

## EARLY MIOCENE BIOCHRONOLOGY OF WESTERN CHERRY COUNTY, NEBRASKA

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In Western Cherry County, Nebraska, an upper Arikarean Group fluvial volcaniclastic sandstone, informally named the Hugen Ranch Beds, is disconformably overlain by plutonic epiclastic sand and gravel of the Runningwater Formation, here considered the base of the Ogallala Group. Stratigraphic ranges of mammalian taxa were established based on a collection of over 1,000 identifiable specimens. Of the 48 taxa present, 83 percent are new to the study area.

The Hugen Ranch fauna is characterized by Late Arikarean species and the Runningwater fauna by Early Hemingfordian species. Examples of the gradual evolution of autochthonous lineages across the Arikarean-Hemingfordian boundary include: *Merycochoerus matthewsi* - *M. propius*; *Merychys minimus* - *M. elegans*; *Tomarctus* sp. A - T. sp. B; *Daphaenodon* sp. - *D. niobrarensis*. The Hugen Ranch fauna is further characterized by the last local occurrence of *Cynelaps*, *Desmathys*, *Oxydactylus longipes*, and *Tomarctus thompsoni*, while the Runningwater fauna is significantly enriched by allochthonous taxa including *Aletomyx*, *Arctotherium*, *Barbouvomyx*, *Brolana*, and *Cynorca*. The combined use of immigrant and endemic taxa serves to refine local biochronologic units and may prove useful in the regional characterization of North American Land Mammal Ages.

In western Cherry Co. the Arikarean-Hemingfordian transition took place prior to the beginning of deposition of the Runningwater Formation following a hiatus of unknown, but probably brief, duration. The local section contains three vitric tuffs, one below and two above the unconformity which, when dated, will provide temporal resolution of this hiatus.

## PTEROSAURS FROM CONTINENTAL ENVIRONMENTS

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Most birds and virtually all bats live in continental habitats. By contrast, the majority of pterosaur remains have been found in marginal marine or fully marine deposits. Rare, fragmentary material shows that pterosaurs did penetrate into continental environments, but only now, thanks to the discovery of reasonably complete remains, principally from the Jurassic of Asia and Cretaceous of Laurasia, are details of these pterosaurs beginning to emerge.

Key discoveries include: *Sordes* and *Batrachognathus* from the Late Jurassic of Kazakhstan, *Huanhepterus* from the Late Jurassic of China, *Phobocera* and *Dsungaripterus* from the Lower Cretaceous of Central Asia, and various azhdarchids from the Upper Cretaceous of North America, Middle Asia and China. These, other discoveries, and functional studies also suggest that some taxa found in marginal marine deposits (e.g. *Anurognathus* and *Tapelara*), are 'exotics' from continental environments.

Some pterosaurs from continental deposits, such as the anurognathids (probably insectivorous) and *Tapelara* (possibly frugivorous), are strikingly different from pterosaurs found in marginal marine and marine settings, and seem to have been components of terrestrial ecosystems. However, most of these pterosaurs (e.g. *Sordes*, *Huanhepterus*, azhdarchids) are similar to filter-feeding and fish-catching forms from marine deposits, and presumably had similar ecologies. In broad terms, the morphological and ecological diversity of continental pterosaurs is low when compared to modern or fossil avifaunas. This can be attributed partly to taphonomic bias, but also reflects strong constraints on diversity imposed by the basic design of pterosaurs, in particular the mechanical linkage of the fore and hind limbs in the flight apparatus.

## CONVERGENCE BETWEEN SABRE-TOOTH MAMMALS AND JURASSIC ALLOSAURIDS - THE KOWALEVSKIAN PROGRAMME

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A century ago, Kowalevsky was praised for being the first Darwinian paleontologist; he used environmental trends to predict morphologic change in mammalian feet and teeth and to explain selective extinction patterns. Kowalevskian rules should be non-time-bounded, and therefore the Schilkin-Kurten theory, that sabre-tooths evolve to cope with gigantic herbivores, should work for dinosaurian communities.

Analysis of tetrapod faunas since 280 mya shows only two episodes when common large herbivores were 10 times or more heavier than the largest predator: 1) 35 mya to 10,000 ya; sabre-tooths evolved at least five times. 2) 160 to 140 mya; sauropod body size was far greater than that of any other well-known herbivore complex.

Maximum dinosaur predator size remained constant despite huge changes in potential prey size. Therefore sabre-toothed structures are predicted for the Late Jurassic. Advanced allosaur jaw joints are found to have extraordinary devices to increase gape; occiputs provide increased length and leverage for muscles pulling head and neck down. Analogous modifications are seen in all sabre-tooths. Allosaurs probably attacked big prey with a slashing blow of the head and neck, using the upper tooth row as a sabre.

## THE TRANSITION FROM ARCHAEOCETI TO MYSTICETI: LATE OLILOCENE TOOTHED MYSTICETES FROM SOUTH CAROLINA, U.S.A.

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A new family of extinct, archaic toothed mysticetes is represented by fossils from Late

Oligocene (circa 28-30 Ma, Chattian correlative) deposits near Charleston, South Carolina, U.S.A. These small- to medium-sized whales have large teeth, like those of the family Basilosauridae, with closely positioned and apically-directed denticles on their anterior and posterior margins. They differ from basilosaurids by having retained the  $M^3$  and having an extra posterior lower molar ( $M_4$ ). They share with balceon-bearing mysticetes such cranial characters as: laterally-directed antorbital process of the maxilla, temporal crest along the posterior border of the flat and nearly horizontal supraorbital process of the frontal, short and inflated zygomatic processes, enlarged peribullary sinus without a pterygoid sinus, and loose mandibular symphysis. Three new species of this family, represented by specimens from the Ashley Formation and the overlying Chandler Bridge Formation, demonstrate morphologic transformation from cetaceans with long rostra and large teeth to cetaceans with short rostra and smaller, crowded teeth.

These fossils are the first reported toothed mysticetes from the Atlantic realm. The new family is more primitive than the small-toothed mysticetes of the Family Aetiocetidae from the North Pacific, and differs from the Llanocetidae of the South Pacific, which have large, widely spaced cheek teeth with separated and divergently-played denticles on the anterior and posterior margins. Discovery of this group suggests that the Suborder Mysticeti evolved from the Subfamily Dorudontinae of the archaic cetacean Family Basilosauridae, and adds to the evidence for cetacean monophyly.

## PALEOCENE AND EOCENE CLIMATIC ESTIMATES FOR THE NORTHERN ROCKY MOUNTAINS--A COMPARISON OF PROXY INDICATORS

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Climatic estimates derived from early Tertiary vertebrate diversity in the Bighorn Basin are compared to predictions based on paleobotanical and isotopic analyses and climatic modeling. Vertebrate diversity analyses indicate that the interval from the middle Paleocene (Torrejonian) through early Eocene (Wasatchian) was characterized by warm and steady Mean Annual Temperatures (MAT=21-22°C), slight fluctuations in Cold Month Mean (CMM=13-18°C) and Mean Annual Range of Temperature (MART=7-15°C), and high levels of Mean Annual Precipitation (MAP=125-150 cm/yr). Within these ranges, the Torrejonian was warm and wet with a warm CMM and low MART, the Tiffanian was wetter and slightly cooler with a depressed CMM and increased MART, and the Clarkforkian cooled slightly despite steady CMM and MART. A drying trend began in the Clarkforkian continued into the Wasatchian and was associated with slight warming due to warmer CMM and the lowest MART of the interval. Increased precipitation and additional slight warming in MAT and CMM characterized the later Wasatchian and continued into the Bridgerian.

These results do not support the generally cooler MAT estimates provided by fossil plant analyses (10 to 17°C) and General Climate Models (GCM, 10 to 15°C), the cool CMM (<0°C) indicated by GCM, the increase in seasonality and substantial warming from the Paleocene to the Eocene predicted by paleobotanical analyses, or the MAT fluctuations and Eocene cooling trend indicated by oxygen isotope analyses.

Each method has limitations and advantages, but vertebrate diversity analysis is preferred since it can predict a wider range of parameters; is based on larger databases and fewer assumptions; and generally provides more reasonable results.

## A RE-EVALUATION OF THE *MICROTUS* POPULATION FROM THE TYPE LOCALITY OF THE CUDAHY FAUNA AND SUNBRIGHT ASH PIT, MEADE CO., KANSAS

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The Cudahy fauna of Meade Co., Kansas was collected directly beneath the Pearlite type-O volcanic ash dated at 600,000 yr. B.P. The fauna is one of the few Irvingtonian age assemblages in North America that is directly associated with a radiometric date, and has played a key role in the development of a microtine rodent biochronology for the Irvingtonian land mammal age. It is the type locality for *Microtus paraperarius*, a widespread taxon in the Irvingtonian of the Great Plains.

Our analysis indicates that a much higher degree of morphological variation is present in the type population than has previously been reported. We examined over 1,800 lower first molars assigned to *M. paraperarius* from the type Cudahy locality ("Locality 10") and the Sunbright Ash Pit ("Locality 17"). 73.8% of these specimens have the 'typical' morphology of *M. paraperarius* where the 5th triangle is developed, but broadly confluent with the anterop. 141 specimens (17.5%) have a more complex lower first molar, with 5 fully closed triangles (15.9%) or with 6 fully closed triangles (1.6%). 70 specimens (8.7%) have the 'typical' morphology on the anterior portion of the tooth, but the first and second triangles are broadly confluent in a rhomb. A small number (3.5%) of 1,028 upper second molars have a posterior dentine field like that found in *Microtus pennsylvanicus* and *M. californicus*. These morphological variants suggest the possibility that there are two species of *Microtus* in the type Cudahy fauna, providing a significant change in the characterization of the Irvingtonian II microtine rodent subdivision.

## THE FIRST DIRECT EVIDENCE OF LIVE BIRTH IN MOSASAURIDAE (SQUAMATA): EXCEPTIONAL PRESERVATION IN THE CRETACEOUS PIERRE SHALE OF SOUTH DAKOTA

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The remains of at least two small individuals here interpreted as the first recognized mososaur embryos are associated with a recently excavated, large conspecific specimen of