FUNCTIONAL MORPHOLOGY AND LOCOMOTION IN AN EOCENE PROTOCETID WHALE FROM GEORGIA

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An associated skeleton of a protocetid whale from Georgia includes 22 vertebrae (3 cervical, 7 thoracic, 7 lumbar, 4 sacral, and 1 caudal), 14 ribs, and a complete pelvic girdle. Analysis of the morphology of the hindlimb and pelvic musculature by comparative dissection of Recent terrestrial and semi-aquatic mammals (*Felis catus*, *Lutra canadensis*) suggests that the protocetid had less development of pelvic and hindlimb muscles than mammals that use the hindlimbs in terrestrial or aquatic locomotion. Comparative analysis of the neural canal cross-sectional area and centrum length indicate that the whale may have used primarily its forelimbs in aquatic locomotion. The hindlimbs were possibly used in terrestrial locomotion in a manner similar to that exhibited by walruses, and may also have acted as rudders in swimming.

PRELIMINARY RESULTS OF A STUDY OF AN EGGSHELL SITE IN THE MORRISON FORMATION OF COLORADO.

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A new dinosaur eggshell locality has been discovered in the Upper Jurassic Morrison Formation of the Garden Park area of Colorado. A grid system is being used to map the eggshells on the surface in order to determine if there are patterns in the distribution of eggshell type and morphology.

Preliminary results indicate that at least two morphotypes are present. One type, which represents the majority of eggshell collected, has recently been named by Karl Hirsch and may belong to the ornithopod Dryosaurus. A second type is very thin and occurs infrequently at this site. Preliminarily, also, it appears that eggshells do not occur on the bottom of rills but on their upper sides and across the hillslopes between the rills. Additionally, eggshell fragments are larger and more concentrated near the source areas. It is predicted that micro-analysis of the eggshell material will demonstrate there to be a non-random distribution of eggshells showing varying degrees of erosion effects and diagenetic changes.

CONTINUOUS TRACK ANALYSIS AND THE PHYLOGENETICS OF OLD AND NEW WORLD HIPPARIONINI (MAMMALIA, EQUIDAE)

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Continuous Track Analysis allows identification of reticulate evolution and avoids hypothesizing unknown ancestors. It redefines the goal of phylogenetics as maximizing the continuity of character distributions instead of minimizing character state transitions. The reticulations may represent convergence, hybridization, or (in biogeography) dispersal. A data set of over 50 Holarctic hipparionine species is analyzed with CTA. Sister grouping of the New World endemics Pseudhipparion and Neohipparion is rejected; their loss of the facial fossa is convergent. The Old World hipparionines did not originate independently from Cormohipparion and North American "Hipparion." No true skulls of "H. forcei" exist; "H." shirleyi resembles Hipparion s.s. only superficially; and "H." tehonense is a dead-end lineage. Hipparion s.s. is probably restricted to the Old World, and Cormohipparion alone is responsible for the Miocene "Hipparion Datum Plane." A supposed primitive Nannippus that resembles Cormohipparion is actually "H." tehonense. True Nannippus is probably derives from either Hipparion s.s. or a second Old World endemic, Cremohipparion. Migrations from the Old World to the New have not previously been entertained. The hipparionine phylogeny does not include reticulate links, which justifies the belief that hybridization is rare in mammals. There is little support for the existence of multiple unknown ancestors, which is reasonable in light of the excellent hipparionine fossil record. In paleontological studies like this one, the tendency of CTA to emphasize ancestor-descendent relationships will make it more appropriate than standard Wagner parsimony methods.

A PALEOBIOGEOGRAPHIC STUDY OF MORPHOLOGICAL CHANGE IN THE SOUTH AMERICAN RODENT Acaremys

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Over two hundred specimens of Acaremys, an Octodontid rodent, were collected from the Pinturas Formation of the Santa Cruz Province, Argentina, South America. The Pinturas Formation is Early Miocene Age (16 mya) and hypothesized to be slightly older than the Santa Cruz Formation. The first lower molar of each specimen was analyzed quantitatively and qualitatively to detect any change in morphology in time. Possible paleobiogeographic connections between the Santa Cruz and Pinturas Formations were also considered.

Over time the populations revealed a significant decrease in molar size followed by a slight increase in size and then a period of stasis. Crown pattern did not change significantly. Change in molar size followed by a period of stasis suggests a significant change in environmental conditions followed by more stable environmental conditions.

Acaremys was the most abundant small rodent at the Pinturas Formation, but was found infrequently at the Santa Cruz Formation, where Spanomys (also an Octodontid) was the most abundant. These results support the hypothesis that the Pinturas Formation and Santa Cruz Formation are of different ages with the former being the older formation based on geographic location.

SIZE STRUCTURE AND TROPHIC STRUCTURE OF MAMMALIAN FAUNAS

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In terrestrial communities, the distributions of heterotrophic species by size (size structure) and by feeding habits (trophic structure) reflect the three-dimensional complexity of habitat, the seasonal availability of plant food resources, and the amount of primary productivity. These aspects of habitat change along global climatic gradients. A survey of modern communities containing about half of the extant species of mammals reveals correlated patterns in the size structure and trophic structure of mammalian faunas.

The inverse relationship between body size and metabolic rate constrains the size range of mammalian species with particular feeding specializations. For example, granivorous and invertivorous mammals generally weigh less than 1 kg. Omnivorous mammals generally weigh less than 10 kg. Herbivorous species exhibit the broadest range of sizes, with the larger species using fermentative digestion to process forage of lower quality. Aspects of size structure are correlated with climatic variables that determine the amount and seasonal availability of food resources. Covariations of size structure and trophic structure in relation to climatic conditions are presented for modern faunas and for selected Cenozoic mammalian assemblages.

EARLY CRETACEOUS PTEROSAURS FROM WESTERN MONGOLIA AND THE EVOLUTIONARY HISTORY OF THE DSUNGARIPTEROIDEA

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In the early 1980's extensive remains of a medium sized pteroctactyloid pterosaur, Phobetor Bakhurina, 1986, were collected from early Lower Cretaceous sediments of Tatal'n western Mongolia. The remains, usually disarticulated but often well preserved and uncrushed, were found in fluvial/lacustrine sediments and associated with fragmentary remains of dinosaurs (Psittacosaurus, a sauropod and a large theropod) and a dorsetisaurid lizard. Material includes skulls with elongate mid-line crests, and most of the postcranial skeleton with the exception of parts of the pelvis, manus digits i-iii and the pes.

The toothless jaw tips are followed by about 14 teeth, the posteriormost relatively stout and apparently designed for crushing heavy scaled fish and molluscs. Construction of the shoulder joint allowed the forelimb an extensive range of movement including adduction close to the body. This, and the proportionately long hindlimbs, suggest a relatively efficient quadrupedal gait when grounded.

This pterosaur neatly fills the morphological and temporal gap between Germanodactylus (relatively primitive) from the Upper Jurassic of Europe and Dsungaripterus (relatively derived) from the mid-Lower Cretaceous of China. These three taxa are the best known members of the Dsungaripteroidea, an important clade characterised by a suite of cranial and postcranial characters. Records from the Upper Jurassic of Europe, East Africa and ?North America and the Lower Cretaceous of Romania, Mongolia, China, and South America show that dsungaripteroids were widespread, persistent and possibly better adapted to terrestrial environments than other pterodactyloid pterosaurs.

A MULTIVARIATE COMPARISON OF VARIATION IN FOSSIL AND LIVING RHINOCEROS SKULLS

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The evolutionary diversity of the superfamily Rhinocerotoidea is represented by relatively many fossils and a few surviving taxa. Morphological variation in the skull was assessed for 15 extinct genera and four extant genera (living analogues). The latter provide a guage of intrageneric and intraspecific variation for the fossils.

Separate multivariate analyses were performed on adult crania (19 measurements on 83 living and 103 fossil specimens) and adult mandibles (11 measurements on 80 living and 84 fossil specimens). These data included regression estimates of missing values for some specimens. Procedures programmed in SAS IML, including principal components, were used to observe multivariate within-group dispersions.

The black rhino sample (living genus *Diceros*) was the best group in terms of sample size (n = 48) and homogeneity (monospecific, geographically circumscribed, and no apparent subgroups) and, among the living forms, showed the greatest variation. Variation in fossil genera ranged from greater to less than that of the black rhino. Morphological, geographical, and temporal criteria were used to dissect the fossil genera into subgroups. Morphological variation

in these subgroups is generally more consistent with that of the living analogues. Previous species-level designations were not always consistent with the subgroupings.

Mandibles of *Aphelops* (n = 17) provide an example. This genus of Miocene browsers shows a large range of morphological variation divisible into a temporal sequence of four non-overlapping subgroups: Barstovian (several localities; includes *A. megalodus*), late Clarendonian (several localities), early Hemphillian (several localities; includes *A. longipes*), and late Hemphillian (*A. mutilis*).

OSTEOLOGY OF THE MOST PRIMITIVE KNOWN PORPOISE, LATE MIOCENE *PISCOLITHAX TEDFORDI* BARNES, 1984, (CETACEA; PHOCOENIDAE), FROM ISLA DE CEDROS, MEXICO

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The odontocete family Phocoenidae, comprised of the living harbor porpoises and other related living and extinct species, has a fossil record going back to approximately 11 Ma. Several fossil taxa, all rare, have been described, but the ancestry of the family has remained unclear. Although it is not the oldest known species in the family, *Piscolithax tedfordi* Barnes, 1984, is the most primitive one known, and sheds light on the origin and early evolution of the group. This species is known only by a single specimen from the latest Miocene (*circa* 8 Ma) part of the Almejas Formation on Isla de Cedros, off the west coast of Baja California, México.

Originally the species was described on the basis of the cranium, periotic, tympanic bulla, and mandible, but in 1992 much of the remainder of the holotype skeleton was discovered and collected. This new material indicates that the porpoise was approximately 2.5 m long, and its body shape in life might have somewhat resembled that of the living bottlenose dolphin, *Tursiops truncatus*. *Piscolithax tedfordi* had a robust skull with large crests and processes, differing from the paedomorphic skulls of all modern phocoenids and of some fossil species. It had a long rostrum of moderate width, numerous large teeth, elongate vertebral centra, and a long and broad pectoral flipper. Many of the osteological characters of *P. tedfordi* suggest that Phocoenidae may be a sister taxon of Delphinidae. The unusually deep brain case and anteroposteriorly expanded radius and ulna of *P. tedfordi* are autapomorphies. The cervical vertebrae were unfused. This indicates that cervical vertebra fusion among Delphinidae and later phocoenids is not in itself indicative of phylogenetic relationships.

PHYLOGEOGRAPHY OF MIOCENE INSECTIVORES FROM INTERMONTANE BASINS OF THE NORTHERN ROCKY MOUNTAINS

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The insectivores *Mystipterus*, *Mesoscalops* and *Domninoides* occur in numerous intermontane basins of the Rocky Mountains of Montana, Idaho, and Wyoming, as well as in other western Cordilleran and Great Plains localities. Dental and humeral morphology of specimens within each taxon were cladistically analyzed in order to determine evolutionary relationships within each genus. Then the phylogenetic cladograms were compared with cladograms of geographic position and temporal placement in order to assess whether geography or time was most important in determining evolutionary pattern. Preliminary results for *Mystipterus* suggest the closest correlation of evolutionary pattern is with temporal placement of localities. The morphological affinities of Nevada and Oregon species appear equally close to Montana species, but less close to each other. In contrast, the morphological relationships of species within *Mesoscalops* seem uncorrelated with time, because the least derived specimens come from the youngest of the basinal deposits, which are found in the Yellowstone Valley, Montana. This may indicate a long period of geographic isolation for the Yellowstone Valley species. Analyses of *Domninoides* are underway.

DINOSAUR LONG BONE GROWTH PLATES

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Discs of growth plate cartilage are located near the ends of growing long bones and these growth plates produce bone elongation. The cells of the growth plate (chondrocytes) have a particular temporal and spatial arrangement and undergo a series of phenotypic changes over their brief life span. Chondrocytes produce, maintain and modify a specialized extracellular matrix vital to the proper function of the growth plate. Growth plate chondrocytes hypertrophy near the end of their life. Hypertrophic chondrocytes eventually calcify their extracellular matrix in one of the final events prior to replacement of the growth plate by bone. This calcified portion of the growth plate, adjacent to the newly forming metaphyseal bone, has the greatest potential to become fossilized. Light microscopic examination of the ends of long bones of juvenile maiasaurs from the Two Medicine Formation, MT, revealed the presence of structure which we hypothesized to be the growth plate. In longitudinal section, the architecture of a growth plate interfacing with cancellous bone was evident. The morphology of the avian growth plate is unique in the configuration of the chondro-osseous junction. The size, shape and distribution of hypertrophic chondrocytes are also distinct. From light and scanning electron microscopic comparison of the dinosaur with a recent bird, lizard and mammal, we conclude that an avian-like growth plate is present in these hadrosaurs. The avian growth plate is specialized for rapid determinate growth and the same mode of long bone growth is suggested for dinosaurs.

NICHE SEPARATION OF FLUVIAL AND LACUSTRINE REPTILES FROM THE EOCENE GREEN RIVER AND BRIDGER FORMATIONS OF WYOMING

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Recent studies of reptiles have documented extensive niche separation among living forms. Striking separation of lake and river faunas can now be demonstrated for Eocene reptiles.

The late early and early middle Eocene Green River Formation has yielded a diverse, if not abundant, assemblage of aquatic reptiles known from isolated, often spectacular, specimens. Eleven species can be identified from these lake beds. Most were recovered during commercial fish collecting operations, and many are in private collections. Recent Albion College-University of Michigan collections provide a large sample of early middle Eocene (Br1) reptiles from the fluvial lower Bridger Formation ("Bridger A") where at least 16 species are recognized.

Taxa that are restricted to the Green River lakes include the baenid Chisternon, the trionychid Plastomenus, a chelydrid, the alligator Procaimanoides, and the narrow snouted crocodylid "Crocodylus" acer. Reptiles that may have been tolerant of lake and near-lake fluvial environments include Baena, the trionychid Amyda, and a single species of the emydid Echmatemys. Reptiles that appear to be restricted to fluvial environments include several other species of Echmatemys, the dermatemydid Baptemys, the carettochelyid Anosteira, the trionychid Aspideretes, the alligator Allognathosuchus, an undescribed crocodylid, the more broad snouted "Crocodylus" affinis, and the problematic crocodylians Diplocynodon and Pristichampsus. As expected, lizards are more abundant and diverse in the fluvial beds. The lower Bridger has yielded Xestops, Proglyptosaurus, and Prosauromalus, while the Green River has produced one complete specimen of the varanid Saniwa (known from fluvial deposits elsewhere) and a few indeterminate skin impressions. Snakes are very rare in both formation, represented by a few fragments from the Bridger and a single articulated Green River specimen of Boavus idelmani. In general, the sample sizes of lepidosauromorphs are too low to provide meaningful comparisons.

This research has been supported by Pew Foundation, Hewlett-Mellon Fund, and National Geographic Society grants.

MID-WISCONSIN FAUNA FROM PENDEJO CAVE, OTERO COUNTY, NEW MEXICO

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Presently, the fauna in the vicinity of Pendejo Cave, near Orogrande, New Mexico, is that typical of the Chihuahuan Desert. Excavation of the cave in the 1990's, done by the Andover Foundation for Archaeological Research, has revealed deposits dating back at least to the Mid Wisconsin. Zones K, L, and M in the cave have been dated to the Mid Wisconsin and have yielded a diverse vertebrate fauna. This includes extinct taxa such as *Hemiauchenia*, *Camelops*, *Capromeryx*, *Stockoceros*, *Equus alaskae*, *E. cf. laurentius*, *Aztlanolagus agilis*, *cf. Coragyps occidentalis*, and *Geococcyx californianus conklingi*. Remains of living taxa that presently are not found near the cave include *Lemmiscus curtatus*, *Sylvilagus nuttalli*, *Neotoma cinerea*, and *Tamias*. These extinct and extralimital forms suggest a very different climatic regime than exists today.

The vertebrates from Zones K-M bear comparison with the Mid Wisconsin fauna previously described from U-Bar Cave, approximately 240 km to the southwest. While the two faunas are generally similar, preliminary identifications from Zones K-M from Pendejo Cave lack some forms found in the Mid Wisconsin of U-Bar Cave, such as *Marmota flaviventris* and *Sorex merrami*; conversely, *Desmodus stocki*, *Nothrotheriops shastensis*, and *Arctodus simus* have been identified from U-Bar, though not yet from Pendejo. However, a comparison between the two is noteworthy due to the many similarities of taxa and the fact that both contain remains of essentially the same extralimital forms.

THE FIRST UNDOUBTED ASIAN PLESIADAPOIDS

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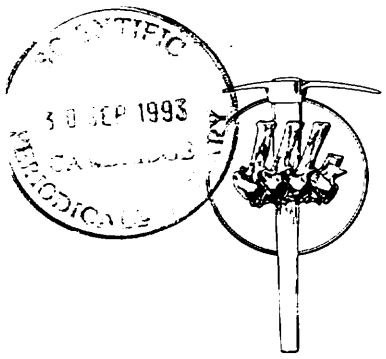
Two new genera and species of carpolestid plesiadapoids are part of a diverse new mammalian fauna from the Wutu Formation, Shandong Province, PRC. The new fauna, which also includes perissodactyls and artiodactyls, occurs about 100 m above the locality that yielded *Homogalax wutuensis* Chow and Li, 1965. The Wutu carpolestids therefore appear to be early Eocene in age; if so, they are the youngest records for this family.

The more common Wutu carpolestid is represented by virtually complete upper and lower dentitions. It possesses an elongated, procumbent i1, hypertrophied p4 lacking the plagiaulacoid specialization of other carpolestids, and reduced i2-p3

Volume 13, Supplement to Number 3
23 September 1993



JOURNAL of VERTEBRATE PALEONTOLOGY

ABSTRACTS OF PAPERS

FIFTY-THIRD ANNUAL MEETING
SOCIETY OF VERTEBRATE PALEONTOLOGY
NEW MEXICO MUSEUM OF
NATURAL HISTORY AND SCIENCE
ALBUQUERQUE, NEW MEXICO

OCTOBER 13–16, 1993

ISSN 0272-4634