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Poster Session IV, (Saturday)

#### **VENTILATION AND HEAT EXCHANGE IN THE RESPIRATORY SYSTEM OF SAUROPOD DINOSAURS**

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Combination of a recent gigantothermic model with physiological and morphometric models for avian and reptilian lungs leads to the conclusion that an avian-like respiratory system would have satisfied the metabolic demands of the largest sauropods during rest and activity. The extremely heterogeneous lung structure would also obviate consideration of gravitational constraints, because the gas-exchange region could have been restricted vertically and the thoracic/abdominal sac-like regions (SLR) would lack pulmonary circulation. Simulation of breathing movements based on 3-D reconstruction of rib swing beginning at a resting angle determined from Sharpey's fiber traces yields such a large tidal volume that the SLR would have easily accommodated tracheal dead space air. Our preliminary calculations demonstrate the degree to which evaporative cooling in the trachea plus heat transfer to humidified air in the flow-through lungs and SLR could have contributed to solving the gigantothermy problem. The respiratory system thus did not present an obstacle to sauropod gigantism, but may have exacerbated it.

Technical Session XV, Saturday 9:45

#### **THEROPOD TAIL MUSCLE RECONSTRUCTION AND ASSESSMENT OF THE LOCOMOTIVE CONTRIBUTIONS OF THE *M. CAUDOFEMORALIS***

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Perhaps related to a lack of teeth and claws, the tails of theropods have not been extensively studied, and the size and arrangement of theropod tail musculature is not well understood. Examination of ornithomimid and tyrannosaurid tails has revealed sequential scarring (running diagonally, anterior/ventral to posterior/dorsal) on the lateral faces of four or more haemal spines that consistently correlates with the zone of the tail just anterior to the disappearance of the vertebral transverse processes. This sequential scarring is interpreted as the tapering boundary between the insertions of the *M. caudofemoralis* and the *M. ilioischio-caudalis*. The anterior termination of this scarring is interpreted as evidence that the *M. caudofemoralis* inserted across the entire lateral face of anterior haemal spines. Dissections performed on a range of modern reptiles, including *Caiman crocodilus* (spectacled caiman) and *Tupinambis merianae* (the Argentine black and white tegu), show that an anteriorly expansive *M. caudofemoralis* is consistent with extant analogs. Assuming that the muscle was roughly elliptical in cross-section and that its anterior girth was bound dorsoventrally by the undersurface of the transverse processes and the ventral tips of the haemal spines, it is now possible to digitally reconstruct the size and shape of the *M. caudofemoralis*. In this study, primary tail musculature is reconstructed for three theropod genera: *Gorgosaurus*, *Ornithomimus*, and *Tyrannosaurus*. The results indicate that these theropods had bulkier tails than has commonly been assumed and depicted. Most of the additional bulk was composed of the *M. caudofemoralis*, a primary retractor of the hind limb. This suggests greater locomotive potential. Muscle force, power, and possible contribution to turning performance are calculated from the digital models.

Poster Session III, (Friday)

#### **MICROBIAL FEATURES IN DINOSAUR BONES FROM UTRILLAS (TERUEL, SPAIN)**

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Histological analyses of fossil bones can throw light on the burial environment and taphonomic history of the site. A study on dinosaur bones from the Albian tidal flood plain facies of Utrillas (Teruel) has been carried out through thin sections, SEM, XRD and EDS. Remains show a poorly preserved cortical tissue and external longitudinal fissures filled with calcite cement. Various phases of inner cementation dominantly calcitic and a fine iron oxide crust produced later have been observed. Iron crust partially fills fissures and coats the bone surface. Original bone phosphate has been replaced by calcite. Examination of polished sections of bones using SEM show a well preserved histological structure in the cortical layer. In this zone both voids and Haversian canals are filled by crystals of calcite growing around several iron microspheres. However, the cancellous bone shows a number of diagenetic cracking as a result of collapse of the internal structure probably influenced by previous bacterial attack. Iron microspheres, range between 6 and 11  $\mu\text{m}$ . They lie within the cracks and are joined to the surfaces of the bone fractures. These structures are spherical aggregates of minor microspheroids preserved in Fe whose diameter ranges between 1 and 2  $\mu\text{m}$ . Microspheres were primarily formed at the edges of bone tissues by bacteria activity; after that, some of these microspheres penetrated into the bone through voids and canals, producing the filling of the Haversian system. There is no evidence of direct bacterial attack on the bone, but the presence of these microspheres is diagnostic of bacterial action in anoxic burial environment. This taphonomic alteration reveals a sequence of different local microenvironmental conditions: an anoxic phase with low pH and bacterial degradation with

partial demineralization of the bone was followed by mechanical cracking. In this phase the formation of iron microspheres by bacteria occurs. After that, the precipitation of calcite, in a rather well oxygenated environment, took place.

Poster Session I, (Wednesday)

#### **PANAMA AS A PALEO-NURSERY AREA FOR GIANT SHARK BABIES (*C. MEGALODON*)**

PIMIENITO, Catalina, Florida Museum of Natural History/University of Florida, Gainesville, FL, USA; EHRET, Dana, Florida Museum of Natural History/University of Florida, Gainesville, FL, USA; MACFADDEN, Bruce, Florida Museum of Natural History/University of Florida, Gainesville, FL, USA

Although sharks are apex predators in the oceans, juveniles are susceptible to being preyed upon by larger individuals. Females give birth to pups in shallow environments called nursery areas that protect their offspring. Juveniles use these environments as a refuge from predators. These nursery areas are essential habitats for the success of sharks. The extinct shark (*Carcharocles megalodon*) "Megalodon", is the biggest predator that ever lived. The huge size of this shark has caused curiosity in both the scientific community and among fossil collectors. A single *C. megalodon* tooth can reach 168 mm in crown height and studies have estimated that an adult could reach more than 15 m of total length. Fossil teeth of this extinct giant are found worldwide, including the Late Miocene Gatun Formation of Panama. We have collected and measured a number of *C. megalodon* teeth from the Gatun Formation. Surprisingly, no large teeth are present (i.e., the crown heights of Gatun *C. megalodon* teeth range from 16 mm to 54 mm). Estimates of the total length based on tooth height show that *C. megalodon* from the Gatun Formation range from 2-6 m, indicating that they are juveniles. In order to test this, we have compared these specimens with different isolated teeth, associated dentitions, and composite jaws from analogous localities such as Bone Valley Formation, Florida; Cooper River, South Carolina; Lee Creek Mine, North Carolina and Calvert, Maryland. These comparisons confirm that *C. megalodon* sharks from the Gatun Formation are juveniles. During the Late Miocene the Gatun was a warm shallow water marine environment that supported a diverse fauna of sharks. We propose that Gatun was a nursery area during this period of time and that *C. megalodon* juveniles spent their juvenile stage in this shallow environment that provided them protection from larger predators. This study represents the first report of a paleo-nursery area that supported *C. megalodon* babies using quantitative and testable data from measurements, comparisons and estimates.

Poster Session IV, (Saturday)

#### **ICHOLOGICAL EVIDENCES OF GIGANTIC DINOSAURS IN THE LATE JURASSIC OF THE IBERIAN PENINSULA**

PIÑUELA, Laura, Museo del Jurásico de Asturias (MUJA), Colunga, Spain; GARCIA-RAMOS, Jose, Museo del Jurásico de Asturias (MUJA), Colunga, Spain; RUIZ-OMENACA, José, Museo del Jurásico de Asturias (MUJA), Colunga, Spain

Several dinosaur footprints recently discovered in the Late Jurassic of Asturias (North Spain) were made by enormous trackmakers. These new footprints come from three localities placed in the coastal cliffs of Colunga and Villaviciosa municipalities, both in the famous Asturian "Dinosaur Coast". All of them are preserved as sandstone casts belonging to Lastres Formation, deltaic in origin and Kimmeridgian in age, and are housed in the Jurassic Museum of Asturias (MUJA). A 57 cm long tridactyl stegosaur pes print, assigned to *Deltapodus* sp., from cape Lastres (Colunga) is the biggest of its kind. A theropod footprint, 82 cm in length, from Argüero (Villaviciosa) is one of the largest worldwide known, only surpassed by a 90 cm long footprint from the Upper Jurassic of the Central High Atlas of Morocco (Iouaridène Formation, Oxfordian-Kimmeridgian). Finally, a sauropod manus print from Tazonos (Villaviciosa), similar in morphology to *Brontopodus*, is 95 cm long, the longest length for a sauropod manus currently known; its corresponding pes print could reach or exceed 2 m in length. It should be noted here, that the pes prints of *Gigantosauropus asturiensis*, a trackway located in La Griega beach (Colunga) from the Tereñes Formation (Kimmeridgian), are between 95 and 125 cm long and are the biggest in the Jurassic record. The Asturian tracks, together with a very big footprint cast, 70 cm in length, from the Upper Jurassic Lourinhã Formation (Kimmeridgian-Tithonian) of Portugal (Lourinhã, Lisbon district) attributed to an ornithomimid by other authors but belonging probably to a theropod for us, indicate the presence of very big stegosaurian, theropod and sauropod dinosaurs in the Late Jurassic of the Iberian Peninsula, not recognized up to the moment by skeletal evidences.