POSTER SESSION

Saturday, April 13th 10:00am to 11:30am

CT SECTIONING OF A UNIQUE FOSSIL BED FROM WYOMING

Brandon T. Campbell; University of Wisconsin-Madison

Day's Hill Locality is a unique series of sedimentary layers 10 miles south of Lander, Wyoming. A field crew from the University of Wisconsin Geology Museum (UWGM) excavated a 20x20 cm sample from a laterally extensive fine grained sandstone that contained abundant fragmentary vertebrate fossils. The sample shows two discrete layers of deposition of fossils, each showing discrete mineralogical properties. Fossils identified so far include fragmentary teeth and skeletal elements of phytosaurs and temnospondyls and a humerus of the first dinosauromorph to be discovered in Wyoming. We are segmenting CT scan data obtained through a partnership with the Wisconsin Institutes for Medical Research (WIMR) in order to identify the remaining elements and to quantify the density and distribution of those fossils. This will allow us to determine how much more should be excavated in order to obtain a representative sample of the stratum so we can extrapolate ecological data such as vertebrate diversity and abundance as well as the taphonomic scenario that led to this unique deposit.

HOW *DEINONYCHUS* AND RELATED TAXA MAY HAVE HUNTED

Thomas Lavery; University of Wisconsin-Madison

The objective of this paper is to test hypotheses about dromaeosaurid behavior. The hypothesis in question states that dromaeosaurs may have used its hand and foot claws to hold onto prey while attempting to subdue it. This hypothesis was tested by taking measurements of dromaeosaurid and mammalian claws that best quantify the overall shape, and then performing principal component analysis upon the resulting data set. Inherent issues in the processes of this study rendered the findings inconclusive; however, these issues have been identified, and solutions that can be implemented in the future have been identified.

STRUCTURAL COMPARISON OF PALATAL BONES OF *CROCODYLUS JOHNSTONI* WITH A NEW PHYTOSAUR FROM THE POPO AGIE FM (WYOMING, USA)

Nadiah Tengku Mahmood[1], A.M. Kufner[1], and D.M. Lovelace[2]

[1]Department of Geoscience, University of Wisconsin-Madison, Madison, WI, [2]University of Wisconsin Geology Museum, Madison, WI

Convergent evolution is exemplified between crocodylians and the archosauriform reptiles, the phytosaurs. The anatomy of the palate is functionally important with regard to respiration as well as feeding. Crocodylians and phytosaurs possessed different structures to achieve a similar skull shape which may have bearing on their ecology. In this study, I segmented the palatine and pterygoid bones from CT scans of the freshwater crocodile, *Crocodylus johnstoni*, and of a basal phytosaur, UWGM 1978. The crocodylian palatines join along the midline and form around the nasal passages. The phytosaurian palatines do not join along the midline. This may be connected with the specialization of the phytosaur snout where the nostrils are placed closer to the eyes and nasal passages are shorter than in modern crocodylians.

DATA COLLECTION AND CONSERVATION AT TWO LATE TRIASSIC BONE BEDS

Hannah Miller, C. So, C. Eaton, D. Lovelace; University of Wisconsin Geology Museum

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Perhaps one of the more pressing issues in the curation of paleontological specimens is the standardization of data collection methods. A 2018 excavation of Triassic fauna in Wyoming served as a case study for the collection of field data with the aim of maximizing efficiency, as well as minimizing the loss of information. The methods themselves are two-fold: an on-site grid system, and a subordinate in-jacket mapping system . The first bone bed—a mass-death assemblage of metoposaurids—involved traditional excavation techniques. The on-site system utilized a six meter by three meter grid to assign jackets and individual elements field identification numbers. These numbers were entered physically into a journal and digitally into a database using a standardized note-taking method. Each grid square at the site is partitioned into smaller, subordinate grid squares within each jacket. As elements are removed in the preparation lab, they are assigned identification numbers according to their position in the grid. This system allows jacket elements to be returned to the larger context of the site, and minimizes data loss during preparation. The second bone bed—a time-averaged assemblage of a fossorial stereospondyl—involved surface collection of preserved burrow infills. A majority of these burrow casts were found to contain fossilized remains. Physical preparation of these specimens is complicated by small size and specimen stability. To advance the study of these animals, micro-CT scans are processed through Dragonfly 3D Software and segmented, producing a digitally prepared specimen. This process of digitally preparing specimens will be ambitiously extended to over three dozen burrows. These digital files become born digital specimens themselves, introducing new challenges in curation. Each physical specimen is associated with micro-CT files, digitally segmented files, and 3D object files, all of which must be tied to each burrow's specimen record. Conserving these files and maintaining their association with the physical specimen presents potential complications in the preservation of data. These methods will be refined and field tested in future excavations.

MICRO-COMPUTED TOMOGRAPHY UNVEILS TRIASSIC STEREOSPONDYLS ENCASED WITHIN THEIR BURROWS

Calvin So[1], A.M Kufner[1], A.K. Huttenlocker[2], J.D. Pardo[3], J. Bevitt[4], D.M. Lovelace[5];
[1]Department of Geosciences, University of Wisconsin-Madison, [2]Department of Integrative Anatomical Sciences, University of Southern California; [3]Department of Comparative Biology and Experimental Medicine, University of Calgary; [4]Australian Nuclear Science and Technology Organisation; [5]University of Wisconsin Geology Museum, University of Wisconsin-Madison

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Micro-computed tomography enables paleontologists to access parts of anatomy in fossils that were previously difficult to observe without damaging specimens. Attempts to use micro-CT have improved our understanding of modern amphibian origins, by scanning burrows of an extinct amphibian that belongs to the dominantly aquatic group of amphibians known as Stereospondyli. Physical preparation of the burrows has proved to be a difficult task--the sandstone matrix is well-cemented and competent, which contrasts with the delicate and diminutive skeletal remains of the burrowing stereospondyls. However, micro-computed tomography has unveiled internal features of the braincase and features otherwise obscured by the surrounding matrix, allowing for the observation, comparison, and description of skeletal elements in several different individuals. Notably, the preservation of the columella in at least one individual is recorded, and the observation of a smaller, juvenile individual allows for comparison with adult individuals. Observations have led to the conclusion that these stereospondyls shift away from an entirely aquatic life and have several adaptations for fossoriality, such as a shovel-like head for burrowing, laterally-oriented eyes, and a smaller body size. From our robust collection of burrowing stereospondyls, the preliminary results of the phylogenetic analysis using a recently published dataset and Bayesian posterior probability finds that this new taxon resolves within a stem-caecilian lineage including *Rileymillerus* and *Chinlestegophis*. These findings reinforce a stepwise acquisition of caecilian characters and give insight into a new mode of life in Stereospondyli.

PALEOECOLOGY OF TRIASSIC PTEROSAURS SUPPORTS AN ARBOREAL-LEAPING ORIGIN OF FLIGHT

Adam Fitch; University of Wisconsin-Madison

As one of three branches of flying vertebrates, pterosaurs can provide important insight into the ecological pathways to vertebrate flight. This utility is hindered by our vague understanding of the ecology of Triassic pterosaurs. Three ecomorphospaces have been hypothesized for basal pterosaurs: aerial marine foraging, terrestrial foraging, and arboreal leaping. Triassic pterosaur teeth and jaw shape lack informative habitat-specific foraging adaptations, so testable differences in these hypotheses lie primarily in proposed environmental preference and associated locomotory specializations for life in these environments. To examine whether Triassic pterosaurs were inhabiting marine or terrestrial habitats, a comprehensive survey of both the depositional environment and taxonomic composition of Triassic pterosaur-bearing strata was performed using the Paleobiology Database, supplemented with literature sources. Both terrestrial and arboreal foragers are found in similar depositional environments so differences between arboreality and terrestriality are were distinguished by morphological specializations for their respective locomotion. A set of 17 morphological characters including claw curvature and numerous postcranial limb proportions were examined and compared in Triassic pterosaurs and extant climbers, scansors, and terrestrial taxa using data from the technical literature and principal coordinates and cluster analyses to test for overlapping ecomorphospace.

Depositional environments provided little support for marine habitats in Triassic pterosaurs. Despite multiple well-studied pelagic deposits in Eurasia and the Americas, no Triassic pterosaurs have ever been found in non-coastal marine strata. Coastal deposits form just over half of Triassic pterosaur-bearing units, and they nearly unanimously possess mixed terrestrial and aquatic vertebrate assemblages, while one exception in the Seefeld Formation is likely a result of the small number of fossils collected from here. Remaining sites bearing Triassic pterosaurs are all inland depositional environments, and they possess strongly non-marine assemblages with very low diversity of aquatic vertebrates. Comparative morphological analyses find considerable evidence for arboreality. Triassic pterosaurs are found to be morphologically disparate from extant terrestrial taxa but cluster closely with arboreal, claw-based climbing mammals and lizards. Among arboreal taxa Triassic pterosaurs were most morphologically similar to sciurids, notably due to elongate distal limb proportions. In scuirids, these proportions are adapted for arboreal-leaping, allowing them to efficiently maneuver through complicated forested environments. That Triassic pterosaurs of disparate groups all exhibit these scuirid-like attributes suggests that arboreal leaping was plesiomorphic to Pterosauria. This is consistent with previous hypotheses that suggested pterosaurs evolved takeoff and eventually powered flight from arboreally-leaping ancestors.

In conclusion, the almost exclusive presence of Triassic pterosaurs in mixed and strongly terrestrial vertebrate assemblages as well as the similarity of Triassic pterosaurs to arboreal taxa strongly supports an arboreal-leaping lifestyle. Pterosaurs join drepanosauromorphs, sharovipterygids, and kuehneosaurids in increasing the known diversity of arboreally-adapted clades from the Triassic.

SPEAKER SESSION

Saturday, April 13th 2:00pm to 5:10pm

PROJECT PROPOSAL: TRAIT COVARIATION AND INFLUENCE OF A GEOMETRIC MORPHOMETRICS APPROACH ON PHYLOGENY, A CASE STUDY USING EXTANT CROCODYLIA (ARCHOSAURIA)

Aaron M. Kufner; Department of Geoscience, University of Wisconsin-Madison, Madison, WI

A phylogenetic framework based on morphological characters is essential for our understanding of macroevolutionary patterns in extinct organisms. A staggering proportion of characters are based on cranial morphology, but the extent to which cranial characters are informative at different temporal scales is uncertain. I am proposing a case study using extant members of Crocodylia. The phylogenetic relationships of Crocodylia are well resolved through molecular techniques, and trees based on morphology with solely discrete characters do not have a congruent topology to molecular trees. I plan to make 3D models of individual cranial bones in a suite of crocodylians and subject the models to landmark and automated semi-landmark analysis to define continuous characters. The cranial bones will be categorized by developmental origin (dermatocranium or neurocranium) and combined into modules for those elements that show a high degree of trait covariance. Different combinations of discrete and continuous characters for covarying traits will be combined in phylogenetic analyses using parsimony and Bayesian methods; the resulting consensus trees will be compared with the molecular tree. I predict that neurocranial characters may be more informative for large scale macroevolutionary changes while dermatocranial characters may be informative for smaller scale intra-generic relationships.

LOOKING GIFT HORSES IN THE MOUTH: AN EXAMINATION OF THE INHIBITORY CASCADE IN EQUID EVOLUTION

Hayley Orlowski, D. Birlenbach, D. Fox; University of Minnesota-Twin Cities

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The Inhibitory Cascade is a developmental model for the molar row of mammals that predicts that posterior molar size is constrained by the size of the molar directly anterior to it. Many modern mammal groups adhere to this pattern; notably, however, modern horses fall outside of expected proportions in molar sizes. In order to address this discrepancy, we compiled a dataset of linear measures of lengths and widths of fossil horses and examined the ratio of molar occlusal areas. Here we present findings which track the adherence of horses to the inhibitory cascade model throughout their evolution from dog-sized browsers in the Eocene to cursorial grazers in the Pleistocene. Preliminary findings indicate that the earliest known horses of the Eocene express a phenotype predicted by the Inhibitory Cascade model, in which successive molars increase in size moving posteriorly. Equids of the Oligocene and Miocene show a shift from the ancestral phenotype towards the reverse trend in molar size, as well as showing the unpredicted phenotype seen in modern horses.

JAW BIOMECHANICS, HISTOLOGICAL IMAGING, AND TURNING ABILITY: IMPLICATIONS FOR HUNTING BEHAVIOR IN SUBADULT TYRANNOSAURIDS

Andre Rowe; University of Wisconsin-La Crosse

Finite element analyses of juvenile tyrannosaurid mandibles reveal skull strength and jaw muscle forces they were capable of exerting. Smaller/subadult tyrannosaurs such as *Raptorex* experienced greater mandible stresses when mandible length and surface area are equalized, but they experienced lower absolute stresses when compared to adult forms. In juvenile *T. rex*, strain on post-dentary ligaments decreases stress and strain in the posterior dentary and where teeth impacted their food.

Synchrotron-based histological imaging of very young tyrannosaurs reveals growth rate and activity. High vascularity is identical to that of fast-growing birds. Secondary canals indicate reworking from vigorous locomotor loads, likely from hunting prey.

The style of prey pursuit in juvenile tyrannosaurs was likely similar to that of larger subadults and adults. As in other tyrannosaurids, *Raptorex* could turn twice as quickly as other theropods its size, with its shorter body and larger leg muscles. *Raptorex* anchors the small end of an allometric continuum of predatory agility in tyrannosaurids across nearly four orders of magnitude in body size.

PALEOHISTOLOGY OF SMALL-BODIED METOPOSAURIDS: IMPLICATIONS FOR ONTOGENY, TAXONOMY, AND ECOLOGY

Bryan M. Gee[1], W.G. Parker[2], A.D. Marsh[2];
[1]Department of Biology, University of Toronto-Mississauga, Mississauga, ON, Canada
[2]Division of Science and Resource Management, Petrified Forest National Park, AZ, USA

Metoposaurids are large-bodied, aquatic temnospondyl amphibians that are abundant components of Late Triassic terrestrial assemblages in North America, Europe, India, and Africa. Of particular interest is *Apachesaurus gregorii* from the southwest of North America, which has been historically interpreted as a diminutive taxon only half the size of all other metoposaurids. Elongate intercentra are considered to be diagnostic for this taxon and to be one of many features interpreted to reflect greater terrestriality than in other metoposaurids, which in turn is interpreted as a heterochronic signal of environmental perturbations. However, these broad-scale interpretations are founded on a poor understanding of early ontogeny in virtually all temnospondyls, literal interpretations of relative abundance, and minor anatomical differences. These may be variably confounded by taphonomy, intraspecific variation, and ontogeny, and these interpretations have not been rigorously tested despite being widely propagated. Here we present a detailed histological analysis of intercentra of small-bodied metoposaurids from Petrified Forest National Park, AZ, USA. This includes both isolated elements and elements associated with partial skulls that would be traditionally referred to *A. gregorii*. Our analysis does not recover any evidence of a trend of size diminution in metoposaurids through *A. gregorii*. All specimens are markedly immature, with incompletely enclosed notochordal canals, absence of lines of arrested growth (LAGs), and absence of remodeling, all features that would characterize the earliest stages of ontogeny. A strong correlation exists between development of histological and anatomical features seen in much larger metoposaurids, and size. Other anatomical features considered to be diagnostic for *A. gregorii* may also be plausibly explained by ontogeny, and ecological evidence such as relative abundance can be explained by ecological factors, such as niche partitioning. This underscores the need for rigorous testing of hypotheses of evolutionary trends and ecological shifts in early tetrapods.

RECONSTRUCTING THE HEARING APPARATUS OF NON-AVIAN DINOSAURS: A CASE STUDY IN INTERPRETING SENSORY ANATOMY IN THE FOSSIL RECORD

JP Nassif, R.C. Ridgely, L.M. Witmer; Ohio University

Sensory systems act as filters, transducing and modifying environmental stimuli for interpretation by the central nervous system. Understanding how the morphology of these systems both enable and limit perception is critical to understanding animal behavior and ecology. Therefore, reconstruction and interpretation of sensory structures in extinct species has been central to paleobiological study for decades. Sonic vibrations are exploited during foraging behaviors, as well as a means of intraspecific communication, by many diverse clades of animals, especially when visual information is limited. Though inner-ear structures are commonly used as a proxy for hearing sensitivity in extinct species, the role of middle- and external-ear morphology is poorly understood. The middle ear is thought to have evolved to decrease the loss of energy as sound waves are conducted from the environment to the inner ear. In living diapsids, a single rod-like ossicle (the columella) typically connects to a tympanic membrane (eardrum) by cartilage. Birds and non-avian dinosaurs present the opportunity to explore the ear across diverse ecologies and sizes. Cadaveric specimens representing a diverse sample of birds, crocodilians, and lepidosaurs were µCT scanned, and ear structures were digitally reconstructed using Avizo. Specimens also were dissected to visualize the anatomy and to validate CT-based interpretations. Fossil specimens were also scanned and photographed. These data were integrated to identify tentative osteological correlates for middle-ear structures, including attachments of the tympanic membrane and neurovasculature. These correlates were compared to the osteology of extinct taxa, consistent with established methods of phylogenetic bracketing. The soft tissue middle-ear structures of fossil specimens were modeled using these and other well-established osteological correlates in Maya. Multiple ankylosaurian and neoceratopsian species show morphologies that may be consistent with the loss of an eardrum. In contrast, strong osteological correlates for the tympanic membrane are preserved in other ornithischian and saurischian species. These independent losses represent the first evidence of this modification of the sound-conduction system in dinosaurs. Ecological and functional consequences of these morphologies require additional investigation. NSF DGE-1645419 to JPN