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, expanding 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 spectral variations between chemically related pigments reflected shifts in hue. This allowed construction of a spectral library for identifying feather pigments in fossils. 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.

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

NO ENVIRONMENTAL PARTITIONING OF CERATOPSIDAE WITHIN THE LOWER DINOSAUR PARK FORMATION (CAMPANIAN) FAUNAL ZONE OF WESTERN CANADA

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The Dinosaur Park Formation (DPF) (Campanian) 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 centrosaurine ceratopsid that closely resemble those of *Centrosaurus apertus* from the DPF of Alberta, and is probably congeneric with it; unfortunately, no diagnostic parietal material has been collected. Of note is a small, adult-sized, centrosaurine nasal (Royal Saskatchewan Museum P1990.6) with a modified nasal horn core collected from near Unity. Although the complete nasal horn core is preserved, it is reduced in size and shape to a thin, laterally compressed, forwardly projecting spine. There is no indication of broken bone surface, rehealed 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, '*Mojoceratops perifania*', 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 transgressing shoreline; however within 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.

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

A NEW GENUS OF THE FAMILY OCHOTONIDAE (LAGOMORPHA, MAMMALIA) AND LAGOMORPH FAUNAL CHANGES AT THE AOERBAN AREA IN CENTRAL INNER MONGOLIA, CHINA

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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 lagomorphs are among the most abundant fossils in this area. Major fossil bearing deposits consist of the Aoerban Formation (late early Miocene), Balunhalagen bed (late middle Miocene), and Bilutu bed (late late Miocene), and four major fossil faunas are recognized as Lower and Upper Aoerban faunas, Balunhalagen Fauna, and Bilutu Fauna in ascending order. A new genus was found in the Lower Aoerban Fauna and is characterized by 1) its much smaller size, 2) rootless cheek teeth, 3) p3 with the anterior reentrant angle as deep as or deeper than external reentrant angle, and 4) length/width ratio of p3 is smaller than that of *Sinolagomys*. The p3 enamel pattern differs distinctly from those of *Desmatolagus*?, *Alloptox*, *Bellatona*, *Ochotona*, and other genera. It is somewhat similar to *Sinolagomys*, but can easily be distinguished by its deep anterior reentrant angle and length/width ratio. The new genus is restricted to the Lower Aoerban Fauna (the late early Miocene) so far. *Desmatolagus*? (with large rooted cheek teeth, known since the Oligocene), is recorded from the Lower Aoerban through Balunharagen faunas, while *Sinolagomys* (common in Oligocene) is recognized only in the Lower Aoerban Fauna in this area. *Alloptox* is recorded from the Upper Aoerban to Balunharagen faunas (from the late early to middle Miocene), which is conformable with the known range of the genus. *Bellatona* and *Ochotona* are recorded from the Balunhalagen to Bilutu faunas, and the former may be the latest record of the genus.

Technical Session VIII (Thursday, October 18, (Thursday, October 18, 1:45 pm)

GENERIC DURATIONS OF TERRESTRIAL MAMMALS IN THE OLIGO-HOLOCENE OF NORTH AMERICA AND IMPLICATIONS FOR THE UTILITY OF BODY SIZE AS A PREDICTOR OF SUPRASPECIFIC EXTINCTION RISK

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Phylogenetic comparative analyses of extinction vulnerability in mammals have typically focused on population statuses of extant species as well as biological traits of recently-extinct, predominantly insular species. In this regard, the mammalian fossil record in deep time is uniquely valuable because of its potential to illuminate general patterns of extirpation and extinction (1) on continents, (2) in the absence of human impacts, and (3) at various scales of phylogeny. Here I examine the North American record of terrestrial mammals to test whether there is a general correlation between body size and extinction risk at the genus level across a body-weight spectrum that spans 7 orders of magnitude. Phylogenetic generalized least-square regression analyses of 220 Oligo-Holocene genera showed no significant correlation between their estimated body weights and sampling-adjusted durations. Thus, expectations from population-biological observations at the species level are not supported at the genus level. These findings suggest that extinction processes are distinct across levels of phylogenetic hierarchy and that prediction of future extinctions at supraspecific levels cannot simply rely on extrapolation of our current understanding of biological correlates of extinction risk at the species level.

Technical Session IV (Wednesday, October 17, 2:00 pm)

ANATOMY OF ARCHOSAUR PELVIC SOFT TISSUES AND ITS SIGNIFICANCE FOR INTERPRETING HINDLIMB FUNCTION

TSAI, Henry P., University of Missouri, Columbia, MO, United States; HOLLIDAY, 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 lack of joint soft tissues in many fossil taxa 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 supraacetabular crest in alligators, whereas in birds, the labrum comprises the dorsal border of the acetabulum, and is continuous with the antitrochanter. This suggests that supraacetabular 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 supraacetabular crest appears to constrain abduction and dorsocranial dislocation of the proximal femur during parasagittal locomotion. On the other hand, the cartilaginous supraacetabular 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, fovea, and FAAN in different clades of archosaurs which impact our hypotheses of homology and function.

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

EVIDENCE FOR PRESENCE OF CLAVICLES AND INTERCLAVICLES IN SAUROPOD DINOSAURS AND ITS IMPLICATIONS ON THE FURCULA-CLAVICLE HOMOLOGY

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Clavicles and interclavicles are plesiomorphically present in Reptilia. However, several groups show reduction or even loss of these elements. Crocodylomorpha, e.g., lost the clavicles, whereas dinosaurs are generally interpreted to only preserve the clavicles, the theropod furcula representing an unique case of fused clavicles. In sauropods, reports of clavicles are relatively frequent in non-titanosauriforms. These elements are elongated,

curved, and rather stout bones with a spatulate and a bifurcate end. However, they were always found as single bones, and differ from the relatively short and unbifurcated clavicles found articulated with the scapulae of basal sauropodomorphs. Elements from the Howe Quarry (Late Jurassic; Wyoming, USA) shed new light on these interpretations. Besides the elongated, curved bones (herein named morphotype A), also pairs of symmetric, L-shaped bones were recovered (morphotype B), associated with diplodocid dorsal and cervical vertebrae. Elements resembling morphotype B - articulated between the scapulae - have recently been reported from a diplodocid found near Ten Sleep, Wyoming. Taphonomic evidence, as well as the fact that they were preserved in symmetrical pairs, therefore implies that morphotype B represents the true sauropod clavicles. Contrary to earlier reports, morphotype A elements from the Howe Quarry, as well as previously reported specimens show a symmetry plane following the long axis of the elements. It is thus possible that the morphotype A elements were single bones from the body midline. The only such elements present in the pectoral girdle of tetrapods are the interclavicle and the furcula. Comparison with crocodilian and lacertiform interclavicles indicates that the bifurcate end of the sauropod elements might represent the reduced transverse processes of the anterior end, and the spatulate end would have covered the coracoids or sternal plates ventrally. The presence of both clavicles and interclavicles in the pectoral girdle stiffens the anterior trunk, and enhances considerably its stability. Such reinforcement might have been needed in diplodocids due to the strong lateral forces imposed on the forelimbs by the posteriorly placed center of mass (due to shorter forelimbs than hindlimbs), as well as lateral movements of the enormously elongated necks and tails. The absence of clavicles and interclavicles in titanosauriforms coincides with the development of the wide-gauge locomotion style. The presence of interclavicles in sauropods supports the recently proposed homology of the furcula with the interclavicle, instead of representing fused clavicles. Interclavicles were thus not lost, but may have remained cartilaginous or have yet to be found in basal dinosauriforms.

Romer Prize Session (Thursday, October 18, 11:30 am)

CONVERGENT EVOLUTION AND ITS FUNCTIONAL MECHANISMS: A CASE STUDY OF BONE-CRACKERS

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The past 65 million years of evolution in carnivoran mammals exhibits numerous cases of convergence in ecomorphologies, stereotypical morphotypes that represent unique ecological adaptations. Such specialist niches are often occupied by unrelated species over evolutionary time and space, indicating the filling of critical ecological roles by functional convergence. To examine proposed mechanistic explanations underlying convergent evolution of ecomorphologies, I document and review feeding specializations in one particular hypercarnivore (meat specialist) niche, the bone-crackers. Bone-cracking specialists evolved at least three times in Carnivora, in the hyaenid, percrocutid, and borophagine canid lineages. An integrative approach to the study of evolutionary change using data from skull shape, enamel microstructure, enamel microwear, and craniodental biomechanics shows that the suite of adaptive morphological characters that correlate with bone-cracking performance, and which are commonly found as a functional complex in hyaenids and canids, evolved in a mosaic manner. Microstructural changes in the enamel were related to increased durophagy as inferred from microwear analysis, followed by subsequent skull shape changes toward increased robustness and strength. Following these changes, skull stress dissipation patterns became adapted to handle mechanical demands of processing larger bones. Given these findings, an updated definition of Carnivoran bone-cracking specialization is presented. This ordered evolutionary sequence of adaptive traits in a functional complex represents a flexible mode of evolution that accommodates different degrees of specialization in increasingly durophagous lineages. Such data indicate that “partial” specialization can nonetheless enhance bone-cracking capability, and this phenomenon may serve as a logical foundation to explain a gradient of adaptations in other carnivorans and non-carnivoran mammal clades.

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, astragalus is 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 phyletic 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 intensively estimated by several methods. However, only a few studies have investigated the relationship between astragalar size and body mass. The previous studies on the relationship between astragalar size and body mass were intended only for a few selected taxonomic groups.

To expand the application of the astragalus 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 trochlear 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 (R^2 = 0.985; %SEE = 42.0; %PE = 28.8): ln (body mass [g]) = 2.789 X ln (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 astragalus 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)

TSUIHIJI, Takanobu, 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 presacral 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 vertebrarterial canal indicates relatively simple diverticular organization. Regarding musculature, a tubercle on the posterodorsal corner of the neural spine in the trunk represents the attachment for the tendon of insertion of *m. semispinalis* of the *m. transversospinalis* group. Similar to the condition observed in extant crocodylians, this tubercle shifts ventrally in the anterior dorsal through posterior cervical regions and eventually disappears anteriorly. The notably low cervical neural spines suggest that the medial part of the *m. transversospinalis* system was not well-developed. In contrast, the relatively large epipophyses suggest that lateral portions of this system (*m. tendinoarticularis* / *m. ascendens cervicalis*) were emphasized, likely serving as the main extensors, lateral flexors, 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* system, supporting this general model. A strong rugosity on the dorsal edge of the cervical rib shaft suggests possibly strong development of the *m. serratus* complex attaching to the shoulder girdle. Overall, the anatomy of the axial muscular system in abelisaurids was likely to be specialized compared to other non-avian theropods. The results demonstrate that detailed reconstruction is possible for some aspects of soft tissue anatomy in extinct dinosaurs.

Technical Session XIV (Saturday, October 20, 9:00 am)

CRANIAL ANATOMY, PHYLOGENETIC RELATIONSHIPS AND BIOGEOGRAPHY OF *BUNOSTEGOS AKOKANENSIS* (PARAREPTILIA: PAREIASAURIDAE)

TSUJI, Linda A., University of Washington, Seattle, WA, United States; SIDOR, Christian A., University of Washington, Seattle, WA, United States

Bunostegos akokanensis is a pareiasaurian reptile known from the Upper Permian Moradi Formation of northern Niger. Recently collected cranial material permits a redescription of the taxon in addition to inclusion of new information in a phylogenetic analysis of pareiasauromorphs. *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 postfrontal, a large foramen present on ventral surface of postfrontal, and a hemispherical supratemporal boss located at posterolateral corner of skull roof. We included *Bunostegos* in a cladistic analysis of 29 parareptilian taxa and 127 cranial and postcranial characters. The results of this analysis place *Bunostegos* as more derived than the South African Middle Permian forms such as *Bradysaurus* and *Embrithosaurus*, and as the sister taxon to the Upper Permian taxa including the Russian genus *Deltavjatia* plus Velosauria. Characters such as the morphology of the cranial sculpture and the size and placement of the tabulars appear to be 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 *Anthodon*, *Nanoparia*, and *Scutosaurus*, were consistent with those of previous analyses.

Pareiasaurs are important biostratigraphic markers within the Permian assemblage zones established for South Africa’s Beaufort Group and the occurrence of *Pareiasuchus* and *Anthodon* in the Ruhuhu Basin of Tanzania and *Pareiasuchus* in the Luangwa Basin of Zambia has contributed to the regional correlation of these Upper Permian strata. The tetrapod fauna of the Moradi Formation, however, has proven difficult to correlate with other African assemblages because it contains genera unknown elsewhere (viz. *Bunostegos*, *Moradisaurus*, *Nigerpeton*, and *Saharastega*). An indeterminate gorgonopsid, the only therapsid known from Niger, suggests an Upper Permian assignment, while all other taxa from the formation have Lower and Middle Permian associations. Moreover, the lack of both dicynodont herbivores and *Glossopteris* in the Permian of Niger indicates a community