Late Triassic Terrestrial Biotas and the Rise of Dinosaurs, Thursday 8:45

CYNODONT DIVERSITY TRENDS IN THE TRIASSIC-EARLY JURASSIC

ABDALA, Fernando, Bernard Price Institute for Palaeontological Research, University of the Witwatersrand, Johannesburg, South Africa

Cynodonts are an important component of Mesozoic faunas, and, in the Triassic, are frequently the most abundant group. Non-mammaliaform cynodonts are basal representatives of this group first documented in the Late Permian, and with their undoubted younger members from the Early Cretaceous. This paraphyletic group is composed of approximately 104 species/92 genera, 66 sp/59 gen of them represented in Gondwana and 39 sp/33 gen in Laurasia. Of these, only three taxa, the Late Permian *Procynosuchus*, the Middle Triassic *Scalenodon* and the Early Jurassic *Pachygenelus* are represented in deposits of both subcontinents. Results of an analysis of the diversity of cynodonts (non-mammaliaform cynodonts and basal mammaliaformes) during the Triassic and Early Jurassic indicate that they reach their maximum diversity of 46 genera during the Upper Triassic. Two peaks of diversity are recognized when analyzing the group at the level of temporal stage: the first during the Anisian with 21 genera and the second during the Norian, here considered as including the Rhaetian, with 28. The first peak is probably reflecting a large number of faunas of Anisian age including cynodonts (11, nine of them in Gondwana). The Norian peak is likely reflecting the number of localities (18, 15 of them in Laurasia), the long duration of the Norian stage (16.9 Ma) and an extensive record of isolated teeth representing several taxa, particularly from Europe.

Poster Session I, (Wednesday)

CROSSING THE BOUNDARY: INSIGHTS ON AN ELASMOBRANCH RECOVERY FAUNA

ADOLFSSEN, Jan, Natural History Museum of Denmark, Copenhagen, Denmark

The K/T-boundary is famously known for its major extinction event, but the extent of this event and the resolution of the subsequent recovery suffer in part due to a lack of suitable exposures. The outcrop at Stevns Klint, south of Copenhagen, Denmark is one such a locality. Here, the boundary clay (the marine Fiskeler member [Fish clay] of the Rødvig Formation) has been investigated for its iridium signature and clay minerals, especially over the last three decades, but its content of vertebrate remains has largely been ignored. The Fiskeler ranges in thickness from 2cm to about 30cm, and can be divided into three distinct layers. While data presented here are still preliminary, they give some insights into the faunal recovery shortly after the extinction event. Tens of kilos of clay have been sampled and screen-washed and have yielded several thousand fragmented and whole, shark teeth, as well as remains of bony fishes. The state of preservation of the teeth is, in general, very good and several new species have been identified. In addition, specimens of very rare species from other north European localities have been found, and these offer the possibility of improving our understanding of some rare taxa. The fauna investigated shows an interesting step-wise recovery, with species and specimen-poor lower layers passing into a specimen and species rich upper layer. The fauna is dominated by Triakidae (Carcharhiniformes) and Odontaspididae (Lamniformes) sharks, but there are also less abundant Hexanchiform, Orectolobiform, Heterodontiform and Squaliform sharks. A total of more than 30 species has been recognized, indicating a remarkably shark-rich milieu. The presence in this fauna of some sharks that are usually considered to be deep-water forms could present some obstacles to the assumption that the clay is an allochthonous deposit or that these sharks just were opportunistically foraging into temporarily unoccupied hunting grounds.

Poster Session I, (Wednesday)

THE LATE PLIOCENE-EARLY PLEISTOCENE SMALL VERTEBRATE SUCCESSION FROM THE GUADIX-BAZA BASIN (SE SPAIN)

AGUSTÍ, Jordi, ICREA-Institut de Paleoecología Humana i Evolució Social, Tarragona, Spain; BLAIN, Hugues-Alexandre, Institut de Paleoecologia Humana i Evolució Social (CSIC associated unit), Tarragona, Spain; FURIÓ, Marc, Institut Català de Paleontología, Sabadell, Spain; DE MARFA, Roger, Universitat de Barcelona, Departament d'Estratigrafia, Paleontologia i Geociències Marines, Barcelona, Spain; SANTOS-CUBEDO, Andrés, Institut Català de Paleontologia, Sabadell, Spain

The Guadix-Baza Basin (Granada, SE Spain) is characterized by its very complete continental succession which ranges from the latest Miocene to the late middle Pleistocene and records the earliest evidence of human presence in Western Europe (sites of Fuente Nueva 3 and Barranco León). It is composed of fluviatile and lacustrine sediments which have yielded dozens of small vertebrate fossiliferous levels, including amphibians, squamates, insectivores, rodents and lagomorphs. In this basin, the late Pliocene rodent communities are not characterized by the European *Mimomys pliocaenicus* and *M. ostramosensis*, but by local lineages ("*Kislangia" gusii, M. medasensis*), which, however, show similar trends towards increasing size and hypsodonty. The first un-rooted microtines making their first occurrence in the earliest Pleistocene of the Guadix-Baza sequence are not members of the genus *Allophaiomys* but archaic ones of the genus *Tibericola*. *T. vandermeuleni* from the Guadix-Baza Basin is accompanied by the last members of the small (*Tcharinomys*) and large *Mimomys* lineages, which finally develop ever-growing molars in a parallel way with the *Allophaiomys* lineage. Early Pleistocene rodent communities are characterized by the vole *A. ruffoi*. A trend to develop nivaloid morphotypes is observed in these southern populations, leading to *A.* aff. *lavocati,* present in the middle early Pleistocene of Fuente Nueva 3 and Barranco León. As a difference with previous levels, *Mimomys savini* is now a common element. In these levels *Oryctolagus* replaces *Prolagus* as dominant lagomorph. Late early Pleistocene rodent communities are characterized by the entry of an advanced microtine usually assigned to *Iberomys huescarensis*. Taxonomic and morphological evolution of amphibians, squamates, insectivores, rodents and lagomorphs will be commented and put in relation with changes in the Eurasian terrestrial ecosystems and the successive climatic pejorations of the beginning of the Pleistocene.

Technical Session II, Wednesday 9:00

THE BODY MUSCULATURE OF ARTHRODIRE PLACODERMS

AHLBERG, Per, Uppsala University, Uppsala, Sweden; TRINAJSTIC, Kate, Curtin University of Technology, Perth, Australia; LONG, John, Museum Victoria, Melbourne, Australia

The exceptionally preserved Late Devonian (Frasnian) fishes from the Gogo Formation, Western Australia, have recently been recognized to contain, sometimes extensive, remains of musculature preserved in three dimensions. Mapping of preserved muscles in multiple specimens of two closely related arthrodire placoderms, *Compagopiscis* and *Incisoscutum*, enable us to present the first partial map of the body musculature in a stem-group jawed vertebrate. In addition to the expected trunk and tail musculature of segmentally arranged myomeres, these placoderms show two areas of specialized muscular development. Dorsally, extending posteriorly from the rear margin of the skull roof across the nuchal gap and in under the median dorsal plate, are a pair of large muscles that contact each other in the midline and are flanked by a pair of smaller but otherwise similar muscles. These muscles, evidently modifications of the epaxial trunk musculature, must be the head elevators that rotated the head dorsally relative to the trunk armor. Ventrally, the posterior part of the abdominal musculature shows surprising complexity. Ventral to the ends of the segmental myomeres, an elongate, longitudinal, sharply defined belt of obliquely transverse muscle fibers without segmental arrangement extends along most of the length of the posteroventrolateral plate towards (and possibly reaching) the pelvis. Functionally, this may be linked to movement of the pelvic fin, erection of the clasper (in the male), and/or modulation of the movement of the tail base relative to the trunk armor during swimming. Developmentally, the arrangement of these muscle fibers at approximate right angles to the myomeric muscles suggests that they lie ventral to the "lateral somitic frontier", within the zone (also occupied by paired appendages) where muscles are repatterned by an interaction between somatic and lateral plate mesoderm. This is the first direct evidence for such muscles in a stem gnathostome.

Edwin H. and Margaret M. Colbert Poster Competition (Thursday)

NOVEL INSIGHTS ON THE BASICRANIUM OF *BUISNICTIS CHISOENSIS* WITH IMPLICATIONS FOR ITS PHYLOGENETIC POSITION

AHRENS, Heather, The University of Texas at Austin, Austin, TX, USA

Mephitdae is the well-known carnivoran taxon that includes skunks and stink badgers, yet some relationships within the clade remain ambiguous. The basicranium has been acknowledged as a useful source of phylogenetic characters for mephitid systematics, but the lack of both cranial material and thorough descriptions of the basicranium has prevented the incorporation of these characters into phylogenetic analyses. Thus, the affinities of many taxa within Mephitidae have previously been determined based primarily on dentition. I provide a detailed description of the basicranium of the stem New World mephitid *Buisnictis chisoensis* using high-resolution X-ray computed tomography, which allows for the examination of previously hidden and undescribed cranial morphology. On the cerebellar side of the petrosal, the subarcuate fossa is clearly present and relatively large, filling most of the space between the semicircular canals. As in other basal mephitids, there is communication between the mastoid sinus and the tympanic bulla via an opening in the epitympanic recess. Within the tympanic bulla, two ridges are present, located on the dorsal and ventral surfaces. These ridges may have served as sites of attachment for a transverse septum, which would have divided the bulla into rostral and caudal chambers; however there is no evidence of a complete septum observed in this specimen. A shallow suprameatal fossa is present on the dorsal surface of the external auditory meatus. The base of the parocciptical process, which extends caudoventrally, minimally contacts the posterior wall of the tympanic bulla. The condyloid canal is present and located dorsally on the medial surface of the occipital condyle, within the foramen magnum. The collection of novel observations indicates that the basicranial morphology of *Buisnictis chisoensis* is plesiomorphic for mephitids and may provide insight to the placement of the taxon within mephitid phylogeny.

Technical Session IV, Wednesday 4:15

RELATIVE ENAMEL THICKNESS IN MIDDLE MIOCENE HOMINOIDS FROM ABOCADOR DE CAN MATA (VALLES-PENEDES BASIN, CATALONIA, SPAIN)

ALBA, David, Dipartimento di Scienze della Terra, Università degli Studi di Firenze, Florence, Italy; FORTUNY, Josep, Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain; MOYÀ-SOLÀ, Salvador, ICREA at Unitat d'Antropologia Biològica (Dept. BABVE) and Institut Català de Paleontologia, Universitat Autònoma de Barcelona, Cerdanyola del Vallès, Spain

We report 2D relative enamel thickness (RET) measurements for Middle Miocene apes (Primates: Hominidae) from the Abocador de Can Mata (ACM) local stratigraphic series

(Vallès-Penedès Basin, Catalonia, Spain): the holotype cranium of *Pierolapithecus catalaunicus* (IPS21350) from BCV1 (ca. 11.9 Ma); a maxilla of *Dryopithecus fontani* (IPS35026) from C3-Ae (ca. 11.8 Ma); and a maxilla of a new genus and species (IPS43000) from C3-Aj (ca. 11.9 Ma). RET was computed on the basis of several measurements (c: enamel cap area; e: length of the enamel-dentine junction; and b: dentine area), taken from CT-scan sections through the mesial cusps of upper molars (except in two cases, where distal sections were used for preservational reasons). Martin's formula was employed: RET = (c/e)/(b^0.5)*100. The following results were obtained (mean and range): 19.5 (17.3-21.8) in *Pierolapithecus* (N=6, SD=1.7); 15.5 (14.1-16.2) in *D. fontani* (N=4, SD=1.0); and 18.6 (16.7-20.6) in the new genus (N=5, SD=1.5). The ACM apes thus share a relatively thick-enameled condition, as opposed to the thinner-enameled extant African apes. Like other Middle Miocene Eurasian taxa (the kenyapithecin *Griphopithecus* and the pongine *Sivapithecus*), *Pierolapithecus* and the new genus display considerably thick enamel, while *Dryopithecus* is somewhat thinner-enameled, more closely approaching orangutans. In the latter, thick enamel has been related to the consumption of relatively tough and hard foot items. As such, the similar (or even thicker-enameled) condition of Middle Miocene Eurasian hominoids is probably indicative of sclerocarpic harvesting, either habitually or seasonally (as fallback foods). The thick-enameled condition of the ACM hominids is consistent with a kenyapithecin-hominid sister-taxon relationship, and also with previous assertions that thick enamel might have been the fundamental adaptation that enabled the out-of-Africa dispersal of large-bodied hominoids and its subsequent initial radiation throughout Eurasia.

Poster Session III, (Friday)

UPDATING DINOSAUR RECORD FROM TERUEL (ARAGON, SPAIN)

ALCALÁ, Luis, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; ROYO-TORRES, Rafael, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; COBOS, Alberto, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain; LUQUE, Luis, Fundación Conjunto Paleontológico de Teruel-Dinópolis, Teruel, Spain

Teruel pioneered the Spanish dinosaur research, including the first new genus ever described in Spain, and recent fossil discoveries are now interesting not only for paleontologists, but also for regional heritage institutions and visitors to Dinópolis. Most findings are placed in Tithonian to Albian age continental sediments. Villar del Arzobispo Fm (Tithonian-Berriasian) is one of the richest in dinosaurs. Ichnites of stegosaurs, ornithopods, big-sized sauropods and theropods are abundant in limestones (El Castellar, Cedrillas, Formiche) but more scarce in lime-sandy facies (Galve). Milestones in this Formation include a giant sauropod partial skeleton and a huge theropod tooth from Riodeva, (and 50 new dinosaur sites there). The giant *Turiasaurus* represents the basal eusauropod clade Turiasauria (reasonably identified in Portugal, France, UK, and, possibly, in Africa). We also recovered there diplodocids, stegosaurids (*Dacentrurus*), ornithopods and theropods (Allosauroidea and others small-sized). In El Castellar there are 8 new sites with footprints -highlighting stegosaurs- and 13 with bones. Upper Hauterivian-Lower Barremian alluvial Castellar Fm includes dinosaurs in its lower part: El Castellar (20 sites) -with *Oplosaurus*- and Miravete (7 sites). Same age deposits in Cantavieja (Mirambel Fm) have yielded a muzzle of a small theropod. Lower Barremian red clays and white sands from Camarillas Fm record tridactyl trackways in El Castellar and bones in Gúdar and Maestrazgo Geopark (Iguanodontoidea in Aliaga). Upper Barremian–Lower Aptian red/grey marls and bioclastic sandstones in Miravete include some scarce dinosaur remains. The Aptian sauropod *Tastavinsaurus* has recently been proposed as belonging to a new clade: Laurasiformes. Finally, dark grey marls from Aptian Forcall Fm. in El Castellar yielded a new partial Macronaria skeleton. Thus, in the last 6 years, 100 bone and 18 ichnite new sites came to light. Many fossils are still in study and they would complete the Mesozoic scenario in this part of the Iberian Range.

Poster Session III, (Friday)

AN IMPORTANT NEW LOWER JURASSIC ICHNOFAUNA FROM THE NAVAJO-NUGGET SANDSTONE OF IDAHO

ALLEN, Tedrow, Rochester Institute of Vertebrate Paleontology, Rochester, NY, USA; LOCKLEY, Martin, University of Colorado at Denver, Denver, CO, USA

Vertebrate tracks from the Navajo Sandstone and its equivalents are rare north of the I 70 corridor that runs east-west through Colorado and Utah. We herein report an important new ichnofauna from the Bear Lake region of Idaho that reveals abundant, well-preserved dinosaur, synapsid and invertebrate traces. Small (4-5 cm long), *Grallator*-like, tridactyl dinosaur tracks represent diminutive theropods (hip height ~18-22 cm). Abundant small (pes length 0.5-5.0 cm) tetradactyl-pentadactyl tracks (cf. *Brasilichnium*) of quadrupedal track makers with moderate to strong heteropody represent a variety of mammaloid or synapsid trackmakers. Enigmatic moderate- to large- sized (>5 cm), tetradactyl tracks (cf. *Batrachopus* and *Navahopus*) may represent prosauropods, other archosaurs or synapsids. Tracks of large spiders (ichnogenus *Octopodichnus*) are also abundant, and indicate a wide range of sizes and gaits. The presence of the shallow-burrowing insect trace, *Entradichnus* is consistent with an arid landscape, with low vegetation and intermittant precipitation. The Bear Lake locality is the most northerly occurrence of tracks in the Navajo-Nugget Sandstone and the first confirmed report from the state of Idaho. The ichnofauna reveals the greatest variety and size range of well-preserved mammaloid (synapsid) tracks yet reported, and together with the Meeker locality in Colorado has the best sample of large spider tracks and other invertebrate traces. Spider tracks are also known from a third locality north of I 70 but have not been reported to the south. The ichnofauna is an important window into the northern expression of the eolian ecosystem in Navajo times and represents an excellent example of what has variously been labeled as the *Chelichnus* (=*Laoporus*), *Chelichnus-Octopodichnus* or *Brasilichnium* ichnofacies, which has multiple expressions (ichnocoenoses) in eolian facies especially in the Permian through Jurassic.

Technical Session XV, Saturday 9:30

THE EVOLUTION OF HINDLIMB MUSCLE MOMENT ARMS AND FUNCTIONAL ANATOMY IN BIRD-LINE THEROPOD DINOSAURS

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Computer models of theropod dinosaur hindlimbs based on skeletal anatomy and extant soft tissues allow quantified estimation of 3D moment arms (leverage) that may not be directly determined by simple observation and measurement of the fossils themselves. Based on 3D models of 10 representative taxa, we present an analysis of the evolution of moment arms in theropod dinosaurs along the evolutionary lineage of modern birds, normalized to remove size biases.

The results concur with previous findings in that most dinosaur hip muscles were multifunctional, with relatively few muscles highly specialized to rotating the hip in a single degree-of-freedom. Many muscles, particularly those originating close to the acetabulum, were found to switch moment arm polarity dependant on joint angles – muscles of the adductor group, hamstrings and iliotibialis group in particular were found to be capable of both limb retraction and protraction at different points in the limb's arc. Muscles crossing the knee, ankle and more distal joints were found to be more stereotyped in their function. Trends observed in our sample support some previous hypotheses about the evolution of limb use in bird-line Dinosauria; expansion of the ilium and proximal ischium and pubis is correlated with increasing limb flexion/extension moment arms of associated muscles and expansion of the cnemial crests was found to correlate with increased knee extension leverage. Contrary to previous estimates hip extension leverage of the adductor group were not found to increase. Although previous estimates of the expansion of femoral medial rotation leverage correlated to expansion of the trochanteric crest were well supported, a potential concomitant reduction of the femoral lateral rotation leverage of the caudofemoral muscles was found. We theorize that the caudofemoral muscles of earlier theropods acted as a major lateral rotator antagonist to the medial rotator iliotrochantericus group and may have hindered stance-phase balancing by medial rotation, which may be a factor in the reduction of the caudofemoral group muscles along the bird-line.

Technical Session IV, Wednesday 4:00

***PIEROLAPITHECUS*, *HISPANOPITHECUS* AND THE EVOLUTION OF POSITIONAL BEHAVIOR IN MIOCENE APES: PERSPECTIVES FROM THE HAND**

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The *Pierolapithecus* partial skeleton (ca. 11.9 Ma) constitutes the earliest record of an unequivocal orthograde body plan in hominoid evolution, thus providing a unique opportunity for understanding the changes in hand anatomy that occurred during the pronogrady/orthogrady transition. We describe the *Pierolapithecus* manual phalanges and compare their morphology and proportions with those of other Miocene apes, in order to make locomotor inferences. In particular, we test whether the acquisition of vertical climbing and suspension was decoupled during evolution. Our results indicate that Miocene apes primitively retain phalangeal features related to powerful-grasping palmigrady, thus suggesting that above-branch quadrupedalism, inherited from stem hominoids, constituted a significant component of the locomotor repertories of several hominoid lineages at least until the Late Miocene. Nonetheless, some Miocene apes do significantly differ regarding phalangeal curvature and/or elongation. The Late Miocene *Hispanopithecus* (ca. 9.5 Ma) departs by displaying, like orangutans, highly-curved and elongated phalanges, which together with other features are indicative of orang-like suspensory capabilities. On the contrary, the remaining Miocene apes display low to moderate phalangeal curvature and elongation, which are indicative of the lack of suspensory adaptations. As such, the transition from a pronograde towards an orthograde bodyplan, as documented by *Pierolapithecus*, is functionally related to enhanced vertical-climbing capabilities, but decoupled from the acquisition of suspensory adaptations (not found until *Hispanopithecus*). Our results thus agree with the view that hominoid locomotor evolution took place in a mosaic fashion: just like taillessness antedated the acquisition of orthogrady, the latter preceded the acquisition of suspensory adaptations as well as the loss of primitively-retained, palmigrade features. This combination of primitive and derived traits in fossil apes, unexpected based on extant taxa alone, should warn us against inferring the positional behavior of extinct taxa on the basis of single morphological traits from single anatomical regions.