Technical Session IX (Thursday, October 10, 2019, 3:00 PM)

THE FIRST KNOWN FOSSIL OF *UMA* DEMONSTRATES EXAPTATION AND ECOLOGICAL EVOLUTION IN A SPECIALIZED CLADE

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Evidence from the fossil record suggests that extant lizard genera of North America (north of Mexico) evolved during the Miocene. Although fossils of Phrynosomatidae (fence lizards, sand lizards, and horned lizards) were previously described, there are no known fossils of the fringe-toed sand lizards (*Uma*). *Uma* are restricted to sand dunes and other desert environments containing fine-grained sand in the extant biota. I describe the first known fossil of *Uma* and refer that fossil to the panstem lineage of *Uma* with a global apomorphy-based diagnosis. The fossil was found in the Miocene strata of the Dove Spring Formation in southern California, dating to 8.77 Ma. The *Uma* fossil is a premaxilla and partially preserves the shape of the shovel-shaped snout of extant *Uma* species, which is used to accelerate sand burial by extant *Uma*. I estimated new divergence times for *Uma* and related phrynosomatid lizards using molecular data and five fossil calibrations, including the new fossil. The new divergence times provide a temporal context for the evolution of *Uma* and for the divergence of *Uma scoparia* from the *Uma notata* complex. The crown clade of *Uma* evolved in the early to middle Miocene, and the west clade of *Uma* evolved in the late Miocene to middle Pliocene. The paleoenvironment of the Dove Spring Formation was semiarid and contained ephemeral streams, but there is no evidence of sand dune deposits in the formation or of fine-grained sand in the strata containing the locality from which the *Uma* fossil was found. In their early history, *Uma* were not restricted to fine-grained sandy habitats but already displayed one of the morphological correlates of living in sand. I recommend exercising caution when using environmental tolerances and morphological features of extant taxa to hypothesize paleoecological reconstructions.

Grant Information:
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Regular Poster Session III (Friday, October 11, 2019, 4:15 - 6:15 PM)

INNER EAR ORIENTATION REFLECTS HEAD POSTURE IN THE WOOLLY RHINO (PERISSODACTYLA: RHINOCEROTIDAE)

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During the Pleistocene a climatic fluctuation occurred between colder glacial and warmer interglacial periods in Eurasia. Each period showed distinct floral and faunal elements adapted to the particular climatic conditions. Beside the woolly mammoth, the woolly rhinoceros (*Coelodonta antiquitatis*) was an important member of the Pleistocene herbivore megafauna. Both taxa were adapted to the cold temperatures of the glacial periods. Mummies from Siberia and Ukraine provide an exceptional insight in the paleobiology of the woolly rhino, much better than reconstructions from solely fossil bones. Stomach content and anteriorly abraded nasal horns show feeding preferences on low vegetation. The nasal horns were abraded because they were used to remove the snow cover from low growing plants on the ground. This specific feeding habit targeting low vegetation is also expressed in the natural head posture. The woolly rhino like the modern grazing white rhino from the African continent shows a downward oriented head posture. This is reflected by the backward inclined occipital crest of the skull, which is seen in both the woolly rhino and the extant white rhino.

In this study different skulls of the woolly rhino from different German localities were scanned using micro-computed tomography to reveal the orientation of the bony labyrinth inside the petrosal bone. The endocast of the inner ear was reconstructed digitally to make the position of the semicircular canals visible. As a premise, it is assumed that the lateral semicircular canal is oriented horizontally in the habitual head posture of mammals. The reconstructed lateral semicircular canals of both petrosals of each skull were aligned to a horizontal plane to calculate the habitual head posture using the orientation of the inner ear within the skull. As a result, the skulls of the woolly rhino show a downgrade head posture. This approach was initially tested using extant rhino skulls, resulting in a downgrade head posture for the grazing white rhino. Thus, beside the shape of the occipital region of the skull, the orientation of the inner ear can be used to reconstruct the habitual head posture (and therefore feeding preferences) in fossil (and extant) rhinos.

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Technical Session XIX (Saturday, October 12, 2019, 3:15 PM)

ANGOLA AND ITS ROLE IN THE PALEOBIOGEOGRAPHY OF GONDWANA

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Tectonic rifting of Africa from South America began by 131 Ma. The rifting of Africa and South America allowed communication of flood plain and terrestrial biota, including fish, crocodylians, and piscivorous dinosaurs between what is now Africa and South America during the Early Cretaceous. Marine flooding and more open ocean conditions were initiated in the central South Atlantic by the late Aptian (113 Ma), interrupting the terrestrial biome. With the opening of the Equatorial Atlantic Gateway by 90 Ma (Turonian), bottom water flowed north to cool global oceans. Mosasaurs entered the central South Atlantic from the northern Tethyan Biogeographic Province and plesiosaurs entered from the southern Weddellian Province.

Our excavations in Angola, ongoing for almost 15 years now, have documented these developments, and show that coastal upwelling traced along the southwestern continental margin as Africa drifted north during the Late Cretaceous and Cenozoic. The Cretaceous rich upwelling ecosystem along what is now Angola gave way, following the Cretaceous-Paleogene extinction event, to a Cenozoic upwelling system increasingly centered on modern day Namibia, which became fully established, apparently with the parameters now observed, in the Late Miocene around 10 Ma. Marine turtles are the only amniotes to inhabit both the Cretaceous and Cenozoic phases of this upwelling ecosystem.

Northward drift of Africa that shifted the position of upwelling along the African coast concomitantly also shifted the position of the associated hyperarid coastal desert that now is the refugium for the enigmatic gnetalian plant Welwitschia. The paleogeographic position of southern Africa since the Miocene established the modern environmental conditions of the Namibian Desert and Benguela Current, and induced development of the hyperdiverse Cape Flora and related biological hotspots in southern Africa.

Technical Session VIII (Thursday, October 10, 2019, 2:45 PM)

NEW INSIGHTS INTO FEEDING PERFORMANCE OF THE VIRGINIA OPOSSUM (*DIDELPHIS VIRGINIANA*) AND IMPLICATIONS FOR THE EVOLUTION OF MAMMALIAFORM MASTICATION

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Fundamental transformations of feeding system, especially jaws and teeth, occurred in early evolution of mammals. Feeding behavior and masticatory function correlate with occlusal patterns. By applying 3D analytical methods and kinematic simulations of the feeding function in modern mammals, we aim to shed light on the masticatory behaviors in early fossil mammals and their relatives. We seek to understand the evolutionary transition of the feeding system by combining classic tooth wear analysis and X-ray Reconstruction of Moving Morphology (XROMM). XROMM visualizes *in vivo* skeletal movements of a feeding animal by aligning CT-based 3D models of the bones with kinematic data of the same individual from biplanar x-ray videofluoroscopy. This creates highly accurate animations of the jaws moving in 3D space. Feeding bouts of *Didelphis virginiana* (n=2, male and female) were recorded during a three month period. Animals were provided a range of food items ranging in material properties with added controlled abrasives (pumice consisting of amorphous aluminum silicate was added to simulate grit). Changes in the tooth wear pattern were recorded by casting the cheek teeth of each animal in regular intervals (every two weeks). Preliminary results show strong dependency in chewing behavior based on food properties. While soft food was directly triggering cyclical chewing movements, hard to brittle food required initial food break down reflected by short intervals of fast opening and closing of the lower jaw without direct tooth contact prior to the cyclical chewing. Food of intermediate hardness required longer periods of cyclical processing compared to the other two types of food. We recorded independent movement of each hemimandible including rotation along the long axis and jaw, which is made possible by the highly mobile symphysis. The movements recorded for *Didelphis virginiana* revealed that differences in food hardness appeared to be correlated with