

Romer Prize Session, Thursday 11:45

#### EVOLUTION OF FORELIMB FUNCTIONAL MORPHOLOGY IN SAUROPOD-MORPH DINOSAURS

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One of the key characters of the sauropod dinosaurs is their obligate quadrupedalism, which is also one of the necessary preadaptations for gigantism in this group. However, to date it has never been shown how the functional transition from “prosauropod” to “sauropod” forelimbs, i.e. from short arms with grasping hands in primary bipedal ancestors, to columnar, weight-bearing forelimbs in quadrupedal descendants might have occurred. In this work, a detailed study of bone morphology of the pectoral girdle and forelimb in a large variety of sauropodomorphs, basal saurischians, and basal dinosauromorphs was integrated with reconstructions of the forelimb musculature, which were achieved by applying the Extant Phylogenetic Bracket approach of Witmer. The results permit new insights on how this transition took place.

In the pectoral girdle, the coracoidea rotate from a ventral position parallel to the vertebral column counterclockwise, facing anteroventrally in higher prosauropods and anteriorly in basal sauropods. Thus, the humerus rotates from a ventrolaterally directed, semi-erect position to a fully erect condition, and the primary abductor-adductor muscles (M. pectoralis, M. deltoideus, and others) change their function or are reduced, respectively. Other muscles become more important, e.g. the posterior Mm. triceps complex takes over the function of the primary retractor of the humerus. A fully erect stance of the forelimb in prosauropods is impossible due to the posteroventrolateral orientation of the glenoid and the inability to fully pronate the hand, a problem that is avoided when a semi-erect stance is assumed. In the forearm, the proximal end of the radius rotates at the elbow joint from lateral to anterior, allowing for a full pronation of the manus, and the flexor-extensor musculature of the forearm and the manus becomes reduced. However, the forearm pronators and supinators are still large in basal sauropods and likely played an important role in stabilizing the limb during walking. On the line to neosauropods, these key adaptations were further optimized.

Student Poster Session

#### HIND LIMB AND PELVIS PROPORTIONS OF *HESPERORNIS REGALIS*: A COMPARISON WITH EXTANT DIVING BIRDS

REYNAUD, F., Fort Hays State Univ., Hays, KS

*Hesperornis regalis* and other hesperornithiforms are often compared to grebes or loons in terms of their life habits, means of locomotion, and hind limb morphology. This comparison is widely used and accepted, and dates back to O. C. Marsh's 1890 monograph on the toothed birds. However, no quantitative analysis has previously been published to determine whether this is an accurate morphological comparison. Ratio, multivariate, and average Euclidian distance analyses of five modern species of foot-propelled diver, including one loon and two grebes, shows that the Common Loon, *Gavia immer*, is significantly similar to *Hesperornis regalis*, *H. gracilis*, and *Paraheperornis alexi* in terms of hind limb bone length ratios, pelvis shape, and position of the acetabulum on the pelvis. The Western Grebe, *Aechmophorus occidentalis*, is also significantly similar to these three extinct species when overall body size is removed from consideration; however, the Red-necked Grebe, *Podiceps grisegena*, is not. Based on these results, the Common Loon is closely analogous to *Hesperornis regalis*, *H. gracilis*, and *Paraheperornis alexi*, and, therefore, a good model on which to base study of their hind limb musculature and locomotion.

Poster Session II

#### IMPRINTS OF HORSE HOOVES IN THE SOUTHWESTERN NEOGENE FOSSIL RECORD

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Neogene horse tracks in southern Nevada and California are reported from only six localities. These limited tracks do not represent all horse tribes known from fossil record. New and previously undescribed horse tracks in the Calico Mountains, California and Meadow Valley Wash, Nevada prompted a review of ichnite morphologies from: Prosperity Canyon, Calico Mountains, CA: late Hemingfordian (He2) NALMA Fossil Canyon area, Mud Hills, CA: middle Barstovian (Ba2) NALMA Shadow Valley Basin, north of Baker, CA: late Barstovian (Ba2) NALMA Muddy Creek Formation, Moapa, NV: late Hemphillian (Hh4) NALMA Copper Canyon Formation, Death Valley, CA: early Blancan (BI I) NALMA Lake Tecopa Sediments, Shoshone, CA: late Irvingtonian (Ir II) NALMA Track measurements are compared to determine if hoof wall thickness increases with geologic age and phylogenetic time; if the surface area of the hoof sole increases over time; and if increases in these two metrics are related. The ratio (length to width) of each horse track was computed to differentiate elongate from equant tracks. Measurements of horse hoof wall thickness from California and Nevada increase through time from the late Hemingfordian NALMA through the middle Irvingtonian NALMA, suggesting an evolutionary trend toward thicker hoof walls. A V-shaped frog in equid tracks is first noted in one of three ichnomorphs from early Blancan (4.33 Ma) sediments at Copper Canyon, where two horse ichnomorphs are equidimensional and the third is elongate. This suggests two monodactyl (pliohippine) forms and one tridactyl (hipparionine) form, the latter print containing a frog. The area displaced by the horse hoof varies through time, perhaps reflecting locomotion or habitat. Track ratio increases in the Barstovian, but remains within certain limits (1.0–1.6) through the late Cenozoic. Small slender horse tracks from the late Miocene of Moapa, Nevada may repre-

sent tridactyl *Nannippus*. This study helps quantify the record of equid foot morphology in the Neogene fossil record. Data gathered does not differentiate monodactyl equid feet from tridactyl equid feet where the lateral phalanges do not touch the ground during standing or walking.

3D Imaging Symposium, Friday 8:00

#### DEAD ON ARRIVAL: OPTIMIZING CT DATA ACQUISITION OF FOSSILS USING MODERN HOSPITAL CT SCANNERS

RIDGELY, Ryan, WITMER, Lawrence, Ohio Univ., Athens, OH

Medical CT scanning at local hospitals is often the best option given constraints on costs, fossil size, travel risks, etc. Advances in medical scanning have allowed greater resolution and improved ability to image high-density objects such that the capabilities of hospital scanners now overlap those of ‘industrial’ scanners. However, hospital CT techs are not paleontologists. Thus, we provide guidelines to assist both paleontologist and CT tech in optimizing data acquisition. If 3D visualization is a goal, then contiguous helically-acquired slices are essential. Thin slices are necessary to resolve fine details (such as foramina), and most modern scanners can reach sub-millimeter resolutions (500-600 microns). For large fossils, a separate thinly sliced dataset of, say, the braincase region can be digitally ‘inserted’ into a coarser dataset of the whole skull. Contrast between fossil and matrix is better at lower energies (120kV), although higher energies (140kV) may be necessary. A ‘bowtie filter’ greatly improves image quality by pre-hardening the X-ray beam. CT techs typically seek to minimize radiation dose, but high-dose scans (currents up to 200mA, slow table speeds) pose no risks to fossils and produce better results. The standard medical grayscale is optimized for the human body and can be the most severe limitation to the scanning of dense fossils; many scanners, however, have an Extended Hounsfield or High Dynamic Range mode, which provides a grayscale broad enough for very dense objects. The specimen should be aligned in the scanner to minimize the amount of material through which X-rays must travel; restoration of canonical orientation can be done later with software. Specimens plagued with ‘streaking’ artifact can be scanned in more than one orientation with differing protocols, and the resulting datasets can then be registered. Slice reconstruction with a bone algorithm is typically preferred to the ‘standard’ (soft tissue) algorithm. Data should be output in digital DICOM format rather than film for subsequent analysis.

Wednesday 9:15

#### MORPHOLOGY AND PHYLOGENETICS OF *EOSANIWA* (SQUAMATA: REPTILIA) BASED ON HIGH-RESOLUTION X-RAY COMPUTED TOMOGRAPHY

RIEPEL, Olivier, Field Museum of Natural History, Chicago, IL; CONRAD, Jack, American Museum of Natural History, New York, NY; MAISANO, Jessica, Univ. of Texas, Austin, TX

*Eosaniwa koehni* from the Eocene of Geiseltal (Germany) originally was described nearly three decades ago, but it has remained an enigma since its discovery. The only known specimen consists of a skull and fragmentary postcrania preserved in association with a partial *Diplocynodon* sp. (Crocodylia) skeleton. Because dorsal surface of the specimen is imbedded in an opaque epoxy plate, only the ventral view of the specimen has been available for description. Analysis of the exposed morphology led to an early referral of *Eosaniwa* to Necrosauridae. Earlier cladistic analyses including *Eosaniwa* were unable to resolve its placement beyond suggesting a platynotan status. Although these analyses included numerous fossil anguimorphs, they did not include mosasauroids.

We used high-resolution X-ray computed tomography (HRXCT) for improved morphological analysis of *Eosaniwa*, including the previously unknown dorsal surface of the specimen. *Eosaniwa* has dorsoventrally broad jugals, very elongate nasals, and paired frontals with well-developed subfactory processes that do not meet at midline. We also identified the sphenoid, basioccipital, and humerus of the specimen among other new observations. We incorporated these data into a new cladistic analysis of 28 ingroup platynotans rooted to two shinisaurid outgroups scored for 155 informative morphological characters. A strict consensus of three shortest recovered trees suggests that *Eosaniwa* is the sister-taxon to a clade composed of *Paravaranus*, Dolichosauridae, and Mosasauroida. This clade is the sister group of a clade containing *Telmasaurus*, *Saniwides*, and crown varanids within Varanoidea.

Poster Session III

#### LOCAL EVOLUTION OF LATE PLEISTOCENE CAPRINAE AND HYAENIDAE

IN THE NORTHEASTERN PART OF THE PYRENEAN MOUNTAINS (FRANCE)  
RIVALS, Florent, Univ. of Hamburg, Hamburg, Germany; TESTU, Agnès, CNRS UMR 5198, Tautavel, France

The Pyrenean Mountains are characterized by high levels of endemism in modern faunas and floras (e.g. Pyrenean desman or water-mole, *Galemys pyrenaicus*; Pyrenean salamander, *Euproctus asper*; or Pyrenean rock lizard, *Lacerta bonnali*). This endemism was to be the result of glaciations which geographically isolated some areas of southern Europe during Pleistocene. We tested this hypothesis by studying the evolution of Caprinae and Hyaenidae found in three late Pleistocene localities of the northeastern Pyrenean Mountains (France), dated from 90,000 to 60,000 years B.P.: Caune de l’Arago, Arche cave, and Portel-Ouest cave. The data obtained on populations of tahr, (*Hemitragus cedrensis*), ibex (*Capra caucasica*), and cave hyena (*Crocota crocuta spelaea*) were compared with those of the French Massif Central populations (Bouxès, Hortus, Baume Moula-Guercy, Saint-Marcel-d’Ardèche) and Provence ones (Adaouste, Bau de l’Aubiesier). This study is mainly based