Poster Session IV (Saturday, October 29, 2016, 4:15–6:15 PM)

MULTIGENERATIONAL ASSEMBLAGE OF *TRICERATOPS* FROM THE NEWCASTLE AREA, WYOMING, USA—AN IN-DEPTH ANALYSIS OF CRANIAL AND POST-CRANIAL ONTOGENESIS

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Here we report on a multigenerational assemblage of *Triceratops* from the Upper Maastrichtian Lance Formation near Newcastle, eastern Wyoming, USA. In excess of five hundred elements were uncovered belonging to a minimal number of five individuals. Detailed geological fieldwork at the excavation site shows that the *Triceratops* skeletons are entombed within an organic-rich siltstone unit characterized by abundant micro- and macro-floral and -vertebrate remains. The *Triceratops* bones are associated, but also show clear disarticulation. The fifth skeleton is located at the same site, but circa 4 meters above the main bonebed.

The site is remarkable since it yields both cranial and post-cranial remains of individuals of different sizes, representing several ontogenetic stages. This assemblage is one of only a handful known sites of the genus *Triceratops* that contain abundant post-cranial material. Ontogeny and especially the validity of taxa in *Triceratops*, and other Chasmosaurinae (e.g. *Torosaurus*), have been heavily debated subjects. However, studies have mostly been restricted to descriptions of cranial material due to the scarcity of post-cranial remains. Therefore, this assemblage helps to fill in a hiatus in our knowledge regarding the post-cranial development of these highly derived ceratopsids.

The *Triceratops* site in Wyoming offers a higher resolution in the ontogenetic development in particularly the late juvenile or early sub-adult to adult stages of *Triceratops*. By combining histology, allometric measurements, and analysis of morphological characters, the timing of attaining skeletal maturity along with the expression of morphological characters, like suture closure and cranial ornamentation, can be specified. It is evident that individuals in the sub-adult stage reach near-adult size before the closure of most cranial sutures. Additionally, it is recognized that certain post-cranial elements, especially in the pelvic region, experience major remodelling during ontogeny.

Future studies with emphasis on intense histological sampling and the use of (μ-) CT scans, will aid in determining the specific timing of these ontogenetic changes.

Poster Session II (Thursday, October 27, 2016, 4:15–6:15 PM)

MORPHOLOGICAL RELEASE FOLLOWING SELECTIVE EXTINCTION AMONGST SHARKS AT THE END OF THE MESOZOIC

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The Cretaceous–Paleogene mass extinction event (K–Pg) is considered a critical phase in the evolutionary history of neoselachians with a documented decline in the taxonomic richness of cartilaginous fishes. However, the ecological significance of this event remains poorly understood with patterns of extinction selectivity being especially controversial. Some authors have proposed a selective decline amongst large-bodied, pelagic apex predators (particularly lamniform sharks), a pattern well established among actinopterygian fishes, but recently contested in neoselachians and alternatively posited as random with respect to environment and ecology. Furthermore, under a non-random selective extinction model, pelagic top-predatory lamniform sharks may have been replaced by other lamniforms as well as ecologically comparable carcharhiniform species following the extinction event. Current analyses, however, are based on assessments of taxonomic richness, and lack the necessary morphological framework with which to adequately test ecological dynamics in sharks across the K–Pg.

Based on a dataset of 806 carcharhiniform and lamniform teeth spanning the Maastrichtian–Paleocene we employed a 2D geometric morphometric analysis to test for: (1) non-random morphological selectivity in these clades across the K–Pg; and (2) ecological dynamics in the diversity of lamniforms vs. carcharhiniforms: the hypothesis that carcharhiniforms filled vacated regions of eco(morpho)space following the extinction event. Our results reveal stasis in lamniform disparity across the K–Pg, whereas carcharhiniformes underwent a notable decline. Both patterns contrast previous understandings of how these clades were affected across the K–Pg interval and hint at more complex extinction dynamics. Notwithstanding their overall disparity stasis, observations along the first principal component (63.19% of the total variance) reveal notable decreases in regions of lamniform morphospace associated with cutting rather than grasping dentitions and support the hypothesis of non-random selectivity against macropredatory forms such as anacoracids (e.g., *Squalicorax*). In contrast, post-extinction carcharhiniforms are more abundant in cutting-type dentitions indicating that they filled regions of morphospace vacated by lamniforms. We therefore propose that the post-Cretaceous radiation of carcharhiniforms was not general, but rather focused on particular ecological opportunities created by the extinction of lamniform sharks.

Technical Session XIII (Friday, October 28, 2016, 3:45 PM)

TETHYAN ISLAND BIOGEOGRAPHY DURING THE EOCENE: A VIEW FROM NORTHERN ANATOLIA

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New paleontological and geochronological data from the Eocene Uzunçarsidere Formation (UCF) in northern Anatolia underscore the highly endemic nature of its mammalian fauna. Fossil mammals currently recorded from the UCF include palaeoamasid embrithopods, multiple species of the pleuraspidotheriid "condylarth" genus *Hilalia*, at least two marsupial taxa, a bat, an omomyid primate, and other mammals whose affinities remain to be deciphered. The most commonly encountered fossils in the UCF are embrithopods and pleuraspidotheriids, and these mammals appear to have been the dominant terrestrial herbivores in the UCF ecosystem. Perissodactyls and artiodactyls are conspicuously absent from the UCF fauna. Elsewhere in Eurasia, a dramatic shift in the composition of the herbivorous mammal guild occurred across the Paleocene–Eocene boundary, when perissodactyls and artiodactyls replaced archaic "condylarth" taxa such as pleuraspidotheriids. If northern Anatolia maintained a direct land connection to either western Europe or Asia during earlier intervals of the Eocene, perissodactyls and artiodactyls would be expected to have replaced pleuraspidotheriids and embrithopods as the dominant terrestrial herbivores. However, new U-Pb detrital zircon age estimates for the UCF mammal fauna suggest that it is no older than 43 Ma. Taken together, the new geochronological and paleontological data from the UCF are consistent with a long interval of isolation for its mammalian fauna, with isolation from western European faunas having been continuous since the late Paleocene (an interval spanning almost 15 million years). The retention of surprisingly primitive features in the UCF bat and primate is consistent with such a long interval of isolation, although both of the latter taxa must have dispersed over water to the Tethyan island on which the sediments comprising the UCF accumulated.

Grant Information
Funding provided by NSF EAR-1543684

Poster Session IV (Saturday, October 29, 2016, 4:15–6:15 PM)

AN INVESTIGATION OF THE IMPACT OF BODY SIZE ON SKELETAL PRESERVATION USING THE ICHTHYOSAUR *STENOPTERYGIUS*

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Specimens of *Stenopterygius* (Reptilia; Ichthyosauria) from the Posidonia Shale Formation were used to test the fundamental assumption of better preservation with larger body size. The investigation, using a semi-quantitative analysis scoring nine distinct anatomical units for articulation and completeness, suggests size does influence final appearance. But while high values of articulation and completeness are noted in large (ca. 3 metre) specimens, similar high values were also returned for smaller specimens, ca. 1 metre. However, in the smaller specimens the range of articulation and completeness values is considerably wider, which is interpreted as the greater susceptibility of smaller skeletons and the elements comprising them to the effects of biostratinomic processes, notably bottom currents in the depositional setting. Further investigation of articulation and completeness separately against body length revealed that while size has a limited influence on articulation, completeness of an ichthyopterygian skeleton apparently improves with increasing size in the absence of all but the most intense biostratinomic processes. That is, elements from larger carcasses were more difficult to move and remove after arrival at the sediment. Crucially, the body size categories relate to ontogenetic stages, the extent of disarticulation and loss of completeness being greater in juveniles (0-1.5 metres ±) compared to adults (over 1.5 metres). An additional group of 'embryonic' skeletons was also designated (>0.6 metres long), which showed articulation and completeness values between the other two groups. These specimens were observed either in the abdominal region of, or outside but in close proximity to, an adult skeleton, suggesting that such an association provided the embryo with shelter, unavailable to the isolated juvenile specimens, that limited disarticulation and loss of completeness to some degree. The findings of the study have important implications for the preservation of ichthyopterygians and marine reptiles as well as the preservation of different body size ranges in vertebrates generally.

Technical Session IV (Wednesday, October 26, 2016, 1:45 PM)

ASSESSMENT OF LUMBAR MOBILITY IN ARCHAEOCETES (MAMMALIA, CETACEA): INSIGHTS INTO THE EVOLUTION OF AQUATIC LOCOMOTION IN THE EARLIEST WHALES

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Evaluating functional changes in the vertebral column of early cetaceans is vital to address hypotheses of locomotor evolution. The transition from foot-powered to tail-powered swimming in archaeocete cetaceans required significant reconfiguration of the post-thoracic spine. The evolution of the lumbar region is especially intriguing, given that models of locomotor evolution propose that early cetaceans passed through an undulatory stage of locomotion that would have required substantially greater lumbar flexibility than that presumably possessed by their artiodactyl ancestors. In order to assess relative lumbar mobility across early archaeocetes, data were collected from the lumbar vertebrae of modern dorsostable and dorsomobile mammals. Fourteen linear and three angular measurements were collected from each lumbar vertebra, and principal components analyses (PCAs) were carried out for each vertebral position. The PCAs successfully differentiate mammals with more stable lumbar regions from those with more mobile lumbar regions. Dorsostable mammals tend to have lumbar vertebrae with anteroposteriorly short centra, anteroposteriorly long neural spines, and transverse processes with little cranial or ventral inclination. In contrast, dorsomobile mammals tend to have lumbar vertebrae with anteroposteriorly long centra, anteroposteriorly short neural spines, and transverse processes that are angled cranially and ventrally. When lumbar vertebrae from archaeocetes are included, a general trend of increasing mobility is apparent. More primitive archaeocetes, such as pakicetids and remingtonocetids, tend to plot among the dorsostable mammals, while early protocetids plot closer to dorsomobile mammals. More derived protocetids and basilosaurids plot among the more extreme dorsomobile mammals. This supports the hypothesis that the lumbar region of archaeocetes exhibited a trend of increasing mobility as they became more adapted to an aquatic lifestyle. Notably, a pair of modern cetaceans included in this study plot among the more dorsostable mammals. This is consistent with the observation that most modern cetaceans limit vertebral movement to the middle and posterior caudal vertebrae just anterior to the fluke. In sum, these results suggest that the lumbar region of cetaceans was marked by an increase in mobility during the transition from foot-powered swimming to dorsoventral undulation, followed by a subsequent decrease in lumbar mobility during the development of an oscillatory swimming mode.