MEETING PROGRAM AND ABSTRACTS

OCTOBER 17–20, 2018

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SOCIETY OF VERTEBRATE PALEONTOLOGY

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ALBUQUERQUE CONVENTION CENTER • ALBUQUERQUE, NM

Poster Session I (Wednesday, October 17, 2018, 4:15 – 6:15 PM)

THE SKELETON OF *DIPLOBUNOPS* AND IMPLICATIONS FOR UNDERSTANDING VARIATION IN EARLY ARTIODACTYLS

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The middle Eocene is a time of incredible diversification among the artiodactyls (the even-toed ungulates, such as sheep, cows, deer). During this period, artiodactyls began to 'modernize' and many basal taxa arose that formed many of the taxonomic groups of artiodactyls that we recognize today (i.e., ruminants, camels, pigs). The genus *Diplobunops* is an intriguing taxon that is restricted to the late Uintan interval of the middle Eocene (~43–39 Ma) and has had a checkered taxonomic history: some scholars do not consider it a valid genus, while others think the opposite. Based on our study of closely-related taxa and thorough investigation of this new specimen, we hypothesize that *Diplobunops* is a valid genus. Our study is the first to describe in detail the skeleton of *Diplobunops*. The area of the first lower molar is often taken as a proxy for body size and, in this character, the upper end of the *Protoreodon* species range overlaps with that of *Diplobunops*; however, the postcranial comparisons indicate that *Diplobunops* was a more robust animal with stouter limbs than its close relative, *Protoreodon*. The strict consensus tree resembles that of Theodor and Foss (2005) but unlike the published tree of these authors, the addition of *Diplobunops* resolves the polytomy among early ruminant artiodactyls.

In 2013, a rather complete skeleton of *Diplobunops* (13-262) was found at a middle Eocene locality in the Uinta Formation, Uinta Basin, Utah. The skeleton was reconstructed, and measurements were taken using Mitutoyo digital calipers and an osteometric board. To evaluate the position of *Diplobunops* among other early ruminant artiodactyls, we performed a phylogenetic analysis based on the data matrix of Theodor and Foss (2005). We updated this matrix with characters for *Diplobunops*. Trees were generated using a heuristic search option in PAUP 4.0a152 and character evaluation was performed in Mesquite. We evaluated shape indices for major joint surfaces in order to evaluate any major differences in locomotor preferences. Skeletons of *Diplobunops* are available in museums, but none have been described in great detail or used in phylogenetic analyses. Our study is the first step in evaluating this genus and our preliminary data suggest that *Diplobunops* is a valid genus.

Grant Information
This project was funded by Midwestern University Kenneth Suarez Summer Research Fellowship and Midwestern University ORSP Intramural Funding.

Romer Prize Session (Thursday, October 18, 2018, 9:30 AM)

PATAGONIAN ARIDIFICATION AND ECOLOGICAL SHIFTS AT THEONSET OF THE MID-MIOCENE CLIMATIC OPTIMUM

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High atmospheric CO_2concentrations (pCO_2> 400 ppm), low ice volumes, and high ocean temperatures during the mid-Miocene Climatic Optimum (MMCO; ~17.0–14.5 Ma) are thought to have driven the expansion of warm, wet ecosystems to high latitudes. Faunas of fossil bearing strata of the Santa Cruz Formation (SCF.), southern Argentina (47-52° S latitude) record this expansion. The SCF. has produced a diverse assemblage of vertebrate fossils, with species richness similar to modern lowland tropical forests. Previous faunal analysis of the SCF. has suggested high mean annual precipitation (MAP > 1000 mm/yr) and warm mean annual temperatures (MAT > 14° C) but did not investigate ecological changes through time. Here I present stable carbon ($\delta^{13}C$) and oxygen ($\delta^{18}O$) isotope compositions of fossil enamel and bone recovered from strata spanning the initiation of the MMCO. I also present new U-Pb ages for several interbedded tuffs (range ~17.5–16.5 Ma). Combined, I use these data to quantify changes in precipitation and temperature through time.

I collected isotope compositions from ~ 100 individuals dispersed over 150 m of stratigraphic section. Large herbivores—*Nesodon*, *Adinotherium*, and *Astrapotherium*—are best represented. Each sample was assigned an age and uncertainty based on its stratigraphic position using a Bayesian sedimentation model. I estimated intra-tooth variations in isotope composition by serially sampling several teeth. I used a Monte Carlo approach to propagate the uncertainties in age and intra-tooth variability to produce a continuous model of $\delta^{13}C$ and $\delta^{18}O$ values over a ~1.0 Ma interval. Modeled enamel $\delta^{13}C$ values indicate C_3 feeding with an increase from ~-12.3‰ to -11.0‰ over the interval. Modeled $\delta^{18}O$ values increased ~2‰ over the interval. Based on $\delta^{13}C$ of tooth enamel (plants consumed) and the atmosphere, MAP decreased ~50% over the interval from ~1200 to 600 mm/yr. $\delta^{18}O$ values of enamel (H_2O proxy) and bone (carbonate proxy) show an increase in MAT from ~20 to 26°C, over the same period. Isotopic zoning in serial sampled molars is low, ~±0.3‰ and ±0.8‰, for $\delta^{13}C$ and $\delta^{18}O$, respectively, suggesting little seasonal variability in diet and drinking watercompositions.

Combined, these data suggest an aridification of the SCF. and an ecological shift towards more open habitats at the onset of the MMCO. Modern atmospheric pCO_2 reached MMCO levels in mid 2016, making studies of this interval newly relevant to both paleo and modern studies of climate and ecology.

Grant Information
NSF EAR-1349749 (M.J. Kohn)

Podium Symposium (Wednesday, October 17, 2018, 3:30 PM)

CONTRAST-ENHANCED XROMM REVEALS IN VIVO SOFT TISSUE INTERACTION IN THE HIP OF *ALLIGATOR MISSISSIPPIENSIS*: IMPLICATIONS FOR PSEUDOSUCHIA

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Archosaurs (birds, crocodylians, and their extinct relatives) evolved a wide diversity of hind limb skeletal morphologies, suggesting highly divergent articular soft tissue anatomies. Recent studies have shed light on the articular soft tissue anatomy of the archosaur hip joint, but the dynamic interactions among these tissues remain unknown, hampering further functional inferences. Here we use contrast- enhanced computed tomography to generate 3-D surface models of the pelvis, femora, and joint soft tissues of the American alligator, an extant archosaur. The hip joints were then animated using marker-based X-ray Reconstruction of Moving Morphology (XROMM) to visualize soft tissue articulation during forward terrestrial locomotion.

The anatomical femoral head of the alligator travels beyond the cranial extent of the bony acetabulum and does not act as a central pivot as has been suggested for some extinct archosaurs. Additionally, the fibrocartilaginous surfaces of the alligator's antitrochanter and femoral neck maintain engagement during hip flexion and extension, similar to the articulation between homologous structures in birds. Lastly, the fovea capitis of the femur remains in close proximity to the membrane-bound inner acetabular foramen, suggesting that the ligamentum capitis remains within this unossified portion of the acetabulum.

Our results illustrate the utility of contrast-enhanced XROMM for studying articular soft tissue interactions. These results also allow us to generate functional hypotheses about crocodylian hip joint soft tissues, expanding our knowledge of vertebrate connective tissue biology and the role of joint soft tissues in locomotor behavior. When considered in light of the osteological correlates of femoral and pelvic soft tissues in fossil pseudosuchians, these new data improve our ability to reconstruct hip articulation in pseudosuchians. In doing so, they form the basis for further studies of the evolutionary relationship between joint anatomy, locomotor posture, and body size transitions.

Grant Information
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Poster Session III (Friday, October 19, 2018, 4:15–6:15 PM)

INDICATIONS FOR A HORNY BEAK AND EXTENSIVE SUPRAORBITAL CONNECTIVE TISSUE IN DIPLODOCID SAUROPODS

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Soft tissue structures can considerably alter body shape but are rarely preserved in fossils. Based on novel evidence from a new skull of a diplodocid sauropod from the Upper Jurassic Morrison Formation of the Bighorn Basin (Wyoming, U.S.A.), we propose that they had a horny beak and extensive connective tissue covering the orbits. Osteological features indicative of beaks identified in turtles, birds, and ornithischian dinosaurs, were also recognized in diplodocids. These are transversely expanded edges with striated rugosities posterior to the rear maxillary and dentary teeth. These rugosities are associated with neurovascular foramina and grooves, especially towards the tip of the rostrum and its expanded edges. Extensive connective tissue covering the eyes is deduced from striated rugosities on the dorsal orbital rim and the occurrence of bony spurs or tubercles on the lacrimal. The horny beak may have helped dissipate stresses at the tip during feeding and forms a continuous cutting edge along the snout. The supraorbital connective tissue may have provided shade, and both soft tissue structures might have been used for sexual display or species recognition.

Grant Information
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Podium Symposium (Friday, October 19, 2018, 11:15 AM)

3D MORPHOMETRIC AND BIOMECHANICAL ANALYSES SUGGEST STRUCTURE-FUNCTION COVARIATION WITH NON-FEEDING ECOLOGICAL VARIABLES INFLUENCES EVOLUTION OF FEEDING SPECIALIZATION IN CARNIVORA

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Skull shape convergence is pervasive among vertebrates. Although this is frequently inferred to indicate similar functional underpinnings, neither the specific structure-function linkages nor the selective environments in which the supposed functional adaptations arose are commonly identified and tested. Here we demonstrate that non-feeding factors relating to sexual maturity and precipitation-related arboreality also can generate structure-function relationships in the skulls of carnivorans (dogs, cats, seals, and relatives) through covariation with masticatory performance. Using a recently built Computed Tomography database of carnivoran skulls at the American Museum of Natural History, we estimated measures of masticatory performance related to ecological variables that covary with cranial shape in the mammalian order Carnivora, integrating geometric morphometrics and finite element analyses. Even after accounting for phylogenetic autocorrelation, cranial shapes are significantly correlated to both feeding and non-feeding ecological variables, and covariation with both variable types generated significant masticatory performance gradients. This suggests that mechanisms of obligate shape covariation with non-feeding variables can produce performance changes resembling those arising from feeding adaptations in Carnivora. These findings are of direct relevance to efforts underway to study the effect of complex structure-function linkages in paleoecological reconstructions of fossil carnivorans in our database. The results also highlight the power of digital 3D model databases in allowing use of structural morphing to test hypotheses about complex structure-function linkages.

Grant Information
NSF DEB-1257572

Poster Session II (Thursday, October 18, 2018, 4:15 – 6:15 PM)

ESTIMATION OF BODY MASS FROM THE CALCANEUM OF LAND MAMMALS

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In mammalian skeletons, calcaneum and astragali are compact and easily handled bones, and their fossil remains have relatively higher chances of being discovered as undamaged specimens. Fossil calcaneum and astragali have been well studied as indicators of the