Society of Vertebrate Paleontology 77th Annual Meeting Program & Abstracts

SOCIETY OF VERTEBRATE PALEONTOLOGY

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MEETING PROGRAM AND ABSTRACTS

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Technical Session IV (Wednesday, August 23, 2017, 1:45 PM)

PRIMATE CHEWING BIOMECHANICS: THE PERSPECTIVE OF THE DAMAGE IN FOODS

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Primates have diverse diets. Besides of frugivory, basic dietary strategies range from omnivory to pure folivory. The relationship between diet and morphology has been studied in primates over the last years by applying a wide array of techniques including morphometry and biomechanical analyses based on high resolution 3D models. Here we study the biomechanics of chewing using Finite Element Analysis (FEA) models on primate post canine dentitions. Instead of describing tooth morphology, we analyse the effect of morphology to chewed items when a bolus is processed. Subsequently we analyse the damage imposed. Photogrammetry acquired 3D models of corresponding upper and lower postcanine tooth rows from the four extant great ape species, *Pan troglodytes, Gorilla gorilla*, *Pongo pygmaeus* and *Homo sapiens*. Non-linear Static FEA were performed and contacts were defined between upper and lower teeth and the bolus as non-linear contacts with rough properties.

Different biomechanical results from FEA have been examined regarding the stress distribution after biting in the food bolus to assess the damage that each tooth morphology performs. *P. troglodytes* damages and stresses the bolus most. In general, *H. sapiens* causes larger damage than by *P. pygmaeus* and *G. gorilla*, respectively. We interpret these results as reflecting the performance of relatively sharper cusps in more pronounced occlusal reliefs to cope with foods, which can be soft brittle and/or tough. However, this morphology is matched with a diet that is rather low in abrasiveness for the species feeding on these items. This is consistent with the fact that stressing hard and abrasive objects with sharp cusps might heavily damage the tip of the cusp.

Grant Information:
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Podium Symposium (Wednesday, August 23, 2017, 11:45 AM)

LIMB EVOLUTION OF NORTH AMERICAN UNGULATES IN RESPONSE TO CENOZOIC ENVIRONMENTAL CHANGE

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The skeletal anatomy and proportions of ungulate limbs are demonstrably linked to their locomotor function and behavior. The limb morphology of living ungulates from open environments (e.g., grasslands) differs predictably from that of ungulate in closed environments (e.g., forests) in two major ways. First, the limb skeleton of cursorial, open-habitat ungulates is reduced via element fusion and loss. Second, the relative lengths of the major limb segments of cursorial ungulates characteristically differ from those of closed-habitat ungulates. The close link between limb morphology and limb function in different habitats allows to understand the evolutionary response of ungulates to changing environments throughout the Cenozoic.

The Cenozoic generally is characterized by a trend of increasing geographical extent of open habitats (e.g., grasslands) at the expense of closed habitats (e.g., forests). This environmental transformation placed similar selective pressures on the locomotor ecology and corresponding limb morphology of many mammalian taxa. Contrasting the rates and patterns of limb evolution among ungulates provides insight into the degree to which extrinsic environmental stimuli drive evolutionary change.

This study contrasts limb evolution in focal groups of Artiodactyla and Perissodactyla. Reduction and loss of limb skeletal elements are characterized using discrete characters. Changes in limb proportions within Equidae and Camelidae are quantified using linear lengths of the six major elements of the fore- and hind limb skeleton. We use a dated estimate of North American ungulate phylogeny to estimate evolutionary rates and patterns of these two data sets between 55 and 5 Ma, spanning the interval prior to and following the expansion of grass-dominated open environments in North America.

Both limb element reduction and loss, and limb proportions indicate that considerable evolution toward cursorial morphologies began at latest by the late Eocene, and that cursorial ungulates were well established prior to any evidence for the expansion of grass-dominated open environments. Moreover, ungulate clades that span this transition show similar timing of evolutionary dynamics, underscoring the influence of environmental change.

Grant Information:
This research was supported by the National Science Foundation (EAR-1252123)

Poster Session IV (Saturday, August 26, 2017, 4:15 – 6:15 PM)

REGIONALISATION OF THE AVIAN CERVICAL COLUMN: A LINK BETWEEN MORPHOLOGY AND ECOLOGY

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Birds have evolved powerful forelimbs that are used primarily in flapping flight. This has rendered these appendages less useful for environmental manipulation than in many of their dinosaurian antecedents. Reliance on the head and neck for feeding and environmental interaction places high selective pressure on cervical form-function, potentially explaining the diversity in neck morphology seen in birds. However, to-date there has no been systematic study of morphological diversity in the avian neck and its correlation with feeding habits. This study uses a combination of three-dimensional geometric morphometrics (GMM) and qualitative character coding to assess regionalisation within the cervical column of a wide variety of extant birds. These species represent a large diversity of feeding (carnivores, seed eaters) and functional (swimmers, flyers and terrestrial) ecology, cervical count (12-17) and body size. Results provide strong support for 5 cervical subregions (axis, anterior, middle, midposterior, posterior) in all species. The atlas subregion appears to show the strongest signal, with the axis (cervical 2) being clearly separate in all studied birds, possibly owing to its function into head stabilisation. Other subregions with a reasonably stable cervical count (anterior and posterior) also display a clear functional role. The remaining 2 regions (middle, midposterior) show much variability in cervical count between species (middle 2-6 cervicals, midposterior 1-4 cervicals). These results suggest that whilst the underlying *Hox* genetics may restrict avians to 5 cervical subregions, expansive variability in the middle and midposterior regions allow the cervical columns of birds to adapt to many different functional ecologies, and may be responsible for the large variety of neck morphologies observed in extant Aves.

Grant Information:
NERC ACCE DTP PhD studentship to the Institute of Ageing and Chronic Disease, University of Liverpool. CASE award from the Manchester Museum.

Romer Prize Session (Thursday, August 24, 2017, 9:00 AM)

VARIATION IN PTEROSAUR WING BONE GEOMETRY AND IMPLICATIONS FOR PTEROSAUR ECOLOGY

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Pterosaurs are the first vertebrates and largest animals to achieve powered flight. With 10-11 m wingspans, the largest species were nearly twice the size of the largest known birds. Pterosaurs have traditionally been portrayed as having extremely thin-walled wing bones, much thinner than birds. Thin-walled bones are assumed to lower mass, assisting large bodied forms in take-off and flight, yet there is a trade-off as thinner-walls are more likely to buckle or bend under load. Smaller, basal taxa are classified as 'thick'-walled, while more derived pterodactyloids are typically described as thinner-walled, suggesting a size constraint. These ideas persist in the literature, but lack a quantitative, phylogenetically-grounded study. Here I present the first cross-clade study of pterosaur wing bone geometry. I hypothesize that large-bodied pterosaurs maintain thin-walled bones regardless of phylogenetic affinity, and that a size constraint exists in pterosaur wing bone geometry, impacting their ecology. I studied over 100 pterosaur wing bones spanning pterosaur evolution, measuring the cortical thickness (t) and diaphyseal radius (R) of wing bones in order to characterize variation using R/t and K-values (inner to outer bone radius). Cross-sectional geometry was studied using second moment of area (I), providing an estimate of bending stiffness. Phylogenetic generalized linear models and calculating lambda estimated phylogenetic signal. Contrary to previous studies, wing bone cortical thickness does not carry a phylogenetic signal, and does not vary consistently between or within groups. Also differing from classical pterosaur ideology, R/t values from 1 to 8, similar to those seen in modern birds are common, with relatively few large-bodied pterodactyloids reaching extreme values upwards of 15. Incorporating size, which is phylogenetically correlated, reveals a phylogenetic signal in K and R/t values. Bending stiffness varies substantially with I from 30 to 17000 m^4, increasing with bone size. These data show that many pterosaurs, especially smaller-bodied forms, were optimized for impact strength, and to resist compression and buckling, typical of animals flying in forested areas or frequently taking-off and landing. Conversely, larger pterosaurs were optimized for mass reduction and bending resistance, essential for wings under high loads. These findings are consistent with other studies suggesting pterosaur body size is phylogenetically correlated, and show that large pterosaurs were approaching their size limit.

Grant Information:
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Technical Session XVIII (Saturday, August 26, 2017, 12:00 PM)

SYNRIFT SEDIMENTARY DEPOSITION AND VERTEBRATE FOSSIL ABUNDANCE: THE TETRAPOD RECORD FROM GREENLAND

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East Greenland preserves well-exposed sedimentary basins that, ever since the 18th Century, have been target of paleontological explorations, producing some of the most iconic specimens known in vertebrate paleontology. To-date, at least 28 different taxa of fossil tetrapods are known from Greenland, aged from the Late Devonian to the Cenozoic.

The oldest tetrapods from Greenland are five stegocephals from Late Devonian (~365 Mya) fluvial deposits of the Aina Dal and Britta Dal Fms of the Celsius Bjerg Group, including the genera *Acanthostega*, *Ichthyostega*, and *Ymeria*. Late Carboniferous (~315 Mya) floodplain sandstones of the Mesters Vig Fm preserve tetrapod tracks of the morphotype *Limnopus*.

Aquiloniferus, *Selenocara*, *Stoschiosaurus*, and *Tupilakosaurus* are the four temnospondyl amphibians from the Early Triassic (~250 Mya) shallow marine deposits of the Wordie Creek Fm. The Late Triassic (~210 Mya) lacustrine deposits of the Fleming Fjord Fm of the Jameson Land Basin record the largest diversity of fossil tetrapods from Greenland: amphibians are represented by the capitosaurid *Cyclotosaurus* and the plagiosaurid *Gerrothorax*; reptiles comprise at least three specimens of testudines, the stagonolepids *Aetosaurus* and *Paratypothorax*, at least four specimens of phytosaurs, the eudimorphodontid *Arcticodactylus*, and sauropodomorph and theropod dinosaurs; therapsids are present with the cynodontid *Mitredon*, and mammals with *Haramiyavia* and *Kuehneotherium*. Tracks are also reported, as the crocodilomorph *Brachychirotherium* and the theropodian *Grallator*. Marine reptiles are the main findings from offshore shelf deposits of the Late Jurassic (~200 Mya) Kap Leslie Fm, namely indeterminate remains of Cryptoclididae plesiosaurs and Eoichthyosauria ichthyosaurs. The only Cenozoic fossil tetrapod known from Greenland is the Great auk *Pinguinus impennis*, extinct at mid-19th Century.

All Paleozoic and Mesozoic fossil tetrapods from Greenland have been found in outcrops on the East Coast, which is snow free during the summer months and available for expeditions. The two most fossiliferous periods are the Late Devonian and the Late Triassic, both in terms of richness and diversity of the tetrapodian fauna. During these two epochs, East Greenland was characterized by extensional crustal movements, followed by rapid synrift sedimentary fillings of the deposition of terrestrial deposits at low paleolatitudes: the Middle to Late Devonian Caledonian crustal welt and the Triassic phases of rifting due to the initial breakup of the Pangaea.
Grant Information:
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Technical Session X (Friday, August 25, 2017, 11:30 AM)

THE OLDEST CROCODYLIA? A NEW EUSUCHIAN FROM THE LATE CRETACEOUS (CENOMANIAN) OF PORTUGAL

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Eusuchia is well-known since the Early Cretaceous (Barremian), being *Hylaeochampsa* from England the oldest representative of this clade. Nevertheless, the eusuchian record from the Barremian to the Santonian is very scarce and fragmentary worldwide. The diversity of Eusuchia increases notably during the Campanian - Maastrichtian with the radiation of Hylaeochampsidae and the first appearance of Allodaposuchidae and Gavialoidea in Europe, or the oldest record of Crocodylia with representatives of Alligatoroidea, Crocodyloidea, Borealosuchidae and Gavialoidea in North America.

Here we described a new eusuchian crocodylomorph based in a partial skull and jaw (ML1818) from the early upper Cenomanian of Baixo Mondego, west central Portugal (Tentúgal Fm.). The specimen presents a series of exclusive characters not seen in other taxa. The most important characters are the presence of a small-sized external mandibular fenestra between the dentary-angular suture, without surangular participation; massive postorbital bar with a very marked mediolateral compression being twice as wide anteroposteriorly as mediolaterally; and dorsal margin of the infratemporal fenestra very elongated with trapezoidal contour rather than triangular.

The resulting cladistic analysis place this specimen nested at the base of Crocodylia in a more derived position than Gavialoidea and as the sister taxon of the rest of Crocodylia. Another change in the Eusuchia phylogeny after the incorporation of this new taxon is the position of Allodaposuchidae within Crocodylia, a clade generally considered as basal eusuchians.

Therefore, this Portuguese specimen would represents the only well documented and valid eusuchian species in the Cenomanian of Europe and probably the oldest representative of Crocodylia worldwide, helping to fill a gap of Eusuchia and Crocodylia record from the Barremian to the Campanian. In addition, the discovery of this new taxon would shed light on the radiation of Eusuchia and the origin of Crocodylia, which probably would have taken place in Europe. Nevertheless, due to the fragmentary nature of these remains, although the position within Eusuchia is undoubtedly (choanae clearly enclosed by the pterygoids), the phylogenetic position of this specimen within Crocodylia is not very well supported. Hence, the recovery of new remains would help to confirm or discard this hypothesis.

Romer Prize Session (Thursday, August 24, 2017, 10:30 AM)

QUANTITATIVE ANALYSIS OF AQUATIC ADAPTATION IN DESMOSTYLIA (MAMMALIA: ?AFROTHERIA) BASED ON CRANIAL CHARACTERISTICS

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Desmostylia is a clade of extinct aquatic mammals with no close living relative. Numerous desmostylian fossils are known from the uppermost Eocene to Miocene marine strata in the North Pacific Rim. However, their paleoecology is still debated, mainly due to unique, highly-specialized postcranial skeletal morphology. In particular, inferences on the habitat and aquatic adaptation of desmostylians greatly vary, depicting them as mostly terrestrial forms, semiaquatic animals restricted to shallow water, or even active swimmers invading the pelagic area, dependent on sources of data (e.g., postcranial osteology or bone histology).

One key for clarifying aquatic adaptation of desmostylians is the cranial and brain morphology, especially characters related to the olfaction and vision, because these characters have been considered as modified in aquatic mammals. However, there have been few studies that analyzed the correlations between such characters and the degrees of aquatic adaptation quantitatively in extant mammals, a prerequisite for inferring aquatic adaptation in fossil taxa.

To rectify the problem, I analyzed cranial and brain endocast characters quantitatively in 97 species of extant mammals covering all major clades based on digital 3D reconstructions using CT scan data, with a particular focus on the sizes of the olfactory bulb, orbit and optic canal, all of which past qualitative observations indicated as having been modified through aquatic adaptation. The result showed that the sizes of the olfactory bulb and optic canal are significantly different among animals of different degrees of aquatic adaptation and become smaller in more extensively aquatic taxa, thus establishing these characters as quantitative indices for making an inference on paleoecology of fossil taxa. The orbital size, however, did not show a clear difference corresponding to different degrees of aquatic adaptation.

Based on the above analysis, an inference was made on the paleoecology of *Paleoparadoxia* using a CT data set of the skull. The relative size of the olfactory bulb of *Paleoparadoxia* was intermediate between the median values of extant aquatic and semiaquatic mammals whereas its optic canal size was close to the median of aquatic and full-aquatic species. These data suggest that *Paleoparadoxia* was likely a semiaquatic species, with its habitat limited to shallow marine realms. Such a habitat preference may explain extinction of Desmostylia at around 10 Ma when the sea-level dropped rapidly, leading to great reduction in the shallow marine area.

Grant Information:
JSPS 16J00546

Poster Session III (Friday, August 25, 2017, 4:15 – 6:15 PM)

A NEW PARAPITHECINE (PRIMATES: ANTHROPOIDEA) FROM THE EARLY OLIGOCENE OF CENTRAL LIBYA

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Parapithecines are an extinct subfamily of stem anthropoid primates known only from the Jebel Qatrani Formation in Egypt. Currently, parapithecines are represented by two monotypic genera: *Parapithecus fraasi* and *Simonsius grangeri*. The generic distinction between these taxa has been questioned in the past, but recent analyses have maintained the validity of both genera on the basis of differences in their lower dental formula and cheek tooth morphology. Here, we report the discovery of a new, relatively small-bodied parapithecine taxon from Zallah Oasis in the Sirt Basin of central Libya. This new taxon documents the first occurrence of parapithecines outside of Egypt. It is currently represented by a right M_3 and a left P_4, both of which show affinities with *Simonsius* and *Parapithecus*. P_4 in the new taxon possesses a buccally and mesially inflated trigonid that is much larger than the reduced talonid, which bears no distinct cusps. This is in contrast to *Parapithecus*, which retains inflated, cuspidate hypoconids on P_{3-4} and shows less buccolingual inflation of the lower premolar trigonids. In these respects, the morphology of P_4 in the new Libyan parapithecine more closely resembles that of *Simonsius*, although P_4 of *Simonsius* bears an extremely reduced talonid. Relative size comparisons between P_4 and M_3 show that the new Libyan parapithecine resembles *Parapithecus* in having P_4 much smaller than M_3. In contrast, the distal premolars of *Simonsius* are hypertrophied so that P_4 is roughly equivalent in size to M_3. M_3 in the new Libyan parapithecine is low-crowned and bunodont, to the extent that the metaconid is the only obviously discernible cusp. As in all parapithecines, the paraconid is completely absent. The overall shape of M_3 seems to ally the new Libyan parapithecine with *Simonsius*, because both taxa possess buccolingually broad trigonids and narrow talonids that taper evenly into the hypoconulid lobe. A phylogenetic analysis based on dental characters reconstructs the new Libyan parapithecine as the sister group of *Simonsius*, with *Parapithecus* as sister to this clade. The new Libyan parapithecine augments previously reported evidence supporting a modest degree of faunal provincialism across northern Africa during the early Oligocene. The relatively small body size of the new Libyan parapithecine likewise supports the convergent acquisition of body mass larger than ~700 g among multiple clades of early Oligocene African anthropoids.

Grant Information:
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Technical Session II (Wednesday, August 23, 2017, 10:15 AM)

RE-EVALUATION OF THE ONTOGENY AND REPRODUCTIVE BIOLOGY OF *SAURICHTHYS* (ACTINOPTERYGII)

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Viviparity has evolved independently at least 12 times in ray-finned fishes. However, it has been reported only in two non-teleost actinopterygians, *Saurichthys curionii* and *S. macrocephalus*, both from the Middle Triassic Meride Limestone (Monte San Giorgio, Switzerland). Recent work on gastrointestinal anatomy has raised the possibility that these reported 'embryos' are predated juveniles. We apply a combination of criteria to distinguish between embryos and gastric contents to draw new conclusions regarding life history and ontogeny in these fishes.

Our criteria are both preservational and positional. Small individuals preserved in the abdominal cavity of males (as indicated by the presence of an ossified gonopodium), incorporated into the gastric mass, positioned in the pharyngeal region, or chaotically oriented in the abdominal cavity were considered to be predated juveniles. Embryos show unusual preservation, never observed in unambiguous gastric contents, in that the notochord is preserved in three dimensions and phosphatized. This was used as one of the primary criteria in separating embryos from cannibalized juveniles in our study. As a rule, embryos were positioned with the skulls usually directed anteriorly, dorsal to the gastrointestinal tract, parallel to the axial skeleton and to each other, in the posterior 2/3 of the abdominal region.

After applying these criteria, of 6/18 adults with small individuals preserved in the abdominal region are unambiguously gravid. A minimum of 16 embryos are preserved in the most fecund females, and based on the largest preserved embryos and smallest preserved neonates, birth must have occurred at 7-12% of maternal fork length. Embryonic crania and teeth are relatively well-ossified. In the postcranium, the median scale rows and lepidotrichia are ossified, but not the lateral scale rows. Ossified squamation suggests that neonates of *S. curionii* did not undergo metamorphosis, and were relatively precocial.

Viviparity is associated with exploitation of pelagic habitats in fishes, and often with higher rates of speciation. A better understanding of early ontogeny in the oldest documented case of actinopterygian viviparity provides additional data to help in uncovering the underlying selective pressures driving the repeated evolution of this life-history strategy. Detailed information on embryonic size, position, and morphology will be of use in identifying fossilized embryos in other non-teleostean actinopterygians.

Technical Session XVII (Saturday, August 26, 2017, 9:15 AM)

HISPANIOLA-LA! UNDEREXPLORED INTRASPECIFIC VARIATION AND TAXONOMIC IMPLICATIONS FOR ISLAND SLOTHS (MAMMALIA: PILOSA: MEGALONYCHIDAE)

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