Student Poster Session (Thursday)
DYNAMIC SIMULATIONS OF THEROPOD DINOSAUR *(ALLOSAURUS FRAGALIS)* LOCOMOTION

BATES, Karl, University of Manchester, Manchester, United Kingdom

Computer processing capabilities now makes it possible to perform dynamic simulation of dinosaur locomotion using a digital musculoskeletal model. To create stable running in a model, an appropriate muscle activation pattern can be developed by a distributed, parallel Genetic Algorithm (GA) optimization system. The GA control systems can be designed to search for muscle activation patterns that maximize performance according to specific fitness criteria (e.g. maximum running speed, metabolic cost) thereby producing explicit quantitative predictions of gait and performance based on morphology. In fossil species this alleviates the need to subjectively infer joint kinematics or rely on extant taxa as dubious locomotor analogues. However, the accuracy of the simulated gait ultimately relies on the bio-fidelity of the anatomical model, which necessarily includes estimation of soft tissue parameters rarely available in the fossil record. An existing bipedal simulator shown to produce accurate information on speed, gait and metabolic energy costs of locomotion in humans has been used to analyze maximum running velocity and energy expenditure in the theropod *Allosaurus fragalis*. In order to quantitatively test the predictive value of the model a 'one-at-a-time' sensitivity analysis was performed, in which the values of specific parameters were altered individually to isolate their effect on gait and performance. Muscle parameters (e.g. maximum muscle contraction velocity) were varied over the range observed in extant vertebrates, while various mass related parameters (e.g., center of mass) were altered within the range of published estimates for *Allosaurus fragalis*. Statistical analysis of the variation produced by each input parameter indicates the relative importance of each on the models predictions. Results indicate the importance of sensitivity analysis to evaluate confidence in dynamic simulations of extinct taxa, particularly where it may serve to constrain higher-level ecological and evolutionary inferences drawn from their predictions of locomotor performance.

Technical Session I, Wednesday 9:15
THE OLDEST NORTH AMERICAN EUPRIMATES (OMOMYIDAE: *TEILHARDINA* SP. NOV.) AND MAMMALIAN BIOGEOGRAPHY NEAR THE PALEOCENE-EOCENE BOUNDARY

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Detailed studies of mammalian biostratigraphy and carbon isotope stratigraphy in the Bighorn Basin of northwestern Wyoming suggest that *Teilhardina brandti* from zone Wa-0 postdates the earliest occurrences of *Teilhardina* in Asia *(T. asiatica)* and Europe *(T. belgica)* by roughly 25 kyr. Morphological analyses of dental characters agree with this apparent chronological sequence, because *T. asiatica* retains several primitive characters that are successively transformed in *T. begica* and *T. brandti*. These observations led to the hypothesis that *Teilhardina* dispersed from Asia to Europe to North America at the beginning of the Eocene, and that dispersal from Europe to North America was facilitated by a major episode of marine regression at that time. Here, I report the occurrence of a new species of *Teilhardina* from earliest Wasatchian strata of the uppermost Tuscahoma Formation on the Gulf Coastal Plain of Mississippi. This new species of *Teilhardina* retains certain primitive characters, including low-crowned m1-2 and distinctive aspects of p4 morphology, in common with *T. asiatica*. It appears to be phylogenetically nested within *Teilhardina* as follows: (*T. asiatica*(T. sp. nov.(*T. belgica, T. brandti*))). The new species of *Teilhardina* from Mississippi is demonstrably older than *T. belgica* on the basis of sequence stratigraphy. As such, it appears to be the oldest North American euprimate. Its provenance supports initial euprimate dispersal from Asia to North America to Europe. Euprimates seemingly required 10^4 yrs or more to colonize intermontane basins of the Rocky Mountain region after they successfully crossed Beringia and invaded coastal areas of North America. Marine regression near the Paleocene-Eocene boundary may have facilitated dispersal of *Teilhardina* from North America to Europe, not vice versa.

Technical Session XVIII, Saturday 1:30
DENTAL MICROWEAR AS AN INDICATOR OF SUBSTRATE AND SUSPENDED SEDIMENT INTERACTION: TOWARDS A FINER VIEW OF MARINE MAMMAL PALEOECOLOGY

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Causes of abrasive dental microwear in terrestrial mammals can come from dietary and/or extrinsic sources (sediment). Of marine mammals, few taxa thoroughly comminute their foods and those that do mostly consume plant foods that lack abrasives such as phytoliths. Thus, sources of dental wear in many cases may have an extrinsic source. In order to assess the role of substrate and suspended sediment in dental wear, observations of relative amounts and directions of occlusal, non-occlusal, and tusk wear were compared among modern Sirenia and Cetacea. Within taxa or closely related taxa, comparisons were made among those with similar diets feeding in environments with different substrate compositions (carbonate or siliclastic) and/or suspended sediment loads (marine vs. riparian; though in some cases, different tributaries of the Amazon with different sediment loads). This was then compared to wear found in several fossil taxa, including fossil dugongids, platanistids, and the Desmostylia. The most conclusive and regularly recognized signal of sediment interactions came from non-occlusal wear on tusks and molars of modern and fossil Sirenia and Desmostylia, which indicate various degrees of substrate interactions related to how they fed and on what parts (rhizomes or leaves) of aquatic plants they fed on. Dental wear in cetaceans appears to be polarized to either much more subtle microwear or complete cusp breakage. Whereas gross dental wear of cetaceans is a complex continuum, cusp breakage is most likely related to dietary differences. Microwear appears to relate most to extrinsic sources, including the few rare modern cases of strand feeding.

Technical Session XVIII, Saturday 2:00
FUNCTIONAL INTERPRETATION OF THE NECK IN EOCENE *REMINGTONOCETUS* FROM PAKISTAN (MAMMALIA, CETACEA, ARCHAEOCETI)

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A well-preserved specimen of *Remingtonocetus*, including a partial skull and much of an articulated vertebral column, was recovered in 2004 from the upper Domanda Formation (late Lutetian; early middle Eocene) in the Kunvit area of Balochistan, Pakistan. Remingtonocetids are semiaquatic archaeocetes endemic to Pakistan and India that are characterized by long narrow rostra, small orbits, relatively long necks, sacra with three to four fused vertebrae, and hind limbs capable of bearing weight. The new specimen includes a series of complete cervical vertebrae with centra longer (relative to width and height) than those of all previously described cetaceans, which is counter to the trend of cervical shortening seen in most mammals secondarily adapted for an aquatic lifestyle. The third to fifth cervical vertebrae possess exceptionally large, plate-like transverse processes extending ventrolaterally from the centra, unlike those of any known cetacean. The largest of these processes are present on C4, where the anteroposterior length of each process is nearly twice the length of the centrum and the dorsoventral height of each process is nearly twice the height of the centrum. These expanded processes served as attachment surfaces for epaxial musculature including the longissimus cervicis, iliocostalis, scalenus, longus capitis, and intertransversarii. These muscles are paired laterally, flexing or extending the head/neck when both sides act together and rotating the head/neck to one side when they act unilaterally. Great expansion of these transverse processes indicates that the associated musculature was massive and implies that remingtonocetids had a strong neck that was likely exceptionally flexible in the lateral plane. While such flexibility would have been inefficient hydrodynamically during swimming, it almost certainly played a role in the capture and manipulation of prey. Reconstruction and interpretation of functional capability is being investigated using 3-D imaging and animation.

Technical Session XV, Saturday 10:30
PETROSALS AND TARSALS OF THE EARLY EOCENE AUSTRALIAN METATHERIAN *DJARTHIA MURGONENSIS:* THE OLDEST CROWN-GROUP MARSUPIAL FROM AUSTRALASIA AND ITS IMPLICATIONS FOR THE EVOLUTION AND BIOGEOGRAPHY OF AUSTRALIDELPHIA

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The origins and early evolution of Australasia's iconic marsupial fauna remain poorly understood, in large part because of a lack of Australasian mammal fossils of appropriate age (Late Cretaceous and early Palaeogene). Indeed, pre-Oligocene Australasian metatherians are currently known only from highly fragmentary remains (largely isolated teeth) from a single site, the early Eocene Tingamarra Local Fauna. Neither of the two metatherian taxa so far described from Tingamarra - the dilambdodont 'marsupicarnivore' *Djarthia* and the bunodont *Thylacotinga*, both known only from dental remains - could be confidently referred to a known order. Here we describe additional, non-dental material - isolated petrosals and tarsals - from Tingamarra that we tentatively refer to *Djarthia*, based on relative abundance and size. This new material indicates that *Djarthia* is a member of the clade Australidelphia, and hence the oldest crown-group marsupial known from Australasia. Most notably, the tarsals show the 'continuous lower ankle joint' and subdivided calcaneocuboid joint characteristic of australidelphians. The australidelphian affinities of *Djarthia* are supported by morphological, molecular scaffold and total evidence phylogenetic analyses. The presence of at least one undoubted australidelphian in the early Eocene of Australia contrasts with the equivocal evidence for members of this clade in similarly aged deposits in South America, and provides critical new information on the morphology, phylogeny and biogeography of crown-group Marsupialia.