

THE ORIGIN OF AN OPISTHOTONIC POSTURE IN FOSSIL VERTEBRATES
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An opisthotonic posture, the recurvature of the neck and head posteriorly over the dorsal side of the animal, is a recurrent feature in both Recent and fossil vertebrate skeletons (avian, dinosaurian and mammalian). Although various hypotheses have been proposed for its origin, the authors of the most recent review considered it to originate peri-mortem, i.e. at the time of death, via muscular spasms induced by poisoning or disease in the central nervous system. This phenomenon is known from clinical literature, but is exhibited by a carcass only for the period in which rigor mortis is present (i.e. for only a relatively short length of time after death). Critically, it will be lost during any subsequent re-orientation of the carcass, for example as a result of transport. To accommodate this, the occurrence of an opisthotonic posture in fossil vertebrates is attributed to a very specific set of taphonomic circumstances, essentially rapid entombment, at, or very shortly after, death. This prevailing model is tested against the depositional context of three fossil faunas in which vertebrates routinely exhibit an opisthotonic posture: the Jehol Biota, a lacustrine sequence of Early Cretaceous age from China; the Monte San Giorgio reptile-dominated fauna of Middle Triassic age from the border region between Switzerland and Italy; and the lagoonal Upper Jurassic Solnhofen Lithographic Limestone. The sedimentary context of none supports the peri-mortem model; in the Jehol Biota articulated vertebrate carcasses occur in laminated to thin-bedded fine-grained facies, and rarely in the rapidly emplaced medium-thick bedded volcanoclastic deposits. Monte San Giorgio reptiles preserved in an opisthotonic posture are known from fine-grained, dark-colored, hemipelagic shales. In each case, there is evidence for an extended residence time in the water column and/or at the sediment/water interface. The opisthotonic posture can more plausibly be attributed to contraction of ligaments through dehydration and desiccation resulting in shortening of the vertebral column's length. Its origin in fossils is post-mortem, not peri-mortem; clear evidence of this timing is provided by re-orientation of Solnhofen specimens after growth of microbial mats and adherence to the substrate.

Technical Session IV, Wednesday 2:45

DENTAL MICROWEAR AS AN INDICATOR OF RESPONSE TO CLIMATE CHANGE IN MODERN AND FOSSIL SIRENIA

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The late Miocene changes in climate, ocean currents, and physiography, in part due to the rise of the Isthmus of Panama, came associated with drastic changes in sea level and shallow benthic communities that have been hypothesized to have affected the diversity of marine mammal herbivores in the West Atlantic and Caribbean. Sirenians today feed in a variety of shallow marine habitats, and in order to test these differences we employed dental microwear analysis of modern manatees from a variety of environments, paying particular attention to diet and the composition of the substrate in which these animals fed. Photomicrographs were taken at 100X under a stereomicroscope and standard microwear features (e.g. pits, scratches) were quantified. Preliminary analysis indicates that though microwear in aquarium-raised manatees is variable, microwear of wild manatees appears restricted to different taxa and their environments. Specifically, the relationship between scratch density and pit density appears to allow separation between individuals feeding in environments in which the substrate is dominated by calcareous versus quartz sand. Among sampled fossil dugongids, *Metaxytherium* appears to have microwear much more like manatees that feed from more calcareous dominated sands, like modern *Dugong* does. This makes sense, as many of the phosphate mines from which these fossil dugongids are known represent the ideal nutritional environment for seagrasses. In addition, we studied the wear patterns of captive raised *T. inunguis*, controlling for environmental conditions that appear to indicate that diet plays a role in gross dental wear as well. Ultimately, microwear is a complex of dietary and environmental interactions with teeth, and resolving its meaning will require more sampling and analysis of modern and fossil Sirenia, as well as experimental approaches with living animals. Despite this complexity, it appears that dental microwear allows us to separate dietary and/or substrate interactions among modern and fossil Sirenians and how they responded to changes in the West Atlantic and Caribbean in the late Miocene/early Pliocene.

Poster Session IV, (Saturday)

POSSIBLE SEXUAL DIMORPHISM IN REMINGTONOCETIDAE (MAMMALIA, CETACEA, ARCHAEOCETI) FROM THE DOMANDA FORMATION OF PAKISTAN

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Remingtonocetidae are semiaquatic archaeocete cetaceans from the early middle Eocene of India and Pakistan. They are characterized by their long necks and long narrow skulls and include the genera *Remingtonocetus* and *Dalanistes*. *Dalanistes* is known from the lower and middle Domanda Formation of Pakistan and has been differentiated from *Remingtonocetus* by its larger size, location of its external nares, height of its sagittal crest, orientation of its braincase, length of its mandibular symphysis, and morphology of its mandibular canals. More recently collected specimens of *Remingtonocetus* show that many of these features do not differ between these genera, and that they are more similar than initially recognized.

This raises the possibility that these genera may instead represent males and females of a single species. Vertebrae from 38 individuals were studied to assess the degree of size variability between taxa. Compared with *Remingtonocetus*, cervical vertebrae of *Dalanistes* are on average 19% larger, close to the 20% difference in published cranial measurements. Lumbar and sacral vertebrae of *Dalanistes* are only 12-13% larger, with a narrower range of sizes among all elements than in the cervical region. Dimensions of dental alveoli indicate that the canines of *Dalanistes* are 18% larger, while their premolars and molars are only about 13% larger. The larger difference in canine size is suggestive of sexual dimorphism, though the disparity is less than that seen in dimorphic protocetids such as *Maiacetus inuus*. Both genera are common in the middle Domanda Formation, but all of the 14 specimens recovered to date from the upper Domanda Formation appear to belong to *Remingtonocetus*. While it is possible that these two taxa comprise a single, sexually dimorphic species, the current evidence indicates that *Dalanistes* and *Remingtonocetus* should continue to be regarded as separate, closely-related species.

Molecular Tools in Paleobiology: Trees, Clocks and linking Geno- with Phenotype, Friday 10:45

RESOLVING THE HIGHER-LEVEL PHYLOGENY OF MARSUPIALIA USING MOLECULAR AND MORPHOLOGICAL DATA: PROGRESS, PROBLEMS AND PROSPECTS

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Recent molecular and morphological estimates of the higher-level phylogeny of marsupials have been characterized more by consensus than by conflict. Both data types support a fundamental split between Australidelphia (Australian marsupials plus South American microbiotherians), and (the probably paraphyletic) Ameridelphia (South American didelphimorphians and paucituberculatans). However, a number of key nodes remain uncertain. Here, I discuss: 1) an isolated calcaneus from the Australian early Eocene Tingamarra Fauna that suggests that Didelphimorphia ('true' opossums) is the sister-group of Australidelphia, and 2) fragmentary remains of plesiomorphic notoryctemorphians (marsupial moles) from the Oligo-Miocene of Australia that appear to support a Notoryctemorphia-Peramelemorphia (bandicoots) clade. Additional molecular data, particularly rare genomic changes, will be required to test these hypotheses and to clarify other problematic relationships, notably the exact position of Microbiotheria within Australidelphia. Determining the relationships of fossil marsupials and stem-metatherians will inevitably be largely reliant on morphological data, although it may be possible to obtain DNA from Late Pleistocene Australian taxa. Future datasets will need to incorporate a much denser sampling of characters (including data from multiple anatomical systems) and taxa (particularly fossil forms). However, progress may be limited without improvements in the fossil record of marsupials and stem-metatherians, particularly from the latest Cretaceous of South America and Late Cretaceous and early Palaeogene of Antarctica and Australia. Recent molecular timescales for Marsupialia have been relatively uncontroversial, in part because the highly incomplete fossil record is permissive of a wide range of potential divergence dates. I present a molecular timescale based on an 18 kb nuclear and mitochondrial matrix and using the IRDITIME method. These dates suggest that all interordinal divergences within living marsupials took place in the latest Cretaceous or early Palaeogene, congruent with the hypothesis that crown-group Marsupialia is an essentially Gondwanan radiation.

Poster Session IV, (Saturday)

EARLY RHINOCEROTOIDS (MAMMALIA: PERISSODACTYLA) FROM SWITZERLAND

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Rhinocerotoids were the most flourishing perissodactyl mammals during Tertiary times, especially in the late middle and late Eocene of North America and Asia. In West Europe, except the occurrences of the cosmopolitan running tropical forest-dwelling *Hyrachyus*, early rhinocerotoids occurred only in the earliest Oligocene and are still poorly documented at this time. The record is so far restricted to two "true" rhinocerotid genera with *Epiacraetherium* and *Ronzotherium*, and two rhinocerotid genera with *Eggyosodon* and *Cadurcotherium*. The appearance of these rhinocerotoids together with other new mammal families (e.g., Entelodontidae, Anthracotheriidae, Gelocidae, Cricetidae) coincides with the extinction/origination event named "Grande Coupure". According to recent literature, this European faunal turnover corresponds to the time interval ca. 33.55–33.20 Ma (ca. MP20/21 boundary of the European Mammal biozones). It reflects both a global climatic change (cooling event) and a major invasion of mammals from Asia, whereas the European and Asian continents fused again after the closure of the Turgai Strait. In the Swiss Molasse Basin, the only pre-"Grande Coupure" faunas are the famous fissure-fills from Egerkingen (MP14) and Mormont (MP16–19), whereas the first post-"Grande Coupure" ones are dated to MP22 and limited to small mammal assemblages (e.g., Balm). Nevertheless, earliest Oligocene rhinocerotoid remains from Switzerland are recorded from the Swiss Jura Molasse (NW Switzerland) from Bressaucourt (MP21/22) and Kleinblauen (MP22), localities known a long time ago, but still poorly dated and with a partially reviewed material. This study gives new stratigraphic data from the Jura Molasse and a first complete description of the specimens from Bressaucourt (*Ronzotherium filholi*, *Cadurcotherium minus*) and Kleinblauen (*R. filholi*, *Epiacraetherium magnum*, *E. aff. magnum*, *Eggyosodon osborni*). It reports the first occurrences of rhinocerotoids and of post-"Grande Coupure" large mammals from Switzerland with their paleogeographic and paleoenvironmental implications.