOMETRIC GROWTH IN THE PACHYPLEUROSAUR KEICHOUSAROUS HUI FROM THE MIDDLE TRIASSIC OF GUIZHOU, SOUTH CHINA

XUE, Yifan, Department of Geology and Geological Museum, Peking University, Beijing, China; JIANG, Da-Yong, Department of Geology and Geological Museum, Peking University, Beijing, China; SUN, Zuo-Yu, Department of Geology and Geological Museum, Peking University, Beijing, China; YANG, Peng-Fei, Department of Geology and Geological Museum, Peking University, Beijing, China; JI, Cheng, Department of Geology and Geological Museum, Peking University, Beijing, China

Sexual dimorphism and allometric growth of the pachypleurosauroidea Keichousaurus hui from Middle Triassic of Xingyi, Guizhou, south China, has been previously described but briefly without details of the precise criteria used. After measuring 22 new specimens of K. hui, and 15 previously described specimens of the same taxon, we gained new information for discriminating between the two sexual forms and describing the ontogeny. The morphology of the ulna has not previously been used as a criterion to determine the sexual form. However, after measurement we found that the proportion of the length of the ulna versus the length of the radius in most specimens of the sexual form y is less than 0.92, whereas it is greater in the sexual form x and subadult, even reaching 1.06, complementing the previous standards which mainly depended on the ratio of the humerus relative to the femur. Furthermore, the proportion of the width of ulna versus the length of ulna is generally greater in the sexual form y than in the sexual form x.

In the aspect of ontogeny of Keichousaurus hui, we found several promising equations to quantify the process of allometric growth, using the model of \( y = b + \exp(x^d) \) to fit the graph, in which two formulas stand out. One represents the change of the width of skull versus the width of gneiss compared to the growth of trunk, and the other represents the change in the length of skull versus gneiss-acetabulum distance with the growth of trunk. The \( r^2 \) of the former formula is 0.91554 while the latter is 0.94419, being significant, and both of them indicate a more rapid growth in incipient stage which decreases to zero during ontogeny. This result corroborates the hypothesis about the model of growth published before. We also examined the development of gneiss and acetabulum and found that during ontogeny, the width of the two parts changes relatively more rapidly than growth of trunk indicating the development of locomotion. The gneiss is particularly rapid and support for the forelimb develops more rapidly than that for the hindlimbs, especially in the sexual form y.

Edwin H. and Margaret M. Colbert Prize Competition (posters displayed October 17 - 20, judging occurs Thursday, October 18)

EFFECTS OF DIETARY DIFFERENCES BETWEEN TWO EXTANT RUMINANTS IN SYMPATRIC HABITAT ON ENVIRONMENTAL RECONSTRUCTION BY MESOWEAR ANALYSIS

YAMADA, Ei skuke, Kagoshima University, Kagoshima, Japan

Mesowear analysis, a method used to reconstruct diets based on facet development on the occlusal surface of cheek teeth, has been mainly applied to reconstruct the food habits of extinct species and the paleoenvironments they lived in. However, little is known about the effects of dietary differences in a sympatric environment. This limitation can introduce errors when applying the method to fossil assemblages. The aim of this study is to determine the sensitivity of mesowear analysis. An interspecific comparison of mesowear variables (i.e., frequencies of occlusal relief and cusp shape) was conducted using wild populations of the Japanese serow (Capricornis crispus, \( n = 37 \)) and the sika deer (Cervus nippon, \( n = 55 \)) in the deciduous broad-leaved forest of the Nikko National Park, central Japan. Mesowear variables between the two populations were significantly different (Fisher’s exact test: \( P < 0.05 \)). The Japanese serow population was classified as browsers and the sika deer population as mixed feeders by hierarchical cluster analysis and principal component analysis. As previous ecological studies provide good support for these results, this study concluded that mesowear analysis was sensitive to dietary differences of several species in a sympatric area. From this perspective, mesowear results of fossil assemblages from the same locality should be interpreted as a reflection of food habits of each species. Thus, the findings of this study will provide basic knowledge for the paleoecological studies based on food availability of fossil herbivorous ungulates.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

SANDSTONE DIAGENESIS AS AN INDICATOR OF DIAGENETIC PATHWAYS IN VERTEBRATE SKELETAL REMAINS AND HEMATITE CONCRETIONS FROM A CREVASSE SPLAY SANDSTONE, HELL CREEK FORMATION (UPPER CRETACEOUS), EASTERN MONTANA

YAMAMURA, Daigo, Montana State University, Bozeman, MT, United States; SCHMITT, James G., Montana State University, Bozeman, MT, United States

Enclosing sandstone matrix is often invoked as an entombing medium facilitating preservation of endogeneous molecules in vertebrate skeletal material by isolation from contact with pore fluids. A fossil-bearing crevasse splay sandstone and enclosed fossilized skeletal remains and hematite concretions formed inside and outside of fossil bones in the Upper Cretaceous Hell Creek Formation (Makoshika State Park, Glendive, MT) were analyzed to document pore fluid geochemistry and its interaction with vertebrate skeletal remains during diagenesis and examine the role of sandstone matrix as an entombing agent. Optical microscopy indicates: 1) multiple generations of calcite and siderite precipitation; 2) complete/partial dissolution of feldspar grains; 3) feldspar grain alteration to clay mineral, 4) preserved bone microstructure, 5) physical degradation of bone mineral phase. X-ray diffractometry indicates authigenic siderite is present in fossil bone matrices. Scanning electron microscopy coupled with energy dispersive spectroscopy indicates 1) presence of detrital grains within Haverien canals and 2) precipitation of authigenic minerals such as siderite and barite within bone matrices and pores. Presence of siderite in bone and concretion matrices engulfing traces of vadose/phreatic calcite precipitation (indicated by isopachous fabric) suggests the concretion originally formed as siderite in eogenesis. Acidity of groundwater was elevated during mesogenesis by organic acid produced by degradation of plant material, which in turn accelerated grain alteration and dissolution. Although interaction between fossils and groundwater was restricted by concretion formation, presence of detrital grains and other authigenic minerals within bone matrices and pores indicate fossil bones were subject to groundwater infiltration.

Poster Session II (Thursday, October 18, 4:15 - 6:15 pm)

DIVERSITY OF DIVING BEHAVIOR OF MOSASAURS (SQUAMATA: MOSASAURIDAE) INFERRRED FROM OPTICAL SYSTEM

YAMASHITA, Momo, Tokyo Gakugei University, Koganei, Japan; KONSHI, Takuya, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; SATO, Tamaki, Tokyo Gakugei University, Koganei, Japan

The Mosasauridae (Diapsida: Squamata) are known to be fully adapted to aquatic life. Previous studies on their bone histology and sedimentary environment suggest that habitual diving depth varied among mosasaur genera, but there is no definitive consensus about which taxon was more suited for life in deeper water. Recent studies found a strong correlation between the visual function (e.g., an f-number of an eye as an index of visual performance under dark) and the living style of various swimming vertebrates. The f-number (the ratio between focus length and maximum entrance pupil diameter) defines the light-gathering capability of an optical system. Eyes with a low f-number can function better at a low level of intensity in the dark than those with a high f-number. Deep diving animals need to be equipped with eyes of a high capability for gathering light for their visual perception, if they rely on their eyesight to move around. The eyes of these animals are expected to have a low f-number. The f-numbers of three genera of mosasaurs, Tylosaurus, Platecarpus, and Clidastes were calculated from the measurements of their skulls and sceral rings. We compared two methods to estimate the optical axial length. One method calculates the axial length from the distance between the midline of the skull and the lateral margin of the frontal, which forms the dorsal rim of the orbit. The second method uses the external diameter of the scleral ring for the calculation of the optical axial length. Size of the maximum entrance pupil diameter was estimated from the internal opening diameter of sceral rings. We examined two Platecarpus, one Tylosaurus, and one Clidastes specimens. Among them, only the Clidastes specimen was not available for the first method due to the poorly preserved frontal. The f-numbers calculated with the first method were 2.95 in Tylosaurus, 1.22 and 1.31 in Platecarpus, whereas those calculated with the second method were 2.47 in Tylosaurus, 1.49 and 1.75 in Platecarpus, and 1.68 in Clidastes. In both methods, the f-numbers of Tylosaurus were larger than those of Platecarpus; the f-number of Clidastes was between those of Tylosaurus and Platecarpus, and within the range of two Platecarpus specimens. From these results, we conclude that Platecarpus and Clidastes could see objects in darker environments, or deeper sea than Tylosaurus. Because the three genera are known from the same horizon of the same area (Santonian–Campanian of the Western Interior Seaway), their different f-numbers are possibly indicative of resource partitioning among these reptilian predators in terms of the water depth, particularly between Tylosaurus and the other two genera.
Technical Session XIX (Saturday, October 20, 2-45 pm)

**EFFECTS OF PLEISTOCENE CLIMATIC REGIMES ON DIETARY NICHES AND ENVIRONMENTAL HETEROGENEITY IN FLORIDA**

YANN, Lindsey T., Vanderbilt University, Nashville, TN, United States; DESANTIS, Larisa R., Vanderbilt University, Nashville, TN, United States

Stable oxygen and carbon isotopes from fossil tooth enamel can be used to better understand mammalian responses to climate change and the impact of interglacial warming on the dietary niches of Pleistocene taxa. Previous work at two Pleistocene sites in Florida, identified as glacial (LEISY 1A) and interglacial (LEISY 1A) based on geological data, demonstrate dramatic dietary responses to interglacial warming. To further test the hypothesis that differing climatic regimes affect mammalian dietary niches, we examined two additional Pleistocene sites (Haile 8A and Tri-Britton) with multiple sympatric taxa. Mean oxygen isotope values of the most evaporation sensitive taxa (i.e., camels and deer) are greatest at Tri-Britton (camels, 3.2‰) followed by LEISY 1A (0.7‰ camels, 0.8‰ Odobenus), demonstrating that Tri-Britton is warmer and/or more arid than LEISY 1A. Haile 8A is intermediate between LEISY 1A and LEISY 1A with camels and Odobenus values of -0.5‰ and -0.2‰, respectively, indicating an transitional site between glacial and interglacial conditions. Rank orders of mean and maximum oxygen isotope values in camels and Odobenus demonstrate identical patterns, further supporting these climatic designations. Environmental heterogeneity, based on δ13C values, is greatest at LEISY 1A, Tri-Britton, and Haile 8A, all with statistically greater values than INGLIS 1A (p≤0.002). Tapirus, Palaeolama, and Equus δ13C values from Tri-Britton are greater than those present at any other site (all yield p≤0.046); increased δ13C values indicate the presence of more open forests (Tapirus, Palaeolama) and abundant C4 grasses (Equus). Grazers at both sites are statistically greater than browsers (taxa with n=2; p≤0.035), but there are no statistical differences within dietary categories. Despite previous interpretations of Mammuthus as an obligate C3 feeder, δ13C values indicate a mixed diet at Tri-Britton that is not significantly different from browsers, grazers, or other mixed feeders. A1 Haile 8A Odobenus and Hemiacentrus δ18O values are statistically indistinguishable from INGLIS 1A, and Mylohyus and Equus are statistically indistinguishable from LEISY 1A, reinforcing the idea of a transitional site, ecologically. Increased heterogeneity at Tri-Britton may also be responsible for the existence of closely related taxa (e.g., two peccaries and two camels), similar to LEISY 1A. Although δ18O values represent a potential temporal history, the relative increase in the diversity of taxa and greater heterogeneity than glacial sites. This research further supports the idea that interglacial warming or transitional periods support a more heterogeneous environment, which allows increased diversity of dietary niches among resident fauna.

Technical Session XVIII (Saturday, October 20, 2:00 pm)

**NEW DATA FOR EVALUATING FUNCTIONAL MORPHOLOGY IN PHILODONTIDAE (ALLOTHERIA, MULTITUBERCULATA) USING DIGITAL PREPARATION**

YAPUNCICH, Gabriel S., CUNY Graduate Center/NYCEP, New York, NY, United States; BOYER, Doug M., Brooklyn College/NYCEP, New York, NY, United States; MAIORINO, Marco B., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; DESOJO, Julia, Museo Argentino de Ciencias Naturales ‘Bernardino Rivadavia’, Buenos Aires, Argentina

Extinct Multituberculata was the longest surviving order of mammals. Given their near ubiquity in Mesozoic and Cenozoic communities, reconstructing their paleoecology is important for a balanced view of mammalian evolutionary history. The relative lack of multituberculate postcranial has hindered the study of their functional morphology and the implications for locomotor and positional behavior. Using microCT scanning and digital extraction of articulated bones, we re-examine the skeleton of *Philodorus kummak* from the Paleocene of Saskatchewan, Canada. Previous work has suggested arboreal locomotion based on the presence of features that could meet the functional demands of this lifestyle. Alternatively, other features of *Philodorus* have been argued to indicate a more terrestrial lifestyle, and inferred from a multituberculate skeleton, more detailed descriptions and measurement of morphology provided by a digital approach facilitates testing these competing hypotheses. Compared to a large sample of extant therian taxa, elements of the manus, pes and caudal vertebral column in *Philodorus* lack many features expected for an obligate arborealist. **Philodorus** exhibits short, robust manual intermediate phalanges relative to its pedal intermediate phalanges, a pattern no extant arborealist exhibits. Rather, similar proportions characterize s taxiforms such as most macrocoids, macroscelidines, and lagomorphs. As in cursorial and saltoanimal, *Philodorus* exhibits metapodials with cylindrical heads, which limit ab- duction and pronation. The relative paucity of metapodial-phalangeal joints. Additionally, the distal phalanges are medially broad and dorsoventrally shallow, resembling terrestrialists more than arborialists, as demonstrated by multivariate comparisons. Finally, arboreal taxa with prehensile tails are characterized by caudal vertebrae that are medially broad. In contrast, the caudal vertebrae of *Philodorus* are dorsoventrally deep and medially narrow, a combination that does not enhance tight tail flexion and is not found within prehensile-tailed animals. The length of caudal chevrons is not significantly correlated with tail function in our sample, bringing the previously supposed significance of long chevrons in *Philodorus* into question. These results suggest that arboreal activities did not dominate the lifestyle of *Philodorus*, although some similarities to scannerists such as syndactylians and sciuroids do not preclude facultative tree climbing. Instead, the examined morphology indicates that *Philodorus* was most likely a terrestrial or sciall mammal that progressed via saltation, potentially similar to Asian multituberculates.

Technical Session IX (Friday, October 19, 10:30 am)

**CRANIODENTAL ANATOMY AND FEEDING MECHANICS OF DAKOSAURUS MAXIMUS AND PLEISOCHUS MANSELII, TWO CONTEMPORARY LARGE-BODIED, MACROPHAGOUS METRIORHYCHID CROCODYLOMORPHS FROM THE LATE JURASSIC OF EUROPE**

YOUNG, Mark, University of Edinburgh, Edinburgh, United Kingdom; BRUSATTE, Stephen L., Columbia University, New York, NY, United States; BEATTY, Brian L., New York College of Osteopathic Medicine, New York, NY, United States; DE ANDRADE, Marco B., Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; DESOJO, Julia, Museo Argentino de Ciencias Naturales ‘Bernardino Rivadavia’, Buenos Aires, Argentina

Metriorhynchidae was a peculiar but long-lived group of marine Mesozoic crocodylomorphs adapted to a pelagic lifestyle. Two contemporaneous species from the Late Jurassic of Brazil (*Dakosaurus maximus* and *Pleiosuchus manselii*) were 5.5 meters in total length) and macrophagous (fed on large-bodied prey). We redescribed the anatomy and reassessed the systematics of both species, which allows for a better understanding of their phylogeny and dietary ecology. Both taxa are diagnosed by several apomorphies. For *D. maximus* these include strongly ornamented maxillae, mesial/distal tooth wear and extensive crown breakage, and for *P. manselii* strongly convex palatines with a pronounced predentary and quadrate distal articular surfaces not separated into two condyles. Phylogenetic analysis places *D. maximus* as the sister taxon of the South American *D. andinensis*, while *P. manselii* is placed in a polytomy at the base of the Geosaurini, the subclade of macrophagous metriorhynchids that includes Dakosaurus, Geosaurus and Torvosaurus. Craniodental morphology indicates that *D. maximus* and *P. manselii* were macrophagous, but may have fed in distinct ways. *D. maximus* had tightly fitting, vertical occlusion, as indicated by reception pits along the upper and lower tooth rows, vertically oriented crowns that were in close contact during occlusion, and vertical microwear striations extending along the mesial and distal margins of the teeth, obliterating the carinae and denticles due to shearing occlusion. Enamel thickness does not seem to be specialized in this group however, possibly reflecting tooth developmental constraints
LAGs. Today the Emperor penguin, Birds evolved high rates of growth, reaching full size within one year, which histologically
Universidad de Chile, Santiago de Chile, Chile; SALLABERRY, Michel, Luis, Universidad de Chile, Santiago de Chile, Chile; RUBILAR-ROGERS, David, Universidad Nacional de Historia Natural, Santiago de Chile, Chile; SALLABERRY, Michel, Universidad de Chile, Santiago de Chile, Chile

Birds evolved high rates of growth, reaching full size within one year, which histologically results in the absence of LAGs (annual lines of arrested growth) that are usually developed by endotherms. With the exception of a very few cases such as the moa and the kiwi, birds lack LAGs. Today the Emperor penguin Aptenodytes forsteri, one of the largest extant penguins, is considered to be the faster vertebrates to reach full adult size. Fossil representatives of penguins are known to easily exceed the size of Emperor penguins, so their patterns of growth has remained obscure even with the large amount of research and interest in fossil penguins in the last decade. We studied thin sections of four representatives of extinct giant penguins: fossil bones referred to the genus Palearciceps or Anthropornis from the Eocene of the La Meseta Formation, Seymour Island, Antarctica, the species Pygoscelis grylls and Spheniscus urbaini, from the late Miocene — Pliocene of the Bahía Inglesa Formation, northern Chile. We also included the Humboldt penguin Spheniscus humboldtii, an extant species, and the genus Palaeospheniscus from the middle Miocene of Argentinian Patagonia, both medium size penguins. The Antarctic species belongs to the high diversity of basal penguins while the Chilean ones are extinct representatives of an extant genus in the crown group Spheniscidae. The Argentinian representative is an outgroup to the crown group. Histology shows that fast growth in penguins is common across the entire phylogenetic sample. As is common in other birds, fossil penguins do not develop the outer circumferential layer that is negatively correlated with size. As the majority of neornithines, they reached full growth within one year. Fast growth, sometimes considered in penguins an adaptation to cold, is a plesiomorphic character to this order of birds.

The Pakistani tarsier is morphologically distinct from all living and fossil tarsiers, but most similar to the Middle Miocene Thai species Tarsius thailandicus. Though living tarsiers have traditionally been classified in a single genus, a recent revision proposed a division into three genera. The differences that separate the Pakistani tarsier from other known species are of the same order of magnitude as those between the living genera, and we have found no evidence to support a close relationship between the Pakistani tarsier and any one of the extant genera. However, the Pakistani tarsier appears to be similar to Tarsius thailandicus, for which the upper molars are unknown. Thus, we propose that the Pakistani tarsier and T. thailandicus should be placed in a new tarsid genus.

This discovery broadens our understanding of the geographic range and morphological diversity of Miocene tarsiers and helps put the living tarsiers into their evolutionary context.
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306 A-C CONCURRENT SESSIONS
FRIDAY, 1:45 p.m. – 4:15 p.m. ONLY

POSTER SESSION/EXHIBITS

Committee Meetings, Student Roundtable Event and After-Hours Party will be held at the Marriott Raleigh City Center, the SVP Headquarters Hotel.

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