Neoceti Symposium, Saturday 8:45

BODY SIZE AND CRYPTIC TROPHIC SEPARATION OF GENERALIZED PIERCE-FEEDING CETACEANS: THE ROLE OF FEEDING DIVERSITY DURING THE RISE OF THE NEOCETI

ADAM, Peter, Univ. of California, Los Angeles, Los Angeles, CA; JETT, Kristin, Univ. of California, Davis, Davis, CA; OLSON, Joshua, Univ. of California, Los Angeles, Los Angeles, CA

Marine mammals with homodont dentition and relatively little specialization of the feeding apparatus are often categorized as generalist eaters of squid and fish. However, analyses of many modern ecosystems reveal the importance of body size in determining trophic partitioning and diversity among predators. We established relationships between body sizes of extant cetaceans and their prey in order to infer prey size and potential trophic separation of generalized fossil cetaceans. Methods for predicting body size of fossil taxa from three occipital measures (bicondylar breadth; foramen magnum and occipital condyle areas) were also developed using allometric models determined from measurements made on ~2500 skulls representing all extant species. Models for body size prediction were confirmed for numerous fossil taxa with well-preserved axial postcrania. Enhanced by inclusion of additional parameters describing the feeding apparatus (tooth density; tooth row length and position; rostrum length/breadth; tooth cross-sectional area and eccentricity as measured at the enamel-dentine juncture), body size was found to be a useful predictor of prey size in generalized cetaceans. We used body size and these other parameters to infer trophic roles for a large number of Oligocene and Miocene cetaceans with unspecialized feeding anatomy. Overall, trophic diversity of generalized cetaceans was low in the Oligocene, but increased dramatically in the Middle-Late Miocene and later. This transition marks the extinction of squalodontids and other pre-neocete lineages and rise and diversification of the Neoceti, and superficially suggests that the Neoceti competitively displaced its ancestors. However, major changes in oceanographic conditions (including latitudinal stratification of oceans and increased coastal upwelling) and changes in the prey base utilized by cetaceans were also occurring during this time, rendering simple competitive scenarios for this transition untenable. We suggest that numerous factors played a role in the rise and diversification of the Neoceti, but their adaptability to changing environmental conditions was a major factor accounting for their success.

Poster Session III

DYNAMICS OF ENVIRONMENTAL CHANGES DURING THE LATE PLEISTOCENE IN THE ALTAI MOUNTAINS (RUSSIA, WESTERN SIBERIA) BASED ON MAMMAL AND MOLLUSK DATA FROM PALEOLITHIC ARCHEOLOGICAL SITES

AGADJANIAN, Alexandre, Paleontological Institute RAS, Moscow, Russia; KON-DRAŞHOV, Peter, Northwest Missouri State Univ., Maryville, MO

Faunal studies aimed for the reconstruction of the paleoenvironment of the late Pleistocene and its dynamics during the time of prehistoric man were conducted through the analysis of extant biota and through the study of the fossil biota including mollusks, birds, and mammals from the deposits of the Paleolithic archaeological sites. Nine major extant plant associations, each with its specific mammal and mollusk fauna, were identified. The most typical existing association in the northwestern Altai Mountains is the taiga with scattered alpine and meadow element communities of both montane and subalpine biota. Birds and mammals from the Altai Mountains went through significant faunal changes during the late Pleistocene-Holocene. Most of the biotic changes were caused by climate, but some could have resulted from the influence of prehistoric man. Climatic changes caused abrupt decrease of the nival and steppe elements in the biota and increase in the number of taiga species. Despite these changes many species survived the Pleistocene/Holocene transition. Presence of Siberian species in both extinct and extant Altai faunas indicates that changes in the ecological composition of the paleocommunities occurred in otherwise zoogeographically stable environment. Changes in the composition of the biota of the studied region occurred through the “recruitment” of taxa from other regions of Altai Mountains and adjacent territories. Using a combined approach and including such groups as mollusks in the analysis allowed us to confirm and more precisely describe the dynamics of the paleoenvironmental changes in the late Pleistocene and Holocene. Number of bones of small and large mammals as well as the number of Paleolithic artifacts showed that prehistoric man had an important influence on the paleoenvironment of the ecosystems of the Altai Mountains. Previously conducted studies show that prehistoric man occupied the niche of a “large carnivore”. It was documented that prehistoric man were eliminating part of the ungulate population and were competing with such carnivores as the cave bear and cave hyena.

Saturday 9:15

CT SCANNING THE NOSE OF EUSTHENOPTERON

AHILBERG, Per, Uppsala Univ., Uppsala, Sweden

Historically, the debate about the origin of the tetrapod choana has focused substantially on a single taxon, the osteolepiform lohe-finned fish Eusthenopteron foordi from the Late Devonian of Miguasha, Quebec. A three-dimensional skull of this fish was described exhaustively by Jarvik from a grinding series, arguably making it the best understood of all Devonian vertebrates. Nevertheless, Jarvik’s description of the tetrapod-like choana in Eusthenopteron was challenged head-on in 1981 by Rosen et al., who claimed that Jarvik had exaggerated the size of the supposed internal nostril, and that this opening was really a fang pit receiving the tip of the anterior coronoid fang. More recently, evidence from the acid-prepared osteoporeims Medoavina and Goggonus has offered strong support for Jarvik’s interpretation, but Eusthenopteron itself has not been reexamined in detail. Unusually, this has persisted above a supposed homology between the large endoskeletal “fenestra endochoanaalis” and the apparently much smaller choana, and about the occlusion of upper and lower jaw fangs relative to the choana.

A CT scan investigation of a large skull of Eusthenopteron, carried out in collaboration with University of Texas and Parc de Miguasha, offers an opportunity to image and digitally “dissect” a complete three-dimensional snout region. We find that a choana is indeed present, somewhat narrower but otherwise similar to that described by Jarvik. It does not receive the anterior coronoid fang, which bites mesial to the edge of the dermalplate and is received by a pit in that bone. The fenestra endochoanaalis is partly bored by the vomer and the dermalplate, restricting the choana to the lateral part of the fenestra. The nasal cavity is proportionately much shorter than in Jarvik’s reconstruction, possibly because the latter was based on two specimens that were incorrectly aligned.

Poster Session III

THE DICROSTONYX PARADOX, NEW EVIDENCE FROM A 40,000 YBP MICRO-FAUNA, JAGUAR CAVE EASTERN IDAHO

AKERSTEN, William, Idaho State Univ., Pocatello, ID

All modern Dicrostonyx are well adapted to arctic tundra conditions; consequently, Pleistocene occurrences have been viewed as definitive evidence of past tundra conditions and dis harmonious associations. A few have suggested that the evidence is more compatible with a change in the ecological requirements of Dicrostonyx. A very fossiliferous 160 cm section recently excavated in 20 cm increments from Jaguar Cave at the base of the Beaverhead Mountains dates from 39,120 BP to ~48,400 BP. The matrix is comprised of small, interlocking siliceous limestone fragments weakly cemented by lsses, very difficult to excavate, which would have all but eliminated mixing of levels. Small numbers of Dicrostonyx greenlandicus occur through most of the section (not all levels have been completely processed and studied) in an association with Lemmiscus, a number of other small mammals, and as yet unidentified snakes and lizards. While the mammal association can readily be explained as an example of a dis harmonious association, the association of snakes and lizards with a supposed tundra form is extremely difficult to explain. The key taxon appears to be Dicrostonyx; its adaptations may be more related to deep snow, not necessarily to tundra conditions. I suggest that its present distribution, allopatric (except for a modest overlap) with the widespread and very adaptable Microtas pennsylvanicus, has resulted from its having been gradually outcompeted by the latter over much of its original range, remaining only in its present tundra refugia. One explanation for the co-occurrence of Dicrostonyx and small reptiles at Jaguar Cave 40,000 years ago is that the winters had fairly deep snows which favored the adaptations of Dicrostonyx, but the summers were relatively warm and long enough for small reptiles to reproduce and obtain adequate food for winter hibernation. My interpretation is that North American Dicrostonyx is an indicator of substantial snow depth but may or may not be an indicator for tundra conditions.

Marine Reptiles Symposium, Wednesday 2:00

AN UPDATE ON NEW MARINE REPTILES FROM THE TROPIC SHALE OF SOUTHERN UTAH

ALLEN, David, DeKalb, IL; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ; TITUS, Alan, Grand Staircase-Escalante National Monument, Kanab, UT

Fieldwork conducted in the Tropic Shale of southern Utah, ongoing since 2000, has resulted in the recovery of several specimens of short-necked plesiosaurs representing both the Polycotylidae and the Phlosauridae. Although these specimens have been reported in previous abstracts, completion of our studies has resulted in revised conclusions. Of three different polycotylids recovered, it has been determined that two represent new taxa. In addition to the known Trinacromerum bentonitum, one of the new taxa appears to share a sister taxon relationship with the late Santonian/early Campanian Polycotylus latipinnus. The second new taxon, together with new unnamed taxa from the late Cenomanian of South Dakota and Japan, represents a new clade of polycotylids based primarily on the distinctive morphology of certain paddle elements. Representing the Phlosauridae are two new species of Brachychetus lucasi, both of which include skull material and one of which includes pectoral and pelvic elements previously unknown for this taxon. Although the Late Cretaceous Cenomanian-Turonian Stage boundary falls within the lower part of this unit, all but one of the specimens was found in lower Turonian strata based on molluscan assemblages found in direct association with the skeletal material. The Turonian plesiosaur fauna of the Tropic Shale, and consequently the large vertebrate fauna of the Cretaceous Western Interior Seaway, is considerably more diverse than previously realized. There is no indication that this fauna suffered any negative consequences as a result of global scale oceanographic events, including marine extinctions, that transpired during late Cenomanian-earl Turonian time.

Romer Prize Session, Thursday 8:00

A NOVEL APPROACH TO RESOLVE BASAL CROCODYLOMORPH SYSTEMATICS

ALLEN, David, DeKalb, IL

Modern crocodylians are crototsauran archosaurs called crocodylomorphs. The basal-most genera belonged to subgroups Sphenosuchia and Protosuchus. In contrast to extant semi-
NEWLY DISCOVERED PARTIAL CRANIUM OF ACRITOPARAMYX FRANCISCI (RODENTIA: ISCHYROMYIDAE) FROM THE BIGHORN BASIN, WYOMING SUPPORTS A CHANGE IN CLASSIFICATION TO THE SUBFAMILY PARAMYIDAE

ANDERSON, Deborah, St. Norbert College, De Pere, WI

Acritoparmyx francisci is one of the earliest known members of the family Ischyromyidae, its fossil record beginning in the Early Eocene (55.5 MA). Originally classified in the subfamily Paramyinae, the genus was moved to the Reithroparamyinae based primarily on characters of the posterior part of the orbit and the anterior portion of the posterior root of the zygoma. Recent discovery of a partial cranium of Acritoparmyx francisci from the Bighorn Basin, Wyoming is the basis for a more complete analysis of the evolutionary relationships and taxonomic status of the genus. The specimen includes a complete set of left molars (dP3-M3) associated with the partial cranium, and the right P4 and M1 on a maxillary fragment, as well as two nearly complete mandibles with all molars in situ. This is the first reported M3 known for the species. Qualitative features of the cranium were compared to other skulls known for the subfamily Reithroparamyinae and Paramyinae. The M3 was described in detail; other molars were similar to those found in previously described specimens. Cranial features found to be distinct from other members of the subfamily Reithroparamyinae include the curved maxilla-premaxilla, large angle of the anterior face of the zygoma, a rounded piece of maxilla separating premaxilla from the orbit, posterior aspect of orbit broad and rounded instead of angular, relatively large infraorbital foramen, and posterior margin of anterior part of the zygomatic arch in line with anteroloph of M1. In each case, the skull more closely resembles those known for the Subfamily Paramyinae, supporting reclassification of this taxon.

Saturday 11:30

ON THE SKULL OFCACOPS ASPIDEPHORUS WILLISTON (TETRAPODA: TEMNOSPONDYLI; DISSOROPHIDAE) FROM THE LOWER PERMIAN OF TEXAS

ANDERSON, Jason, Univ. of Calgary, Calgary, AB, Canada

One of the most frequently depicted amphibians from the Early Permian, the armored temnospondyl Cacops aspidephorus, is also among the most poorly known dissorophids in terms of cranial anatomy. Because the matrix tightly encrusts the bone, it is difficult to determine where matrix ends and bone begins. The type series was prepared in such a manner as to obliterate the external surface of the bone so that, although complete skulls of Cacops are known, no sutures have been described.

A partially prepared specimen on display at the University of Michigan Exhibit Museum was investigated as a part of my revision of dissorophid temnospondyls. After cleaning it was discovered to have a full complement of sutures on the lower jaw, which prompted my present exploration of all unprepared cranial material from the Cacops Bone Bed held at the Field Museum of Natural History. This new material was supplemented by reexamination of the type series.

Sutures demarcating all ossifications of the lower jaw save the articular can be made out with varying degrees of clarity. Sutures on the lateral skull, skull roof, and palate are also discernible. Most important in terms of the state of knowledge are the presence of sutures on the premaxilla, a very thin maxilla, and an LEP that might have been prevented from participating in the ventral orbital margin. Rostrally the lower jaw of Cacops is very narrow and only the dentary can be seen except for a small exposure of the presple- nial. The prespleinal comes to a point at the symphysium but does not seem to contribute to it. An adyphysial ossification, the first described from a dissorophid, bearing a fang and replacement pit forms the lingual half of the symphysium in a pattern similar to that in the colosteid Greerepetor barkemori. These features allow Cacops to be coded in a matrix of lower tetrapod jaw characters, which will be explored in detail. With the recent description of an adyphysial in an amphibian temnospondyl, it raises the possibility that the adyphysial of lower tetrapods may be homologous to the mammalian eye ossification in modern amphibians. This character will be discussed at length.
The end-Permain mass extinction was the largest extinction event of the Phanerozoic, with strong effects on marine and terrestrial communities, but its causes remain obscure. Part of this uncertainty stems from the fact that few unique mechanisms have been definitively associated with mass extinctions. Regardless of their ultimate causes, however, it is clear that mass extinctions represented times of severe ecological crisis, during which ecological community functions were altered or shifted into new states. Thus, many of the species that became extinct during intervals of mass extinction probably did not succumb to the direct effects of abiotic triggers, but instead were victims of the resultant ecological crises and failing communities. In particular, the trophic relationships that exist between different organisms in a community may make them vulnerable to cascades of secondary effects, in which the effects of a perturbation of some members of a community can spread throughout a food web, potentially causing its collapse. However, this raises the question of whether communities of differing trophic connections are equally susceptible to extinction.

To address this question, we constructed probabilistic models of trophic networks for eight terrestrial vertebrate communities, ranging in age from late Middle Permian to early Middle Triassic, from the Karoo Basin of South Africa, and subjected them to different types of perturbations. Our results indicate that the communities’ extinction resistances are not uniform. For example, the earliest Triassic Lystrosaurus Assemblage Zone community is more resistant to a bottom-up trophic perturbation than any of the other communities. However, the latest Permian Dicynodon Assemblage Zone community is only marginally more vulnerable, indicating that a large disturbance would be necessary to account for observed levels of extinction. These results are significant because they help to focus our searches for potential causes of the end-Permian extinction, and can provide insight into whether mass extinctions have acted over time to increase the extinction-resistance of communities.

**THE EARLIEST PTEROSAURS**

ANDRES, Brian, Yale Dept. of Geology and Geophysics, New Haven, CT

The Triassic record of pterosaurs is limited to five species from central Europe, a species from Greenland, two wing metacarpals from Gloucester, and about 30 isolated tooth elements referred to the pterosaurs. The most complete of these isolated elements are two jaw fragments with in situ teeth from the Dockum Group of Texas. These specimens were found in sediments of Carnian age, whereas, the oldest pterosaur specimens are from the Upper Norian. If these fragments belong to pterosaurs, they would be the oldest known members of this group and extend its range by about ten million years.

These jaw fragments and the other isolated teeth have been referred to the pterosaur *Eudimorphodon*. This taxon is unique among Triassic pterosaurs in having a widespread distribution, even without considering these teeth. *Eudimorphodon* is the only Triassic pterosaur taxon known from more than one described specimen, more than one locality, found on more than one modern continent, and present in both terrestrial and marine sediments of most pterosaurs. The teeth of *Eudimorphodon* are unique among pterosaurs in having a multicuspate morphology of up to five large cusps. However, similar dentition is present in nonmammaliamorph cynodonts of the same time. The isolated teeth are often identified as possibly belonging to one or the other. Study of the two more complete jaw fragments from Texas will help infer on whether these isolated teeth belong to pterosaurs and whether this group is older than previously known.

Analysis of the Texas jaw fragments using Microfocus CT scanning at the University of Amherst Digital Paleolab reveal features that allow the referral of one specimen to the pterosaur *Eudimorphodon*, and the other to the Cynodontia. These specimens highlight the unusual convergence and differences between these two groups. Possible reasons for this level of convergence are explored. Phylogenetic analyses by this and other authors do not recover *Eudimorphodon* as a basal pterosaur taxon. This would imply an unrecorded radiation of pterosaurs in the Carnian or even earlier. A review of the referred isolated teeth reveals that most are cynodonts or other archosauriforms. Some teeth are similar to but lie outside the diversity of the Texas and other *Eudimorphodon* specimens.

**MAMMALS AND MARKER BEDS IN THE WASATCH AND GREEN RIVER FORMATIONS: ECocene BIOSTRATIGRAPHY NEAR FREIGHTER GAP, GREAT DIVIDE BASIN, SOUTHWESTERN WYOMING**

ANEMONE, Robert, Western Michigan Univ., Kalamazoo, MI; WATKINS, Ron, Curtin Univ. of Technology, Perth, Australia; MOORE, Bill, Southern Illinois Univ., Carbondale, IL; STROJIK, Laura, Arizona State Univ., Tempe, AZ

Recent palaeontological investigations in Paleocene and Eocene terrestrial deposits of the Great Divide Basin have greatly increased our knowledge of the evolution of early Tertiary mammals in a previously little-studied sedimentary basin along the continental divide in SW Wyoming. During the past ten summer field seasons we have collected and catalogued 7000 fossil mammals from nearly 80 localities in the Great Divide Basin. The early Tertiary deposits of the Wasatch formation in the SW Wyoming region of the Great Divide Basin contain a number of different communities, the most prominent of which are the Assemblage Zones of the lower Wasatchian and the Anisodon beds of the upper Wasatchian. These formations, along with the surrounding marine succession, provide a unique opportunity to study early Tertiary mammals in a terrestrial setting. The diversity of the fauna recovered from these formations is comparable with that of the more famous faunas of the Miocene of Europe and North America. The fauna recovered from the Wasatch formation is unique in that it is composed almost entirely of small mammals, and includes a number of species that are not found in other parts of the world. This makes the Wasatch formation an ideal location for studying the evolution of early Tertiary mammals.

**AN IMPORTANCE OF REVISlNG OLD COLLECTIONS**

ANQUETIN, Jérémy, The Natural History Museum, London, United Kingdom

Chalicotheres are quite peculiar perissodactyls with large biffed claws instead of hooves and reduced hindlimbs. Members of the subfamily Chalicotheriinae present the most derived morphology among chalicotheres, with extremely reduced hindlimbs, quite elongate forelimbs and a knuckle-walking gait (all converging toward a gorilla-like posture). Miocene chalicotheres from France and Germany were also the first chalicotheres to be described at the beginning of the 1800s. During the main part of the 1900s, it was assumed that there was only one chalicotherine genus throughout the Miocene: *Chalicotherium*. Recently, a new taxon from Greece (*Anisodon macdonaldii*) shed new light on chalicotherine phylogeny and it was proposed that middle and late Miocene taxa should be divided into two genera.

In order to test this hypothesis, I revised historic specimens of *Anisodon grandus* from France (including the first known chalicotherine skull). Some of these remains have not been studied since 1890 and most have never been accurately described. In addition, new remains of *Chalicotherium goldfussi* from Saint-Gaudens, France, are described, including the first known complete mandibular symphysis which indicates that *C. goldfussi* has three incisors. Based on these new data, a cladistic analysis was performed and its results are reported here. The division of middle and late Miocene taxa into two main clades (*Anisodon* and *Chalicotherium*) is strongly supported. Furthermore, this analysis proposes a novel pattern of relationships. *Nestotherium sivalense, C. wudunensis* and *C. goldfussi* from Titov Veles (Macedonia) are no longer close relatives of *C. goldfussi* as previously thought, but rather belong to the genus *Anisodon* and become *A. sivalense, A. wudunensis* and *A*. sp., respectively. Recently described *Kalimantinia* needs to be reviewed to properly assess its relationships and nomenclature.
the specimen is fragmentary, a new taxon closely related to the basal ornithopod *Thescelosaurus* may be represented by the Sustut material.

Poster Session III

**EARLY DIVERSIFICATION OF ICTIOBINES IN NORTH AMERICA AND PATTERNS OF DISTRIBUTION**

ARRATIA, Gloria, Univ. of Kansas, Lawrence, KS; ALVARADO-ORTEGA, Jesús, ALVARADO-ORTEGA, Jesús, Universidade Federal do Rio de Janeiro, Rio de Janeiro, Brazil

The order Cypriniformes with about 3,000 species is the largest clade among extant teleosts. Cypriniformes comprise six extant families: Balitoridae, Catostomidae, Cobitidae, Cyprinidae, Gyrinocheilidae, and Psiilorhynchidae. Among them, the family Catostomidae is represented today by about 14 genera and 80 species occurring in China, northeastern Siberia, and North America. Two catostomid species occur in Asia (*Myoxocypinus asiaticus* and *Catostomus catostomus rostratus*), whereas all other species occur in North America. These include icthyobines (*Carpiodes* with 5 spp. and *Ictiobus* with 3 spp.), cycloptines (*Cycloptus*), and catostomines (*C. catostomus, Moscostra*). Concerning the catostomid fossil record, icthyobines are known from Eocene-to-Recent, cycloptines from Oligocene-to-Recent, and catostomines from Miocene-to-Recent localities. The fossil icthyobines have been assigned to the extant genera *Ictiobus* and *Carpiodes*. Important exceptions are the Asiatic genus *Vasnetzovia* and the genus *Amazon* known from 7 extinct species that have been recovered in middle Eocene-early Oligocene localities in both Asia and North America. New icthyobiain material recently recovered in the Pliocene of Mexico enlarges the morphological knowledge of the group, its content and also the range of geographical distribution of icthyobines in the past. The present contribution describes the early diversification of the icthyobines in comparison with the modern members of the group, and discuss evolutionary morphological trends of icthyobines. Past and present patterns of geographical distribution are reviewed and a possible explanation for the major changes is presented.

Poster Session III

**THE FOSSIL RECORD OF ENDEMIC AFRICAN MAMMALS (AFROTHERIA)**

ASHER, Robert, Museum fuer Naturkunde, Berlin, Germany

The fossil record of placental mammals in Africa does not yet adequately document the evolutionary history of several of its endemic clades. In particular, much of the novelty of the recently named order Afrotheria (tenrecs, golden moles, elephant shrews, aardvarks, hyrax-es, elephants, sea cows) is due in part to the lack of well-known fossils that could be perceived as morphologically intermediate between its ungulate-grade (elephants, sea cows, hyraxes, aardvarks) and insectivoran-grade (tenrecs, golden moles, elephant-shrews) constituents. Yet fossil relatives of all of these living clades exist. Furthermore, current hypotheses of afrotherian interrelationships can form the basis of mutually exclusive predictions regarding what we might recover, eventually, from the African fossil record. In this presentation I examine the bearing of new data on afrotherian fossils and interrelationships in order to make predictions regarding the morphology of common ancestors within the afrotherian radiation.

Poster Session II

**RECOGNITION OF INSECT TRACES ON MODERN AND FOSSIL BONES**

BAKER, Caroline, Washington, DC; GRADY, Frederick, Smithsonian Institution, Washington, DC

A nearly complete though somewhat crushed skull of a Pleistocene tapir was recovered from a cave in Bath County, Virginia. The skull was found with three cervical vertebrae, fragments of thoracic vertebrae, rib parts, a nearly complete scapula, a humerus, and a partial ulna. A second metatarsal was found about four meters away. The skull retains all the deciduous premolars and the first molars are fully erupted and unworn. The parietal bones come together to form a sagittal crest rather than a sagittal suture in the only ontogenetically similar aged Pleistocene tapir skull known. Based on all available measurements, this tapir is identified as *Tapirus veroensis*. All previous finds of Pleistocene tapirs from Virginia have been isolated teeth.

Friday 9:45

**EMBRYONIC ORNITHISCHIAN FROM THE UPPER Cretaceous OF MON- GOLIA**

BALANOFF, Amy, NORELL, Mark, American Museum of Natural History, New York, NY

The fossil record is unique in that it provides a direct window through which we can observe deep-time slices of broad and inclusive patterns that characterize morphological evolution. Because organisms can be thought of as the sum of their space-time slices, the ability to observe, in a fossil, multiple levels of the complex hierarchy through which anatomical variation is expressed (e.g., ontogenetic and phylogenetic) increases the potential for gaining important insights into the evolution of morphological diversity. Ontogenetic data, when clearly available, are directly applicable to important questions such as the evolution of growth rates, the acquisition and polarization of ontological characters, and paleobiological properties of organisms. Immature specimens, however, may be difficult to confidently place within a phylogenetic context because of a lack of recognized apomorphic characters and the difficulty of visualizing sometimes very small and obscured embryonic speci-
The Rhinocerotoidea (Perissodactyla: Ceratomorpha), a large mammalian group appearing early in the Tertiary, achieved widespread geographic, ecological, and taxonomic diversity. The rhino fossil record includes many partial (half) and complete mandibles of genera representing a significant temporal and spatial diversity. The half mandible (including body, angle, ramus, condyle, and coronoid process) is a relatively two-dimensional structure when viewed laterally. As such, it is amenable to 2-D landmark morphometric analyses (splines and outlines) as well as distance methods (bivariate and multivariate ordinations). The functional role of the mandible is dominated by its mechanical participation in supporting the lower grinding tooth row and providing the force and motion of the teeth in chewing. Mandible shape may be hypothesized to include aspects of these mechanical requirements as influence on diet and type of chewing (in addition to historical constraints and accommodation of other evolutionary features like skull size). Fifty-five fossil mandibles represent 15 extinct genera are analysed. Included are Hyrachus, an early small rhinocerotoeid, and Paraceratherium, the largest rhinoceroid. Thirteen specimens of Teleoceras provide a glimpse of intrageneric variation. The four living genera provide a good correlation with known feeding ecology. Ten landmark distances were measured directly on the mandibles to capture aspects of shape included in the parts listed above. Twelve 2-D landmarks were digitized from photographs. The distance and 2-D landmarks sets overlap but are not identical. Preliminary analysis shows that few of the parts are highly intercorrelated, suggesting more “local” control of shape within the mandible. Among the more obvious shape features are the coronoid processes which seem to vary mostly with respect to three aspects (a) length, (b) forward angulation, and (c) the degree of backward curvature to a point by the upper half of the processes. The mechanical significance of these features has yet to be determined.

Poster Session I

ANURANS FROM THE LOWER CRETACEOUS CRATO FORMATION OF BRAZIL: A PRELIMINARY REPORT
BARGOS DE MOURA, Gerald, Universidad Federal de Pernambuco, Recife, Brazil; BAEZ, Ana, Universidad de Buenos Aires, Buenos Aires, Argentina
The Aptian Crato Formation, Araripe Basin, northeastern Brazil, has yielded one of the most significant Early Cretaceous fossil assemblages in the world, being well-known for its taxonomic diversity and remarkable preservation. Plant, invertebrate, and vertebrate remains have been discovered in beds interpreted as representing a lacustrine environment. Herein we describe several anuran specimens recently recovered from the upper limestone beds of the Crato sequence. These remains are mainly characterized by their articulated condition and relative completeness (notably the hindlimbs), suggestive of rapid burial, minimal transport, and absence of post-mortem scavenging. In addition to a pipi morph pipid, at least two neobatrachian taxa are represented, which are the earliest records of Neobatrachia to date. The probable affinities of one of the neobatrachians indicate not only that basal splitting of this group had already occurred, but that the radiation of hylioids was well underway. Other anurans, with possible exceptions of the basalmost morphotypes, are not yet inhabited the paludal marginal areas of the Crato lake. The Crato anuran record contrasts with other known Early Cretaceous anuran faunas, such as that from the Barremian lithographic limestone locality of Las Hoyas in Spain, which include only “archaeobatrachians” but no neobatrachians.

Poster Session I

IMPLICATIONS OF THE PRESENCE OF THE MEGALOSAURUS-THERAN-
GOSPODUS ICNOCOMMATION (THERIPODA) IN THE BERRIASIAN (EARLY CRETACEOUS) OF THE IBERIAN PENINSULA
BARCO, José, Zaragoza, Spain; CANUDO, José, Univ. of Zaragoza, Zaragoza, Spain; CUENCA-BESCOS, Gloria, Univ. of Zaragoza, Zaragoza, Spain; RUIZ-OMEÑACA, José, MUJA, Colunga, Spain
The Megalosaurus-Therangosporus ichnocommation (M-Ti) is characterized by the presence of these two ichnogenera. They are well documented in the Late Jurassic of North America and Asia, and has been considered a good biostratigraphic marker for this time interval. The presence of M-Ti in sediments of the Berriasian Huértelas Alloformation (Soria) suggests that the deposit could be Late Jurassic. Our studies also recognize the M-Ti in the Villar del Arzobispo Fm (Teruel) dated with foraminifers as Early-Middle Berriasian. This does not detract from its biostratigraphical value but allows us to extend its upper limit as far as the Berriasian, at least in this region of the Iberian Plate. Since the theropod ichnological record at the base of the Cretaceous grows, it is possible that M-Ti’s will be discovered in other parts of Laurasia. However, there is another possible interpretation for this presence within a new and interesting panorama. The break-up of Pangaea at the end of the Late Jurassic brought the separation of the faunas of Laurasia and Gondwana, producing biogeographic isolation among them, as was the case with the Late Jurassic-earliest Cretaceous saurophods of East Africa. The theropod skeletal record currently discovered is fragmentary and fails to shed light upon this issue. Tracks, by contrast, provide more information: the presence of the “jurassic” theropods of the M-Ti at the base of the Early Cretaceous might also be explained in terms of the presence of endemic faunas that survived through to the beginning of the Cretaceous in some parts of the archipelago formed by the lands emerged at south Europe.

Poster Session II

REPTILIAN FAUNAS FROM THE MAASICHTHIAN PHOSPHATES OF MOROCCO
BARDET, Nathalie, PARIS, France; PEREDA-SUBERBOL, Xiaier, Universidad del Pais Vasco, Facultad de Ciencia y Tecnologia, Departamento de Estratigrafia y Paleontologia, Bilbao, Spain; JOUVE, Stéphane, JALIL, Nour-Eddine, Cadi Ayyad Univ., Faculty of Sciences Semlalia, Dept. of Earth Sciences, Marrakech, Morocco; BOUYA, Bâlidi, Office Chirifien des Phosphates, Khouribga, Morocco
The Upper Cretaceous-middle Eocene (Maastichtian to Lutetian) phosphatic deposits of Morocco (i.e. Oulad Abdou and Gantour basins) are well known by very rich and diversified vertebrate faunas, including selachians, bony fishes, marine reptiles, dinosaurs, pterosaurs, mammals and marine birds. Since the pioneer work of Arambourg in the 1950’s, only selachians have received scientific attention because of their biostratigraphical utility. Recently, an active collaboration between the Office Chirifien des Phosphates (Morocco), the Ministère de l’Energie et des Mines (Morocco) and the Centre National de la Recherche Scientifique (France), has lead to extensive field work and a very rich collection has been accumulated. A great number of well preserved and articulated specimens have been collected, contrasting with the isolated and fragmentary remains previously known.

The Maastichtian phosphatic outcrops have yielded one of the most diverse mosasaur fauna of the world. It consists of Mosasaurus beauegi, Platecarpus pychodon, Prognaothorax crassispinis, Globidens phosphaticus, Halisaurus arambourgi, Prognathodon sp. (Mosasaurus cf. Leidion aniceps of Arambourg) and, tentatively, Carinodens belgicus. This assemblage is typical of the southern margin of the Mediterranean Tethys. Marine reptiles also include the varanoid squamate Pachyvaranus crassispinis, a new elasmosaurid pleiosaur, both bothrymyd and chelonioid turtles, and very scarce remains of dyrosaurid, gavialoid and euxusian crocodyliformes. Continental reptiles are also found in this shallow marine environment. They consist of the eutharchid pterosaur Phasphrophaco mauritanicus and saurischian dinosaurs, including a ceratasaurian theropod and a titanosauriform sauropod.

Neoceti Symposium, Saturday 11:00
THE FAMILY AETIOCETIDAE AS A MODEL FOR EVOLUTION OF STEM MYSCETI
BARNES, Lawrence, Natural History Museum of Los Angeles County, Los Angeles, CA; GOEDERT, James, Univ. of Washington, Wauna, WA
The tooth-bearing family of primitive mysticete whales, the Aetiocetidae is, with many new discoveries, becoming recognized as increasingly diverse both morphologically and taxonomically. The family is limited to Oligocene occurrences, and all documented aetio- ceteids are from the North Pacific realm. Four subfamilies can be recognized within the family, three named and one un-named. The subfamily Chonectidae are stem aetioceti, with elongate skulls and the eutherian dental formula. The Morawanocetidae are divergent aetioceti with wide crania, elaborate cheek tooth columns, and short necks. The Aetiocetinae, the longest-surviving clade of aetioceti, are characterized by simplified cheek tooth columns, and polydonty in some derived taxa. Character analyses indicate that Aetiocetidae were derived from Archaeoceti, although there probably were as-yet unnamed, intermediate, family-level taxa. No known aetiocetid can be demonstrated to have had baleen, and all taxa are younger geochronologically than the earliest-occurring baleen-bearing mysticeti. The Aetiocetidae are, however, a model for the evolutionary stages between the Archaeoceti and the baleen-bearing Mysticeti.

Friday 9:45
THE ROLE OF VERTEBRATE PALEONTOLOGY IN FORECASTING FUTURE ECOLOGICAL CHANGE
BARNOSKY, Anthony, Univ. of California, Berkeley, CA
Sustaining ecosystem dynamics and services is one of the most critical issues facing human-
from the Lujiatun Beds of the Yixian Formation (Barremian: MN1 and at the base of MN2. 
aff. shares a number of synapomorphies probably ranges from MP30 (latest Oligocene) with is still represent- and pongines (orang-Germany. 
Lamilloque (France), mammal zone MP29, at the beginning of a Late Oligocene regional diversity, it is represented by three species (Neocetus). We report the discovery of a skull of a juvenile rhinocerotid from the Swiss locality of BÜRGIN, Toni, OBERLI, Urs, Naturmuseum St. Gallen, St. Gallen, Switzerland ICS, BIOSTRATIGRAPHY AND PALEOBIOGEOGRAPHY DAE) FROM THE AQUITANIAN MOLASSE OF SWITZERLAND: SYSTEMAT-
A JUVENILE SKULL OF Psittacosaurus 


diagnosing the rusty-waterfall phenomenon as the most likely explanation of the abrupt transitions to alternative ecosystem states. Here I use data compiled from FAUNMAP, MIOMAP, individual Pleistocene and Miocene localities, and modern fauna of the American West to examine the ‘ecological baseline’ of mammalian communities at varying spatial and temporal scales. Methods include constructing species-area curves for various regions and time-slices, locally tracking species richness through time within size and trophic categories, and examining abundance patterns through time and space. Results are used to forecast how (or if) basic features of mammalian communities might be expected to change over the next century or so, or, given projected rates of global change.

Friday 11:00 EVIDENCE FOR POST-NESTLING GREGARIOUS BEHAVIOUR IN THE BASAL 
CECOTRANS Dinosaur Psittacosaurus BARRETT, Paul, The Natural History Museum, London, United Kingdom; ZHAO, Qi, Institute of Vertebrate Palaeontology and Paleoanthropology, Beijing, China Elaborate cranial ornamentation (horns, frills) and evidence from paucispeciﬁc bonebeds indicate that many neoceratopsian dinosaurs had complex social behaviours, including living in herds and intraspeciﬁc display. However, many of these features are unknown or poorly developed in basal ceratopsians, which have relatively unadorned skulls and do not occur in bonebeds. Here, we report an exceptionally preserved group of the basalmost ceratop-
sian dinosaur Psittacosaurus from the Lujiatun Beds of the Yixian Formation (Barremian: Lower Cretaceous) in Liaoning, People’s Republic of China. The specimen consists of six juvenile individuals that were apparently killed in a mass mortality event. Developmental Mass Extrapolation permits reconstruction of the age profile of this group: the youngest individual was aged just over four years old, whereas the oldest was just under three years old. This proﬁle is consistent with the presence of individuals from several different clutches within the same group and suggests that Psittacosaurus lived in small stable herds including several age classes. We interpret this as the ﬁrst evidence of post-nesting gregarious behaviour in a basal ceratopsian. This indicates that potentially complex social behaviours emerged early in the evolutionary his-
tory of the clade and preceded the appearance of the spectacular cranial ornamentation that characterises neoceratopsians.

Neoceti Symposium, Saturday 8:30 THE ORIGINS OF REPETITIVE DEEP DIVING IN THE NEOCETI: EVIDENCE FROM AVASCULAR NECROSIS BEATTY, Brian, Univ. of Chicago, Chicago, IL; ROTHSCILD, Bruce, Arthritis-Center of Ohio, Rootstown, OH Most modern whales repetitively dive deep to feed and should be susceptible to decompres-
sion syndrome, though they are not known to suffer the symptoms associated pathologies. Avascular necrosis has been recognized as an indicator of diving habits of extinct marine amniotes. Vertebrate of 331 individual modern and 996 fossils whales were subjected to macroscopic and radiographic examination. Avascular necrosis was found in some speciﬁcs of Odontoceti (Lophorhynchus) and in some geologically younger mysticetes, including specimens of Aegyptis (considered a sister-taxa to Balaenopteridae + Eschrichtiidae clade by some). These are likely representative of early “experiments” in repetitive deep diving before the development of diving physiology, indicating that the Odontoceti and Mysticeti may have independently converged on their similar, yet different, specialized diving physiologies.

Poster Session III A JUVENILE SKULL OF Diacertatherium lemanense (RHINOCEROTI-
DAE) FROM THE AQUITANIAN MOLASSE OF SWITZERLAND: SYSTEMAT-
ICS, BIOSTRATIGRAPHY AND PALEOBIOGEOGRAPHY BECKER, Damien, Section d’archéologie et paléontologie, Porrentruy, Switzerland; BÜRGIN, Toni, OBERLI, Urs, Naturmuseum St. Gallen, St. Gallen, Switzerland. We report the discovery of the skull of a juvenile of Diaceratherium lema-

and in France, whereas the genus disappears in Germany in MN3 and in Switzerland in MN4. At the end of MN4 (latest Early Miocene), just after the Proboscidean event, Dicraeotherium definitively disappears to be replaced in MN5 by the ﬁrst true European 

Saturday 3:30 REVISION OF THE DRYOPITHECIN BEGIN, David, Univ. of Toronto, Toronto, ON, Canada Dryopithecus is one of the ﬁrst fossil genera to be recognized as a great ape ancestor, and has been central in debates about hominoid evolution since the mid 19th century. Currently, four species of Dryopithecus are recognized. Moya Solà et al. (2005) describe a new genus, Pierolapithecus, which they think is related to Dryopithecus and pongines (orang-

Friday 10:30 POST-MORTEM DAMAGE TO BONE SURFACES IN THE MODERN LAND-
SCAPE ASSEMBLAGE OF AMBOSELI PARK, KENYA, WITH IMPLICATIONS FOR THE FOSSIL RECORD BEHRENSMAYER, Anna, Washington, DC; FAITH, J. Tyler, George Washington Univ., Washington, DC Modern bones in subaerial environments acquire evidence for surface exposure in the form of weathering, abrasion, insect damage, trample marks, rodent gnawing, and other features that can be used to interpret pre-burial taphonomic history in fossils. These types of dam-
gage accumulate over the post-mortem “lifetime” of a bone and differ from early post-
mortem damage caused by large predators and scavengers. In general, once flesh-eaters and/or bone-consumers have processed a carcass, any remaining bones disintegrate over years to decades unless they are buried. Damage acquired during the period of exposure can be taphonomically and ecologically informative, but diagnostic evidence for the agents responsible is usually preserved only on weathered to lightly weathered bone surfaces. Mammalian carcasses documented in Amboseli Park, Kenya, since 1975 show that bones of ungulates 150 kg and larger can survive for several decades on the soil surface in a semi-arid, tropical ecosystem. Bone surfaces capable of preserving trace fossils usually weather away in less than a few years, leaving traces that deﬁning a limited time span when burial must occur in order to preserve informative post-mortem surface damage. Progressive weathering stages relate to increasing years since death, allowing estimates for how long a fossil bone was exposed on the surface prior to burial. There are signiﬁcant error-bars on these esti-
mates because weathering rates also depend on body size and the degree of exposure to sun and moisture in micro-environments where bones occur. Applying modern weathering stages to fossils is problematic because weathering features can be obscured or mimicked by diagenesis or altered by preparation techniques. Nevertheless, it often is possible to sep-
ate completely unweathered fossil bones from those in early vs. later weathering stages. This three-part categorization provides a useful framework for examining pre-burial tapho-
nomic history in fossil bone assemblages.

Friday 12:00 THE IMPACT OF THE SPOTTED HYAENA, CROCUTA CROCUTA AS A TAPHO-
NOMIC BIAS IN THE LARGE MAMMAL BIODIVERSITY PATTERNS OVER 300 KY IN UBEIDIYA (ISRAEL) AS ITS IMPLICATIONS TO PALEOEOLOGICAL RESEARCH BELMAKER, Miriam, Harvard University, Cambridge, MA. Theories have emphasized the importance of climate change in the formation of fossil faunas as opposed to biotic factors. Distinguishing between such hypotheses requires in depth analyses of faunal communities over various temporal and spatial scales. Faunal communities derived from fossil assemblages are subjected to a wide variety of taphonom-
ic processes which may alter their composition compared to the living populations. This study presents a paleoecological and taphonomic analysis of six successive mammalian fossil assemblages from the Pleistocene site of U’beidiya (Israel) spanning ca. 300 Ka. Results indicate that despite geomorphological evidence for local climatic change, the observed changes in the biodiversity of the mammalian community may be attributed to taphonomic bias. The accumulation behavior of the spotted hyaena, Crocuta crocuta, and the prefer-
ences towards specific prey, best explains the changes in presence absence of taxa, abun-
dance of small/medium cervid and biodiversity indices patterns through time at the site.

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Poster Session II

NEW DATA FROM THE CONTINENTAL LATE CRETACEOUS FAUNAS FROM NORTHERN MEXICO

BENAMMI, Mouselud, Instituto de Geofisica, UNAM, Mexico; MONTELLANO-BALLESTEROS, Marisol, Instituto de Geologia, UNAM, Mexico

During recent years field work had been carried out in the continental and transitional marine Late Cretaceous deposits in the northern areas of the states of Coahuila and Chihuahua. As a result several fossiliferous sites bearing dinosaur, other vertebrates and plant remains had been located. Sediment for screen-washing was collected and microvertebrates were recovered.

The geological framework in this area is practically unknown. To determine the stratigraphic position of each fossiliferous site, five sections were established. A marine section represents the lowest part and it is characterized by alternating calcareous shale, shale, silty shale and phosphate nodule facies with interbedded sandstones. The sandstone layers yield poorly preserved gastropods and bivalves, and well preserved shark teeth. The continental section is characterized by a sequence of variegated mudstones and sandstones with conglomeratic lagers of paleo-caliche nodules, it suggests a fluvial environment in a deltaic coastal plain and inland floodplain. There is no evidence of faulting or folding.

Samples were collected from the five sections for magnetostratigraphic analysis. All of them showed normal polarity which correlates to the Chron C33n.In and corresponds to the upper Campanian age. It is interesting to mention that ceratoid remains identified as Chasmosaurus mariscalis are stratigraphically in higher position than titanosaurid remains. This is contrary to the order present in the Big Bend National Park, Texas. The record of the titanosaurid supports the hypothesis that the group was present during the Campanian in North America. The ceratoid record is congruent with the age suggested by the magnetostratigraphy results. This new geological information and that provided by the fossils will help to establish a more detail correlation ship with the Late Cretaceous outcrops of the Big Bend National Park.

Thursday 2:30

ARTICULATION AND FUNCTION OF THE PTEROID BONE OF PTEROSAURS

BENNETT, S., Fort Hays State Univ., Hays, KS

For over 100 years most pterosaur workers have accepted the traditional reconstruction of the pteroid, articulated in the fovea of the preaxial carpal and directed medially along the anterior margin of a small propatagium in order to control it. A few workers have rejected the traditional reconstruction and advocated an alternative reconstruction with the pteroid directed anteriorly, spreading and controlling a large propatagium extending as far laterally as the second interphalangeal joint of the wingfinger. Recently they argued that the fossil record does not provide sufficient information to resolve the debate about pteroid function; however, that is incorrect.

Some articulated specimens of Eudimorphodon, Petrosaurus, Dorygnathus, Rhamphorynchus, Pterodactylus, Anhanguera, and Pteranodon preserve a sessile asso- ciation with the tendon of M. extensor carpi ulnaris in the fovea of the preaxial carpal, and thus the preaxial carpal acted as a strut to increase the leverage of M. extensor carpi ulnaris for wrist extension. No specimen preserves the pteroid articulated in the fovea, and because the sessile association there the pteroid could not. Therefore, both the traditional and alternative reconstructions, which are based on the assumption that the pteroid articulated in the fovea, are falsified. The pteroid did articulate with the preaxial carpal, but because there is much variation in the morphology of the articular end of pteroid there is also much variation in the location and manner of articulation. In both Pteranodon and Anhanguera, the pteroid articulated with the medial side of the carpal, but whereas in Pteranodon, the articulation was a loose ball and socket joint, in Anhanguera it was a saddle joint. In Nyctosaurus, the pteroid articulated with the ventral side of the carpal. In those taxa, the pteroid can only be articulated when directed medially to control a small propatagium, and could be extended and depressed to increase wing area, camber, and lift or flexed to fold the propatagium. Thus, the traditional reconstruction of the pteroid articulation is incorrect, the traditional view of pteroid function is correct.

Thursday 1:30

MULTIPHASIC ALLOMETRIC ANALYSIS IN LIONS (PANTHERA LEO): LIFE HISTORY EXPRESSED THROUGH MORPHOMETRICS

BENOIT, Matthew, Yale Univ., New Haven, CT

Lions (Panthera leo) are the only social-living felids alive today. They have complex pride structures and life histories that reflect a great deal of behavioral modification in order to allow for group living. These life histories have been studied extensively, and ontogenetic studies of lions have attributed a great deal of knowledge to our understanding of their development. However, few researchers have examined how these life histories may be expressed in the skeletal features of lions (the only features that survive in the fossil record).

I took 34 measurements from 94 lion skulls using a Microscribe G2X 3D digitizer. The age range of the lions spanned from a few days postnatal to old adults. I plotted the logged measurements of each feature against the logged skull length (LOGSKL, a proxy for developmental age). For each set of data, several multiphasic regressions were run allowing for increasing numbers of phases. While correlations tend to rise with more phases, I used the Model Selection Criterion (MSC, an adaptation of Akaike’s Information Criterion) to determine which multiphasic regression best fit the data.

Braincase width (BCW) showed a highly correlated (r² = 0.98) growth allometry with three phases (MSC = 3.77). The first phase captures brain growth in early postnatal developmental. The second phase shows a period of relative inactivity. The third and final phase, however, shows an increase in growth rate of the braincase width. This growth does not reflect growth of the brain, but rather a thickening of the braincase itself. This final growth phase begins shortly before the age of subadult dispersal from natal prides. Dispersal is usually forced by invading adult males, who kill any subadults that cannot defend themselves and drive out those that can. The implications of this growth pattern in such a life history are discussed.

Student Poster Session

THE TAXONOMY, SYSTEMATICS AND EVOLUTION OF THE BRITISH THEROPOD DINOSAUR, MEGALOSAURUS

BENSON, Roger, Univ. of Cambridge, Cambridge, United Kingdom

Megalosaurus, a theropod dinosaur from the Bathonian of Oxfordshire, was the first dinosaur to be formally named and described. Since its original description at least 38 species have been referred to the genus, spanning a temporal range from the Late Triassic to the Late Cretaceous. Much of this material has subsequently been transferred to other genera (representing a wide range of theropod groups) or represents nominadubia. Of the remaining material very little is unambiguously referable to the genus. A tentative list of the type species, Megalosaurus bucklandii. The remainder of the syntype series is not formally associated with this specimen and recent suggestions that more than one species of large theropod is represented in the Stonesfield fauna have cast doubt on the taxonomic assignment of this material. Most recent authors who have commented on the genus agree that a major revision is long overdue and it has been suggested that its retention obscures the diversity of Middle Jurassic European theropods.

Recent finds of relatively complete material of basal tetanurans and allosaurids from England, France, Portugal, Argentina, Antarctica, China and Japan are difficult to fit into a phylogenetic framework due to the outdated legacy of megalosaurus taxonomy, which clouds our understanding of character evolution along the lineage leading to derived coelurosaur clades (including Aves) making reliable diagnosis of higher-level taxa difficult. I am currently engaged in a comprehensive revision of all material that has been referred to Megalosaurus in order to clarify the taxonomy and systematics of the genus. I will be using this opportunity to present some of my initial findings.

Poster Session II

DATA CHECKS AND OTHER TYPES OF DATA COLLECTION STRATEGIES: TWO CASE STUDIES AT BADLANDS NATIONAL PARK

BENTON, Rachel, National Park Service, Interior, SD; HARGRAVE, Reko, Science Applications International Corporation (SAIC), Norman, OK

Two paleontological field projects at Badlands National Park provide important examples of the use of data checks in paleontological field collection. Both of these projects have lasted for several years and have included a large number of participants. The Big Pig Dig was discovered in 1993 and has been operating for over 12 field seasons. During the past 6 years, park staff and partners have also completed 2 major paleontological field surveys which documented several new paleontological localities within the park. To provide consistency in data collection, detailed protocols for note taking, excavation, grid setup and total station operation have been drafted for both the Pig Dig and the field surveys. Often one mode of data collection is not entirely reliable. For example, at the Pig Dig, both a total station and grid measurements are collected to document the position of each bone found at the site. Total station readings are constantly compared with associated grid locations. At the beginning of each mapping session, 3 reference points are taken to determine any potential errors during data collection. Data is exported into Arcview on a weekly basis to track any potential errors. During field surveys, both GPS (Global Positioning System) units and high resolution aerial photos are used to document new paleontological localities.

Due to the dissected nature of the badlands topography, satellite signals can not always be received. Localities can be marked on aerial photos and digitized into Arcview. Because shape files are generated for both the paleontological field surveys and quarry collection, detailed metadata is developed to document all aspects of GPS and GIS (Geographic Information System) data collection. Metadata provides a way to document the type of equipment and software used, gives details on data collection methods and lists any type of problems encountered and their subsequent resolution. It also includes a listing of people involved and their contact information. Because paleontological locality data can be highly sensitive, metadata includes a discussion on data access and recommended security levels.

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Mysticete phylogeny: the role of stem taxa and character evolution in the transition to modern mysticetes.

BERTA, Annalisa, San Diego State Univ, San Diego, CA; McGOWEN, M., GATESY, J., Univ. of California, Riverside, Riverside, CA; DEMÉRÉ, T., San Diego Natural History Museum, San Diego, CA

We report results of our study on the phylogeny of mysticetes. A total evidence analysis included 30 taxa (19 extinct, 11 extant) and ~27,000 characters. We found a monophyletic Mysticeti and Neobalaenidae + Balaenidae positioned as successive sister taxa to Eschrichtiidae + Balaenopteridae. Several well substantiated relationships among extinct taxa emerged from our analyses: 1) a toothed mysticete clade composed of monophyletic Aetiocetidae and Mammalodon assumed a basal position; 2) Eomysticetidae robustly grouped with other edentulous taxa; and 3) "cetotheres" diverged between Eomysticetidae and modern lineages.

To explore the role of stem taxa, and document key evolutionary changes in the skull and mandible, we optimized morphological characters onto our most parsimonious tree. The anterior position of the nares, elongate nasals, dorsally placed supraorbital processes, and mandible, we optimized morphological characters onto our most parsimonious tree. Long intertemporal parietal exposure, and flat palate with teeth in acteisodects reflects their dorudontine ancestry. A key transformation in later diverging mysticetes involved expansion of the volume of the oral cavity. Modern mysticetes rely on cranial, rostral and mandibular kinesis to accommodate the increased volume of the oral cavity. Acteisodects possess features associated with mandibular kinesis (e.g. ligamentous mandibular symphysis) but lack features associated with kinesis of the rostrum (e.g. lack of fusion between maxilla and premaxilla) and cranium (e.g. lack of fusion between maxilla and vomer, maxilla and frontal and maxilla and palatine) seen in modern mysticetes. The stem edentulous mysticete Eomysticus exhibits rostral kinesis and may possess some features of cranial kinesis, although the latter cannot be confirmed due to poor preservation. Character optimization suggests that mandibular kinesis was present 30 Ma. Rostral kinesis evolved by 28 Ma and this same date marks the initial evolutionary loss of the adult dentition. Cranial kinesis was present in "cetotheres" (e.g. Cophocetus, Pelocetus, Parietobalaenula) by at least the middle Miocene (15 Ma). Advanced cranial kinesis developed later (10 Ma) in stem balaenopterids.

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POSTNATAL ONTOGENETIC CHANGES IN THE CRANIUM OF VARANUS EXANTHETICUS WITH COMPARISONS TO OTHER VARANOIDS AND APPLICATIONS TO THE FOSSIL RECORD

BHULLAR, Bhart-Anjan, The Univ. of Texas at Austin, Austin, TX

Fossils are anatomically incompletely both because many structures are not preserved and because the generally low sample sizes of fossil taxa preclude the dense sampling of anatomical variation that collections of extant taxa or repeated examination of individual living organisms provide. Diagnoses and phylogenetic analyses commonly use a vaguely-defined “adult” stage for comparative purposes although anatomy changes throughout the life of an organism. In order to securely refer fossils at different ontogenetic stages to clades and to examine the full four-dimensional span of anatomy across vertebrates, data concerning the ontogeny of extant taxa are required.

The problems are compounded by the technical difficulty of making a ontogenetic comparative timeframe, and its full ontogeny needs documentation. Though a number of general ideas exist of the ways in which skulls vary through ontogeny, there is remarkably little documentation of this variation, especially postnatal variation, and many of the existing data lack an explicit phylogenetic context. Thus, the postnatal ontogeny of the skull within Varaanoidea, a lizard clade with a good fossil record, was examined by bracketing the clade using a dense sample (five size stages) of Varanus exanthematicus and sparser samples of Varanus salvator and both extant species of Heloderma. Changes in individual elements were emphasized in order to cover cranial osteology thoroughly and to apply the data to fragmentary and disarticulated fossils. Variation throughout postnatal ontogeny was found, especially in the braincase, but also in the remainder of the cranium and the dentition. This variation included character state transitions from plesiomorphic to apomorphic at different levels, which would affect phylogenetic analysis, including specimen diagnosis. Systematic differences in ontogenetic variation were also found within a clade. Finally, brains of extant and fossil members of the ophidian lineages were examined to determine if it was satisfactory as a first step in holding the log substance together. Following that, the very porous material was further consolidated by penetrating the structure with a 5% solution of Butvar B-90 in an ethanol carrier solvent. Plaster was injected under the log to fill the cavity between the log and its casing that had formed by loss of sand in transit. The log in its casing was placed on a metal supporting frame to facilitate moving it in the future.

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TEMPORAL VARIATION IN TOOTH FRACUURE AND TOOTH WEAR AMONG RANCHO LA BREA SABERTOOTHED CATS

BINDER, Wendy, Loyola Marymount Univ., Los Angeles, CA; VAN VALKENBURGH, Blaire, UCLA, Los Angeles, CA

Several extinct carnivores preserved in the late Pleistocene Rancho La Brea deposits display variations in tooth wear and fracture patterns. These fractures were categorized into a series of 5 stages. Most of the cats were assigned to a stage diplomatically. This could be of interest if an individual stage were associated with a specific taxon or diet. We were interested in understanding the pattern of tooth wear and fracture in the sabertoothed cat Smilodon fatalis. Unlike many species of canids, felids, especially sabertoothed cats, are classified as hypercarnivores. We were interested in how a hypercarnivore would compare to a more omnivorous carnivore in terms of tooth wear and breakage, as canid diets tend to include harder items such as bone. S. fatalis in Pit 3 had significantly more fractured teeth than in Pit 61/67. However, contrary to the dire wolves, the cats did not also exhibit significantly heavier tooth wear. To eliminate the possible effects of individual age and of tooth fracture, we estimated individual age of S. fatalis from pulp cavity dimensions of lower canine teeth. Like the C. dirus sample, pulp cavity analysis indicated no significant difference between pits in the age structure of the preserved populations. These results indicate a decoupling between tooth breakage and
wear for S. fatalis. At times, the big cats may have been under pressure to more fully utilize carcasses (consume bone) resulting in increased tooth breakage, but their diets as a whole did not shift to greater bone consumption and associated heavier tooth wear.

Poster Session II

LATE QUATERNARY MAMMALIAN FAUNA FROM HERRING PARK CAVE, SOUTH PARK, CENTRAL COLORADO
BLACK, Victoria, Northern Arizona Univ. Dept. of Geology, Flagstaff, AZ
Herring Park Cave is a small overhang located in the Mosquito Range, bordering the southwestern edge of South Park, central Colorado. The surrounding area today consists of montane grasslands and forests with Ponderosa and bristlecone pine. Remains from the deposit include modern Bison, which have been extirpated from the area since the 1880s. Other remains consist of mostly rodents, including Neotoma, Microtus, and several species of Sciuridae. Lagomorphs and small carnivores are also present. A charcoal layer taken from near the bottom of the excavation was radiocarbon dated at 130 ± 60 years BP, placing the deposit during the late Quaternary. Site taphonomy at Herring Park Cave is complex, with at least two taphonomic agents depositing bone at the site: (1) Neotoma and (2) raptor. This study provides the first baseline examination of a late Holocene faunal community in central Colorado.

Poster Session III

NEW MAMMAL-BEARING QUARRY FROM THE EARLIEST TIFFANIAN (EARLY LATE PALEOCENE) OF THE EASTERN CRAZY MOUNTAINS BASIN, MONTANA
BLOCH, Jonathan, Univ. of Florida, Gainesville, FL; BOYER, Doug, KRAUSE, David, Stony Brook Univ., Stony Brook, NY
A new earliest Tiffanian mammal-bearing quarry, Donald Quarry (Q), was discovered during a Florida Museum of Natural History-Stony Brook University field expedition in the eastern Crazy Mountains Basin (CMB) during the summer of 2005. Preliminary excavations yielding at least 16 mammalian jaw fragments and 109 isolated teeth. Fossils are concentrated in 10-20 cm thick grey mudstone lenses that bear freshwater mollusks and amber, and have patchy exposure laterally, over 140 meters of outcrop. To date, 30 mammal species have been identified. These include, but are not limited to, multituberculates (Ancomodon, Neoplagiaulax, Ptilodus), pantolestids (Aphrornurus, Paleostomus, Propalaeosinopa), a cimolestid (Acmoeadon), “pleiadiforms” (Elphidostaristes, Ignacius, Nannodontes, Palaeocheta, Picrodus), “condylarth” (Ectocion, Phenaodus, Promioclanus, Thryptodon, Chucrius), a large viverravid carnivoran, and a didelphid marsupial (Peradectes).

Prior to the discovery of Donald Q, Bingo Q was the lowest richest fossiliferous site in the Melville Formation, and the oldest quarry with mammals indicating a Tiffanian (Ti) age. So far, Donald Q is the only Ti locality and the only one in the CMB. Donald Q extends the record of Ti mammals (Nannodontes, Ectocion, and Aphrornurus ariei) to ~75 m below Bingo Q. This narrows the stratigraphic distance between the lowest Ti site and the highest Torrejonian (To) site (Kansas Q) to ~100 m, and substantially improves stratigraphic resolution from well-sampled localities in this critical interval of the eastern CMB. Additionally, paleomagnetic analysis indicates a reversed field orientation that can be attributed to Chron C27r, and limits the numerical age of this interval of the eastern CMB. Ali, 169.9 Ma. Similarities among Donald Q, Bingo Q, the Bangtail locality, and others (peritrochon, Acmoeadon, a small pamelomerycid, and presence of Ectocion with relatively large premolars) correspond to differences with Douglass Q (type locality for Ti), suggesting an extended “transitional To-Ti” faunal zone.

Wednesday 8:15

RESPONSE OF GROUND SQUIRRELS (SPERMOPHILUS BEECHEYI) TO THE LAST 20,000 YEARS OF ENVIRONMENTAL VARIATION
BLOIS, Jessica, FERANC, Robert, HADDILL, Elizabeth, Stanford Univ., Stanford, CA
Body size change is a common response to habitat variability in small mammals and can indicate both ecological and evolutionary responses to fluctuations in the environment. Mammals generally react to temperature directly or indirectly through response to vegetation change, and body size tracks these forces in different ways. For example, using Bergmann’s Rule as a theoretical framework, body size should decrease with increasing temperature if mammals respond directly to climatic warming. However, if mammals respond to vegetation changes, we expect a more individualistic response based on the natural history of the organism and the nature of the vegetation change. One of the most dramatic periods of environmental change to affect extant animals was the Pleistocene-Holocene transition. Many environmental changes occurred during this transition, including climatic warming and vegetation change (potentially caused by both climate change and megafaunal extinction). In order to reveal how the ground squirrel, Spermophilus beecheyi, responds to climate, we quantified diastemal length and mandibular tooththrow length on two temporal groups of specimens: museum specimens dated to the last Glacial Maximum from two caves in northern California (Samwel and Potter Creek Caves) and modern museum specimens from throughout the range of this species. First, we found that ground squirrels conform to Bergmann’s Rule using modern populations distributed along a latitudinal gradient throughout California. We then quantified the amount of body size change over the past 20,000 years to determine the extent and direction of body size evolution. Our data will provide us with clear predictions for the response of these mammalian survivors of the Pleistocene extinction event to future global warming.

Poster Session II

A NEW MARINE VERTEBRATE ASSEMBLAGE FROM THE LATE NEOGENE PURISIMA FORMATION AT POMPONIO STATE BEACH, CALIFORNIA
BOESSENECKER, Robert, Montana State Univ. Bozeman, MT
The late Neogene marine Purisima Formation of central California is a series of marine sandstones and siltstones representing shoreline to continental slope depositional settings. The formation outcrops in numerous tectonic blocks from Santa Cruz to Point Reyes, California. The Purisima Formation exposures at Pomponio State Beach (PSB) comprise 7 km of a 25 km section of coastal cliffs; deposits at PSB lie within the Pigeon Point block, bounded by the San Gregorio fault to the east. The rocks here have traditionally been mapped as the late Miocene (5-6 Ma) Tahan Member of the Purisima Formation. However, an ash bed here has previously been correlated with the late Pliocene (2.5ma) Ishi Tuff. Researchers have questioned both age determinations. Preliminary results of palaeontological research at PSB have recorded seven elasmostrenches (Squatinus, Cethorhinas, Carcharodus, Iurus, Sphyrna, Dasyatis, and calcified skeletal elements of an unidentified batoïd), one teleost (Thunnus), a flightless avian (Manucilla), otidid bones referred to Thalassocetus, indeterminate odontocete vertebrae, and cranial elements of a balaenopterid whale near Plesiosuctes. The composition of the assemblage reinforces previous interpretations that the Purisima Formation at PSB represents middle shelf depositional settings. The presence of the stingray, Dasyatis centroura, is the first record outside its modern Atlantic distribution; this occurrence may have paleoecologic and biogeographic implications.

Several vertebrate taxa allow a refinement of previous age determinations for the Purisima Formation at PSB. Vertebrate taxa from PSB are indicative of an early to late Pliocene (4.5-2ma) age. This new data will aid in understanding the stratigraphic relations of Purisima Formation deposits on either side of the San Gregorio fault.

Wednesday 10:45

FOSSIL 10-45 POPATAMIADAE AND SUIDAE FROM TOROS-MÉNALLA, CHAD, CENTRAL AFRICA: OUTLINING LATE MIocene BIOPROVINCIALISM IN AFRICA
BOISERIE, Jean-Renaud, Museum National d’Histoire Naturelle, Paris Cedex 05, France; VIGNAUD, Patrick, BRUNET, Michel, Université de Poitiers, Poitiers Cedex, France; MACKAYE, Hassane Taisso, LIKIUS, Andossa, Université de N’Djaména, N’Djaména, Chad
Toros-Ménalla (TM) forms a large area located in the Djourab desert, about 600 km NNE from Lake Chad. This locality is formed by several hundred fossiliferous sandstone patches isolated by modern sand dunes. Since 1997, the Mission Paléoanthropologique Franco-Tchadienne (MPT) unearthed at TM more than 8,000 fossils of vertebrates, mostly from a sedimentary facies named ‘Anthracotheriid Unit’ (AU). The AU fauna notably associates the anthracotheriid Lycobosaurus, a very primitive Lasiodonta, the early hominid Sahelanthropus. The AU was biologically correlated to the lower Member of the Navata Formation at Lothagam, Kenya. Thus the AU provided unique evidence for African vertebrate diversity and biogeography during the late Miocene, particularly for hippopotamids and suids. Among the AU vertebrates, the hippopotamid Hexaprotodon gayrum is the most commonly collected species, with more than 1,500 specimens. This species is slightly larger than the extant H. amphibius and P. gomphotherium, with consequences on their pelvic and mandibular features, whereas its mandibular anatomy recalls the Asian Neogene Hexaprotodon. A smaller hippopotamid is associated with H. gayrum, but, being extremely rare, its affinities remain uncertain. Suids are represented by a primitive member of the genus Nyanyachoerus, known through several fragmentary mandibles and crania and a large sample of tooth rows. This material should allow a better assessment of morphological variation and relationships between basal species within Nyanyachoerus, with consequences on their relevance for biochronology. Whereas suids dispersal is more likely influenced by terrrestrial habitat distribution, hippopotamids are particularly dependent on aquatic habitats, with dispersion abilities linked to hydrographic dynamics. Comparisons between hippopotamids and between suids from TM and other localities from northern and eastern Africa should, therefore, allow for complementary approaches of African late Miocene bio-provincialism.

Poster Session I

PELVIC EVOLUTION DURING THE TRANSITION TO LAND: COMPARATIVE DEVELOPMENT OF THE AUSTRALIAN LUNGFISH AND THE MEXICAN AFOXOTL
BOISVERT, Catherine, Upsala Univ., Upsala, Sweden
During the fish-tetrapod transition, the pelvic girdle was transformed from a unipartite element uncoupled with the vertebral column as observed in sarcopterygian fishes such as Eusthenopteron to a tripartite weight-bearing structure connected to the vertebral column through an ilium and a sacral rib as in tetrapods such as Acanthostega and Ichthyostega. Despite careful study of these forms and the pelvic girdle of Panderichthys, the morphology of this form is still insufficient to explain how tetrapod characters such as an ischiium, an ilium and a complete ventro-mesial contact between left and right moieties were acquired. The use of developmental data from eurypterus organisms provides clues as to how a structure evolved. Given that a certain morphology remained substantially unchanged during the course of the evolution of a lineage, it is more parsimonious to assume that the development
of that morphology has remained substantially unchanged too. When comparing the develop-
ment of that structure in extant organisms and verifying hypotheses against the fossil
record, it is possible to understand how novel structures arose. In this case, the Australian
lungfish *Neoceratodus forsteri* has been chosen as a representant of the sarcopterygian fish-
es since it is the only one that has been successfully raised in captivity. As for the tetrapods,
the Mexican Axolotl Amphibystoma mexicanum has been chosen since its morphology is close
to that of early tetrapods and it can also be easily raised in captivity. Growth series of
*Neoceratodus forsteri* and of *Amphibystoma mexicanum* have been cleared and stained and
immunostained to study the development of muscles, cartilage and bone of the pelvic gird-
le and appendicular skeleton. Comparison in the development of insertion points for
homologous muscles in relation to the pelvic girdle, the study of the comparison of the for-
mation of the ventro-mesial connection between the left and right moseities of the pelvic gird-
le as well as the sequence of development of the tetrapod ischium and ilium in relation to
tetrapod-specific muscle groups provides hypotheses about how novel structures arose and
how the tetrapod pelvis evolved during the transition.

Wednesday 3:45

A PECULIAR PALAEORYCTID-LIKE MAMMAL FROM THE MAASTRICT-
IAN OF MONGOLIA

BOLTROSTSEG, Minjin, New York, NY; MINJIN, Chuluun, Mongolian Univ. of
Sciences and Technology, Ulaanbaatar-46, Mongolia; GEISLER, Jonathan, Georgia
Southern Univ., Statesboro, GA

Unlike North America, the record of Maastrichtian mammals in Asia is poor. Excluding
India, which was separate from Asia at the time, the only definitive Maastrichtian mammal
from Asia is an undescribed metatherian skull from Gurilin Tsav, Mongolia. A possible sec-
ond record consists of the multibuttressed *Buginbaatar transaltaiensis*, which is known
from Mongolian locality of Khachin-1. The reported fauna of this locality is meager and is
consistent with a Late Cretaceous or Paleocene age. In the summer of 2005, we collected
additional specimens from Khachin-1. Although our focus is on a single mammal fossil we
discovered, we also found fragmentary remains of non-avian theropods, which together with
the stratigraphic position of Khachin-1, establishes the age of this locality as late Maastrichtian.

Our most important discoveries from Khachin-1 are 3 specimens of mammals. The first
of these is a partial dentary of the metatherian *Deltatherium pretrittuberculare*, which was
formerly restricted to Campanian age strata from Mongolia and Kazakhstan. The remaining
two specimens, including a partial skull, represent a new and unusual species of eutherian
mammal. Remarkable features of these species are large “saber-like” upper canines, loss
or extreme reduction of lower incisors, and only two lower premolars. Like *Cimolocetes
and Palaeocoryctidae*, our new taxon has talonids narrower than trigonids, trigonids that
tower above the talonids, transversely elongate upper molars, and P4 paracone higher than those
on the molars. Like *Palaeocoryctidae*, the paracone and metacone on M1 and M2 are twined
and have steep lingual and labial faces. These similarities suggest that our new mammal is
more closely related to Cretaceous and Paleocene taxa from North America than to other
Cretaceous, Mongolian, endemic mammals. A similar argument has been put forth for
*Buginbaatar*, thus the late Maastrichtian may have been a period of increased faunal
exchange between Asia and North America.

Poster Session II

THE FORELIMB OF THE BASAL SAUROPODOMORPH MELANOROSAUS
AND THE EVOLUTION OF PRONATION, MANUS SHAPE, AND
QUADRUPEDALISM IN SAUROPODS

BÖNNAN, Matthew, Western Illinois Univ., Macomb, IL; YATES, Adam, Univ. of
the Witwatersrand, Johannesburg, South Africa

The evolution of a quadrupedal limb posture is characteristic of the earliest sauropod
dinosaurs and involved secondarily modifying a non-supporting forelimb into a pronated
support column with a semi-circular metacarpus. *Melanorosaurus* is a basal sauropodopomorph phylogenetically close to the earliest sauropods, and the morphology of its
forelimb sheds additional light on the origins of manus shape and pronation in sauropods.

The osteology of a complete forelimb from *Melanorosaurus*, as well as partial referred
specimens from the same locality, suggests that the small elements of this taxon comprise a mosaic of basal sauropodopomorph and basal sauropod characteristics. The manus retains the plesiomorphic
morphology of basal sauropodomorphs. However, like sauropods, the forearm of
*Melanorosaurus* clearly shows the development of a proximal cranialateral process on
its ulna and a shift in the position of the radius to a more cranial orientation relative to the ulna.
The manus of *Melanorosaurus* was not semi-circular as in eusauropods; instead its condyles
were aligned closer to the orientation more typical of theropods and basal sauropodomorphs. A recurved, medially-divergent pollex claw and straighter, blunter claws on digits II and III were present, yet it appears that there was phalangeal reduction in the
central three digits of the manus. We suggest that the characteristic U-shaped manus of
eusauropods and neosauropods may have evolved through a process of mosaic evolution.

The forelimb morphology of *Melanorosaurus* suggests manus pronation occurred early inasauropods through a change in anterioanterior morphology, but that changes to manus
morphology followed later in euauraptods. Although the focus of this abstract is the
of pronation and weight-bearing efficiency of the manus. We conclude that changes to
anteriolateral morphology and manus morphology were not temporally linked in sauropods
and constitute separate phylogenetic events.

Wednesday 12:00

NEW MORPHOLOGICAL DATA FOR MYOTRAGUS BALEARICUS (AR TICTO-
DACTYLA, CAPRINAE), FROM THE BALEARIC ISLANDS (WESTERN
MEDITERRANEAN)

BOVER ARBOS, Pere, American Museum of Natural History, New York, NY

*Myotragus balearicus* was a dwarf fossil bovid from the upper Pleistocene-Holocene of
the Balearic Islands (Western Mediterranean Sea). The species displays very unusual derived
characteristics acquired throughout its insular evolution. Among these features we must
emphasize in the short and stout limb bones, the reduction of mobility in some limb joints and
fusion of small limb bones (some carpal and tarsal bones). *M. balearicus* displayed a low-gear locomotion.

Thanks to the important amount of *M. balearicus* bones curated in the vertebral collect-
ion “Museu de la Naturalesa de les Illes Balears” (MNIB), new morphological features
are defined within the Neoaves: Phaethontiformes (Phaethontidae and Prophaethontidae)
and Procellariformes, Ardeiformes plus redefined Pelecaniformes (Steganopodes sensu
Cracraft 1985) and Abdounornithidae plus Charadriiformes.

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Cracraft 1985) and Abdounornithidae plus Charadriiformes.
Poster Session II

A CONTRIBUTION TO THE STRATIGRAPHY OF THE MIOCENE/PLIOCENE PISCO FORMATION, PERU

BRAND, Leonard, Loma Linda Univ., Loma Linda, CA; URBINA, Mario, Museo de Historia Natural, Lima, Perú; CARVAJAL, Cristian, Loma Linda Univ., Loma Linda, CA; DEVRIES, Thomas, Univ. of Washington, Seattle, WA; ESPERANTE, Raul, Geoscience Research Institute, Loma Linda, CA.

The Pisco Formation was deposited during the most recent of three major marine transgressions along the southern Peruvian coast, in the Pisco Basin. These transgressions produced a marine sedimentary sequence from Eocene to Pliocene, with a rich vertebrate fossil record, followed by Pleistocene deposits. The Middle Miocene through Early Pliocene Pisco Formation contains abundant and unusually well preserved cetaceans, seals, ground sloths, marine birds, sharks, and fish. We present progress on developing a stratigraphic framework for the Pisco Formation to facilitate further study of the paleobiology of this fauna. This work has concentrated on two areas where the most paleontological work is being done. These areas are the vicinity of Lomas, and the Ica valley from the contact with the Chiclaya Formation near Cerro Yesera de Amara to the highest Pisco Formation exposure on north Cerro Blanco, near Ocacua.

The data in this study includes measured sections at several locations and geological mapping using GPS. In the Ica valley section a number of marker beds were identified, with distinctive geological and/or palaeontological characteristics, that were laterally extensive. These beds were walked out, GPS positions and altitudes taken at successive intervals, and strikes and dips of the sediments determined. Faults and folds were identified throughout the section. A composite section was then measured and described for the entire Pisco Fm exposure in the Ica Valley.

The more extensive modern sand cover in some parts of the area around Lomas made structural study difficult. Sediment thickness in part of the area was estimated, based on the altitude change and strikes and dips of the sediment. A section was measured in the valley of Aguada de Lomas, with its extensive sequence of well-exposed beds. Available data on diatom zones, vertebrate collecting sites, mollusks, and radiometric dates are being correlated with this new stratigraphic information.

Saturday 9:30

RHIZODONTID (STEM-TETRAPOD) HYOMANDIBULAE: INSIGHTS INTO THE PALEOBIOLOGY OF AN EXTINCT AQUATIC PREDATOR

BRAZEAU, Martin, Evolutionary Biology Centre, Uppsala, Sweden; JEFFERY, Jonathan, International School of Amsterdam, Amsterdam, Netherlands.

The hyomandibular bone is an integrated element of the feeding and respiratory mechanisms of the skull of basal jawed vertebrates. In digitigrade tetrapods, the hyomandibular underwent a major morphological and functional transformation to become the stapes of the middle ear. The hyomandibulae of basal fish-like, stem-tetrapods therefore provide data on the primitive conditions preceding this important change. Previous workers have made numerous conjectures about the morphological homologies and soft-tissues associated with this bone, but few well-preserved examples are known, hampering wide-ranging comparisons.

We present the first examples of hyomandibulae from a basal stem-tetrapod clade, the Rhizodontida. The specimens, from Canada, the UK and Turkey, are generally well-preserved and present a range of sizes. All are robust and show a consistent suite of characters which distinguish them from all other known sarcopterygian hyomandibulae. Probable bone remodeling in the largest specimen suggests rapid changes to the structure and shape of the bone during ontogeny. Together, these specimens provide new insights into the morphological diversity of the hyomandibulae in fossil sarcopterygians. They allow a detailed examination of muscle insertion scars, and new insights on innervation and vascularization. Comparisons with other stem-tetrapod hyomandibulae reveal considerable variation in musculature, suggesting that there was substantial diversity in feeding and respiratory mechanisms, possibly related to the size variation among fish-like stem-tetrapods.

Marine Reptiles Symposium, Wednesday 3:45

NEW CHENOLOID TURTLES FROM THE LATE CAMPAIGN OF NORTH AMERICA

BRINKMAN, Donald, Royal Tyrrell Museum, Drumheller, AB, Canada; JAMNICKZY, Heather, Univ. of Calgary, Calgary, AB, Canada; DE LEO, DAVILA, Claudia, AGUIL- LON-MARTINEZ, Martha, Secretaria de Educacion y Cultura, Saltillo, Mexico; HART, Maggie, San Diego Natural History Museum, San Diego, CA.

Two new chelonoids from the late Campaign of North America provide new data on the early diversification of the group. The first is Nicholsemys baikeri, a primitive chelonoid from the late Campanian Bearpaw Formation of Alberta, Canada, and DeGrey member of the Pierre Shale of South Dakota. It is similar to Tomistoma and primitive with respect to Cleidostoma, exhibiting a large triturating surface that is larger than the vomer, a large foramen palatinum posterius, and a well-developed processus pterygoideus externus on the pterygoid. It is derived relative to Tomistoma in the presence of a reduced area of exposure of the basisphenoid on the ventral surface of the braincase, a mid-ventral ridge on the palate extending between the basisphenoid and vomer, a rod-like rostrum basisnoidale, and a foramen caroticum laterale larger in diameter than the foramen anterior canalis caroticci interni. Based on these features Nicholsemys is interpreted as phylogeneti- cally intermediate between Tomistoma and Cleidostoma. The presence of Nicholsemys in Alberta and South Dakota demonstrates that it was widely distributed in the northern region of the Western Interior Seaway during the late Campanian. The second turtle is a member of the genus Euclastes from the late Campanian Cerro del Pueblo Formation of Coahuila State, Mexico. It is represented by both isolated skulls and associated skeletons. It differs from late Maastrichtian species of Euclastes in exhibiting a sharper face, deeper labial ridge on the maxilla, and longer transverse process of the pterygoid. Based on the latter two features, it is interpreted to be the most primitive member of the genus. These new chelonoids demonstrate the presence latitudinal differentiation in the cheloniod assemblages of the late Campanian of North America and support the interpretation that marine turtles were more abundant in southern localities at this time.

Friday 2:30

THE PHYLOGENETIC RELATIONSHIPS OF GAVIALOID CROCODYLIANS: NEW FOSSILS, NEW GENES, OLD CONFLICTS

BROCHU, Christopher, Univ. of Iowa, Iowa City, IA; WILLIS, Ray, DENSMORE, L.W., LWWELLYN, Texas Tech Univ., Lubbock, TX.

The historical conflict between morphological and molecular data sets regarding the relationships of the modern Indian gharial (Gavialis) has yet to be resolved. Continuing analy- ses of morphology, including high-resolution CT data and new fossils from the Late Cretaceous and Paleocene, continue to reflect the historical morphological view that Gavialis is basal to other living crocodilians, but new molecular data, including some robust nuclear sequence data sets, continue to reinforce the view that Gavialis is closer to the Indonesian false gharial (Tomistoma). Resolution of the debate has important bearing on understanding crocodylian morphological evolution and the use of Crocodylia as a model clade in the development of molecular dating methods. Combined analyses reflect different levels of signal strength and do not help resolve the relationships of fossil taxa if living species are constrained to reflect the morphological view. If current morphological data sets support an incorrect topology, resolution will come not from new characters, but from two sources of new taxa—new early members of Btoriauchus and Pristichampsinae, groups which currently fall out as proximal outgroups to the non-gavialid crocodylian clade; and long-snouted forms lying within a 20-million-year block of time (the “Gharial Gap”) between the disappearance of “thoracosaur” in the early Ypresian and the reappearance of gavialoids in the Priabonian. Some later thoracosaur preserves suit of characters resem- bling those found in tomositomes, though the phylogenetic distribution of states is not hier- archical and, at present, does not overturn the prevailing signal. Ironically, cranial morphol- ogy of thoracosaur and early tomositomes suggests that even if Gavialis and Tomistoma are extant sister taxa, their derived rostral shapes might have been derived independently.

Poster Session II

CYCLODODECANNE AS A TEMPORARY SEALER AND FILLER IN MOLDING SPECIMENS WITH POROUS AND PENETRABLE SURFACES

BROWN, Gregory, Univ. of Nebraska State Museum, Lincoln, NE.

One of the exceptional properties of silicone RTV molding compounds is their ability to flow and thereby capture and reproduce extreme detail from the object being molded. One of their less admirable properties is their somewhat limited tear-strength. When these two properties meet on a specimen with deep cracks, open sutures, exposed cancellous bone or remnant porous matrix, there can be grave results. RTV may flow into these areas, penetrate the specimen deeply and tear during de-molding, ruining not only the mold but the speci- men as well. Residual silicone RTV is impossible to remove from these deep interstices without damaging the specimen. There are several traditional methods of preventing unwanted penetration of RTV into these areas, but each has its own shortcomings. Clay and wax fillers are themselves difficult to remove, especially from very narrow sutures and cracks, as are thick consolidants from porous areas. Using a thixotropic (non-flowing) RTV may result in less detail-capture and a greater risk of mold flaws from air-entrainment. Choosing a molding compound with higher tear-strength could result in specimen failure rather than mold failure during de-molding.

Cyclodecane (C_{12}H_{24}) is waxy hydrocarbon that sublimates completely over time at room temperature. This property makes it extremely useful as a temporary filler and con- solidant. Applied as a melt, it provides a very effective filler or seal to penetrate or porous areas of specimens, and then simply disappears after de-molding. A case study of molding an exquisitely preserved juvenile Castoroides skull recently donated to the museum readi- ly demonstrates the tools, techniques and benefits of using cyclodecane as a conserva- tionally-sound temporary filler/sealant, allowing us to take full advantage of RTV proper- ties to produce high-resolution, high-quality molds while minimizing risk to the specimen.
A SIMPLE PROCESS FOR FABRICATING SMALL DISPLAY MOUNTS
BROWN, Matthew, VAN BEEK, Constance, HOLSTEIN, James, Field Museum of Natural History, Chicago, IL

Occasionally preparators are called upon to perform duties that, while not outside our job description, may be outside our normal experience. For a preparator without experience mounting a cast specimen, the task may at first seem daunting. Here we examine a recent project mounting a small dromaeosaur for display. In the absence of a suitable mount-making facility or metal shop, techniques were developed through trial and error to easily mount the cast skeleton. Most materials were obtained from a local hardware store, and the work was performed using tools already present in most prep labs. The final design required an internal armature to optimize aesthetic appeal, which introduced a challenge in balancing a dynamic and anatomical pose with the need to hide a structure within the gracle elements.

NEW USES OF A RELATIONAL DATABASE TO IMPROVE THE CONSISTENCY AND QUALITY OF FOSSIL LOCALITY DATA IN ACADEMIC INSTITUTIONS AND ENVIRONMENTAL CONSULTING FIRMS
BROWNE, Ian, RANDALL, Kesler, San Diego Natural History Museum, San Diego, CA

The paleontological collections of the San Diego Natural History Museum have grown considerably since the inception of the California Environmental Quality Act in 1970. The museum provides paleontological migration services through its Department of PaleoServices and serves as a repository for private migration firms. This creates an almost constant influx of specimens and related locality data. In the past, specimens were logged directly into a handwritten ledger and field tags were handwritten for each bucket and cardboard flat of material associated with a field number. This system was prone to a number of common problems and errors, including problems with developer/donor names being recorded incorrectly, missing data, and illegible handwriting.

In an attempt to improve data quality and consistency a relational database was developed to alleviate these problems. Users select the project name from a list linked directly to the contract management table; project and donor information is then automatically associated with the field number. Information about the field site is then entered, including: geologic formation, elevation, UTM coordinates, types of fossils recovered, and brief notes specific to the field number. The user then enters the number of field tags they require and the system prints them.

What makes this system particularly useful are the added features that have taken this system beyond being a simple data entry tool. The system automatically sends daily e-mails detailing the day’s collections to key curatorial staff. Prior to the implementation of this system erroneous or missing data were usually not discovered until the beginning of the formal curation process (several months after the initial collection). E-mail notification allows curatorial staff to remedy data inconsistencies within 24 hours of collection. Additionally, daily notifications to contract and project management staff improve communications with clients and government oversight agencies. Ultimately this system increases locality data accuracy, benefiting researchers, students, and citizens.

NEOCECIS SYMPOSIUM, Thursday 9:45
A NEW LATE PALEOCENE VERTEBRATE FAUNA FROM THE OHIO CREEK CONGLOMERATE OF WESTERN COLORADO
BURGER, Benjamin, Univ. of Colorado at Boulder, Boulder, CO

The paleoecology of the Late Paleocene (Eocene) was an important transition in the Earth's history. The interglacial paleoenvironments of the Upper Cretaceous and Lower Paleocene are marked by great geographic and temporal variation, indicating that the Late Cretaceous and Early Paleogene were times of rapid species extinction, speciation and diversification. In this project, we attempt to examine the Middle to Late Paleocene oceanic vertebrate paleocommunity. We use skeletal morphology to determine the origin/evolution of these vertebrates and their paleoecology.

THE RANGES OF MOTION OF THE GLENO-HUMERAL JOINT OF THE THERIZINOSAUR NEIMONGOSAURUS YANGI (DINOSAURIA: THEROPODA)
BURCH, Sara, Univ. of Chicago, Chicago, IL

This reconstruction, along with an associated humerus, was then used to determine the range of motion of the gleno-humeral joint. The unusual morphology of the scapular and coracoid margins restricted the overall range of motion in the dorsoventral direction, although the lateral position of the glenoid allowed for a more extensive dorsal excursion of the humerus than has been previously described. The humerus was also found to be capable of considerable anterior protraction. The total dorsoventral motion of the humerus was measured as 72° in anterior view, and the total anteroposterior motion was measured as 119° in dorsal view. The overall range of motion was roughly circular and directed laterally and slightly ventrally, which differs from the more oval and posteroventrally directed ranges of motion that have been described for other theropods. Such extensive protraction is very different than the flight stroke of extant birds, indicating that this glenoid morphology was most likely not an evolutionary transition to the morphology of modern birds. Therizinosaur may have used this ability to extend their arms forward considerably for activities such as reaching for and grasping foliage.
the Tifanian NALMA. Presence of Nannodectes further constrains the deposits to an early Tifanian age (T1t to T13 biostratigraphic zones), since Nannodectes first occurrences in the Tifanian.

Lithologically the Ohio Creek Conglomerate is characterized by the absence of coal and shale, and the presence of tan mudstones and siltstones spaced between thick and wide-spread units of clay pebble conglomerates and sandstones. The revised age and unique lithic characteristics of the Ohio Creek Conglomerate excludes it from the late Cretaceous Mesa Verde Group. The apparent absence of early Paleocene strata in the basin indicates that the basin formed later than the surrounding Green River, Wasatchie, South Park, and Denver Basins. Revising the biostratigraphic zonation of the late Cretaceous and early Tertiary strata of the Piceance Creek Basin is important for understanding the complex tectonic history of the Rocky Mountain Region.

Poster Session I

THE VALIDITY OF MOSASAURUS DEKAYI (REPTILIA) BASED ON TWO NEW SKULLS FROM SOUTH DAKOTA, AND THEIR RELATIONSHIPS WITHIN THE MOSASAURIDAЕ

BURROWS, Rebecca, South Dakota School of Mines and Technology, Dyer, IN

Two undescribed mosasaur specimens from the Museum of Geology, South Dakota School of Mines and Technology (SDSM), were analyzed based on morphological characteristics and compared with known specimens from the Mosasaurinae and Tylosauroinae. These Campanian specimens share a unique feature, a highly-faceted, prismatic tooth structure. This character had previously been associated with Mosasaurus dekayi, identified in 1830 from Maastrichtian deposits of New Jersey and diagnosed based on a single tooth. With the type specimen now lost, the description of two mosasaur skulls which seem to exhibit this diagnostic character is of great value to the classification of the Mosasauroidea. Although, SDSM 74869 and SDSM 6819, have faceted teeth, they have other distinct characteristics unique to two different genera from two subfamilies. The predental rostrum and the predental suture place them in SDSM 74869 within Tylosaurus and subsequently within Tylusaurus. A unique species is indicated by the well defined asymmetrical prismatic teeth, the predental rostrum with localized foramina on the anterior end of the snout, a dorsally domed, and laterally broad premaxillae. SDSM 74869 then broadens the subfamilial definition to include a species with highly-faceted teeth. SDSM 6819, is unequivocally nested within the Mosasauroidea, based on highly-faceted symmetrical teeth, the smooth reversed “L” shaped premaxilla-maxilla suture, and the lack of a predental rostrum. The two skulls are very different members of the Mosasauroidea, both sharing the previously thought apomorphic highly-faceted tooth structure. The characters outlined for each specimen prove faceted teeth as described by DeKay, while important, are not diagnostic and can not be used alone to differentiate species.

Poster Session II

PODOCNEMIDIDAE AND CHELDAE TURTLES FROM THE EARLY MIOCENE, MIDDLE MAGDALENA VALLEY, COLOMBIA: THE OLDEST RECORD OF PODOCNEMIS AND CHElus IN SOUTH AMERICA

CADENA RUEDA, Edwin, Smithsonian Tropical Research Institute, Panama; PARAMO, María, Universidad Nacional de Colombia, Bogota, Colombia; GONZALEZ, Tatiana, Instituto Colombiano de Geología y Minería- INGEMINAS, Bogota, Colombia; RUIZ-OMEÑACA, José, MUJA, Colin, and the first occurrence of Pachyophis mesophis in Colombia, which has been described as a species from the late Cretaceous. This occurrence is significant because it provides new insights into the evolutionary relationships and biogeographic history of these reptiles in South America.

THE DISCOVERY OF A SINGULAR FAUNA: THE SAUROPODS FROM THE LATE JURASSIC AND EARLIEST CRETACEOUS OF SPAIN

CANUDO, José, Zaragoza, Spain; RUIZ-OMEÑACA, José, MUJA, Colin, Spain

The Late Jurassic and Early Cretaceous faunas from Spain are rich in sauropod fossils, and the newly discovered fauna from Spain is notable for its diversity and age. This fauna includes several species of titanosaurids, such as Aradisaurus, and is older than previously known faunas from Spain. This discovery provides new insights into the biogeographic history of sauropods in Europe.

VOLUNTEERS AS FORCE-MULTIPLIERS IN RESEARCH AND IN THE FOSSIL LAB

North Dakota, USA; GARCIA-RAMOS, José, PINUELA Laura, MUJA, Colin, Spain

Volunteers have been an integral part of research and preparation work at the Museum of Natural History in Denver, Colorado. They have played a crucial role in preparing fossils for research and have contributed to the museum's educational and outreach programs. The use of volunteers has helped the museum to increase its outreach and educational efforts, and has also helped to reduce the cost of fossil preparation. Volunteers have also been a source of new ideas and directions for research projects.

Revisiting the ‘lost’ type specimens of Mesophis nopsis by Okada, 1925

Caldwell, Michael, Universita of Alberta, Edmonton, AB, Canada

Mesophis nopsis (Upper Cretaceous) limestones deposited in a variety of Tethyan basins, now outcropping or being quarried in Slovenia, Croatia, Bosnia-Hercegovina, Lebanon, and the West Bank, have produced a large number of marine squamates, most notably including both rearlimbed and limbless snakes. Mesophis nopsis Bolkay, 1925, is the second snake taxon known from the western most region of Bosnia-Hercegovina; the first was Pachyophis woodwardi. Mesophis, was differentiated from Pachyophis, as not demonstrating a very high degree of pachyostosis in either the ribs or vertebrae, and by having an exceptionally small skull; the original description likened the body proportions of Mesophis to those of a modern sea snake or sea krait. Mesophis was assigned to the Chelophidia Nopcsa, 1923, Family Chelydridae, Nopcsa, 1923. The original description was based on part and counterpart slabs of the specimen; the counterpart is lost in a private collection, while the part survived the Balkan Conflict (1992-1995) and is available for study. Redescription recognizes a distinction from Pachyophis on the basis of the degree of pachyostosis; however, based on size criteria it is suggested these differences could be ontogenic. Bolkay (1925) characterization of the size of the skull, and his identification of various cranial elements, is contradicted by identification of only a fragment of the pterygoid and a partial basioccipitum; the skull is small because it is fragmentary, not because Mesophis is a small-headed animal. The best preserved vertebrae on the part show similarities to Simolophis; however, the skull is virtually absent, few other characters assist with the phylogenetic placement of Mesophis. Bolkay’s arguments in support of a marine origin for snakes is neither refuted nor supported by the available data from Mesophis.

THE DISCOVERY OF A SINGULAR FAUNA: THE SAUROPODS FROM THE LATE JURASSIC AND EARLIEST CRETACEOUS OF SPAIN

Canudo, Jose, Zaragoza, Spain; Ruiz-Omenaca, Jose, Muja, Colin, Spain; Barco, Jose, Univ. of Zaragoza, Zaragoza, Spain; Garcia-Ramos, Jose, Pinuela, Laura, Muja, Colin, Spain

In Spain there is a good record of Kimmeridgian to Berriasian continental and coastal faunas. It is common to find fragmentary remains of sauropods, many of them linked to transient environments. Particularly interesting are the remains of sauropods, usually included in Diplodocidae and Camarasauridae, families typical of the end of Jurassic in North America (Morrison Fm). The description of more complete specimens and new studies of fragmentary material has made possible to interpret a new scenario. The phylogenetic possibilities represented by postcranial remains (Galveosaurus, Losillasaurus) locate them outside Neosauropoda or as polytomies with other basal Neosauropoda. This part of the cladogram is poorly resolved, but according to our data it is the position occupied by some of the Iberian sauropods. In addition, the sauropod teeth from the Late Jurassic and earliest Cretaceous are included in two groups, one of them, the non-neosauropod eusauropods, with markedly spatulate teeth. The second has pencil like teeth (diplocodimorphs) from the Kimmeridgian of Asturias and the Berriasian of Galve (Teruel). This second group has slightly spatulate apex distinguishing them from the Diplodocidae, may be located as more primitive Diplodocimorpha. Noteworthy is the absence of Titanosauriformes such as Brachiosauridae, and even other macronarians such as Camarasauridae. This association implies that part of the Iberian Peninsula maintained more primitive sauropods than those present in adjacent areas of Gondwana and Laurasia, in spite of being situated in an intermediate paleogeographic position between these two great continental masses. This would suggest the isolation (endemism?) of the north-east of the Iberian Peninsula, at least its sauropods, during Late Jurassic and earliest Cretaceous.

Preparators Symposium, Thursday 11:45

Volunteers as force-multipliers in research and in the fossil lab

Carpenter, Kenneth, Denver Museum of Nature & Science, Denver, CO

The Denver Museum of Nature & Science has been involved in fossil preparation for over 100 years, and volunteers have played a critical role in this work. Volunteers provide a source of dedicated, hardworking individuals who are able to contribute significant time and effort to the preparation of fossils. Volunteers are an important part of the museum's outreach and educational programs, and provide opportunities for volunteer participants to learn new skills and gain experience in the field of paleontology. The museum has developed a structured volunteer program that provides training and support for volunteers, and has seen a significant increase in the number of volunteers over the past decade. The museum has also developed partnerships with other institutions and organizations to increase the availability of fossil preparation opportunities for volunteers. The museum recognizes the contributions of volunteers and values their commitment to the research and educational goals of the museum.
to admit what they don’t know. This makes guidance of research easier than with some graduate students (“like having graduate students without the whining”). The use of volun-
teers has resulted in an extraordinary high level of productivity for the department than if only by staff.

Poster Session I

IS GUANLONG A TYRANNOSAUROID OR A SUBADULT MONOLOPHOSAURUS?
CARR, Thomas, Carthage College, Kenosha, WI
Guanlong wucaii is a purported Late Jurassic basal tyrannosauroid from the Shishugou Formation of northwestern China. Guanlong bears a tall and fenestrated nasal crest that extends along the top of the snout, as in Monolophosaurus jiangi, a carnosaur that is about twice the size as Guanlong, from a lower level in the same unit. The original cladistic analy-
sis of Guanlong used a data matrix relevant to resolving the relationships among basal theropods, which reconstructed it as a basal tyrannosauroid. However, the similarities shared between Guanlong and Monolophosaurus in the crest prompted a test of the original hypothesis using a data matrix based on characters relevant for resolving ingroup relationships of Tyrannosauroidea.

The data matrix includes 201 characters and 34 theropod species. The matrix was ana-
yzed in PAUP* 4.0b under a heuristic search; Guanlong was reconstructed as a carnosaur, and as the sister species of Monolophosaurus. This relationship is supported by the shape of the rostral ramus of the maxilla; a sagittal, elongate, pneumatic and fenestrated crest along the top of the snout; and a foramen in the pubic process of the ischium. Monolophosaurus is distinguished from Guanlong by a longer crest that includes the premaxilla and lacrimal, a rostrally-positioned maxillary fenestra, a deep maxilla, a long jugal process of the quadra-
tojugal, and a subocular process on the postorbital. Guanlong is distinguished from Monolophosaurus by a wide snout tip, short squamosal process of the postorbital, a concave orbital margin of the postorbital, a corneal process on the jugal, the anterior fossa is deeply excavated into the jugal, absence of a caudal subangular foramen, fewer dentary teeth, anepistropheal cervical centra, presence of a rostrodorsal notch in the ilium, and the pres-
ence of a pubic tubercle. These results suggest two alternative hypotheses for Guanlong: it is either the sister taxon, or it is a subadult, of Monolophosaurus.

Friday 8:15

A NEW PERSPECTIVE ON NON-AVIAN DINOSAUR DIVERSITY
CARRANO, Matthew, Smithsonian Institution, Washington, DC
The taxonomic diversity of non-avian dinosaurs through the Mesozoic Era is very poorly understood. Although counts of known taxa are available (and form the basis for our only existing estimates), the relationship between these samples and true diversity is complex and largely unexplored. More surprisingly, current estimates are entirely empirical; no explicit hypotheses of dinosaur diversity have been offered or tested.

Here, I propose the first hypothetical taxonomic diversity curve for non-avian Dinosauria. This curve was generated a priori, based on inferences from large-vertebrate ecology, land area constraints, and biome distributions. It describes an initial steep increase in diversity from the Late Triassic through the end of the Early Jurassic, coincident with the origins and early radiations of all major dinosaur groups. A shallower increase fol-
looms through the close of the Jurassic, at which time continental fragmentation spurs a sec-
ond, steep (exponential?) diversity rise via geographic isolation and increased biome vari-
ability. The end-Cretaceous event is considered to have been geologically instantaneous.

Total dinosaur diversity was integrated as the area under this curve. Two “metabolic models” of taxonomic longevity were used: crocodilian and mammalian. These models generate considerably different totals, indicating that physiological considerations should not be ignored when estimating diversity on macroevolutionary scales. Next I selected five temporal “point samples” from which global dinosaur diversity could be extrapolated. These provided taxonomically rich samples that were rarefied to project the likely total standing diversity at each interval. The shape and scale of a “best fit” curve to these samples was then compared to the hypothesized curve. This provided a first-order test of the model, and a potential source for development of a second model curve.

Taphonomic, human-induced, and other sampling biases remain important limiting fac-
tors, but this new approach for understanding the dynamics of diversification in an important vertebrate radiation.

Marine Reptiles Symposium, Wednesday 1:30

MARINE ADAPTATION IN REPTILES: A MODEL FOR THE STUDY OF LARGE SCALE PATTERNS AND PROCESSES OF EVOLUTION
CARRROLL, Robert, McGill Univ., Montreal, Canada
Adaptation of reptiles to locomotion, feeding, and reproduction in an aquatic environment resulted in changes throughout the skeleton equivalent in scope to the modifications that occurred in the transitions between fish and amphibians and the origin of birds from dinosaurs. The transitions from terrestrial to aquatic ways of life among reptiles differ, however, in that they occurred many times, independently, from among many distinct line-
ages: e.g. from initially terrestrial turtles, crocodiles, squamates, sphenodontids, basal lepi-
dosauromorphs, basal archosauriforms, and basal diapsids. Their diversity of ancestry makes this a natural experiment from which one can analyse various patterns and modes of evolutionary changes. The scientific achievements of Betsy Nicholls provide a very informative model for how such research can proceed—via thorough analyses of the func-
tional anatomy, biogeography, and environmental distribution of a wide range of aquatic reptiles, especially those near the base of their initial radiation. Her work has demonstrat-
ed the major differences between these groups at their first appearance in the fossil record, and emphasizes the necessity for new approaches to establishing more specific sister-group relationships for the diverse aquatic taxa. The necessity for establishing specific relationships for each clade separately is also shown by the extreme disparity in the results of recent phylogenetic analyses: e.g. turtles are nestled within lepidosauromorphs as a sister-taxon of sauropterygians; sauropterygians at the base of archosauriforms together with ichthyosaurs and thalattosaurs; thalattosaurs nestled with lepidosauromorphs or archosaurau-
morphs. Biogeographical analyses of adaptations of this sort are necessary to determine plausible sequences of ancestor-descendant relationships. Her approach demon-
strates how future studies can lead to determining the actual antecedents of the numerous derived lineages and establish the sequences of change that occurred in the early stages of the many transitions between water and land.

Poster Session II

A CURSORIAL BIRD FROM THE MAAGSTRIKTIAN OF ARCTIC TERRA
CASE, Judd, Saint Mary’s College of California, Moraga, CA; REGUERO, Marcelo, Museo de La Plata, La Plata, Argentina; MARTIN, James, South Dakota School of Mines and Technology, Rapid City, SD; CORDERS-PERSON, Amanda, Sam Noble Oklahoma Museum of Natural History, Norman, OK
A left femur from the early Maastrichtian, Cape Lamb Member of the Lopez de Bertodano Fm. on Vega Island, Antarctic Peninsula, shows striking similarities to modern cursorial predatory birds of South America (Seriemas, Cariamidae) and of Africa (Secretarybirds, Sagittariidae). The size of the Antarctic femur is nearly identical to those of both modern bird families and thus the Antarctic specimen would be about the same size, at around a meter in height. The crucial features in demonstrating the hibbard of this Maastrichtian bird arc: the enlarged and posteriorly prominent tibiofibular cristae; the laterally expansive lateral-
arcanal fossa (into the highly planar and vertically oriented fibular trochea). These apo-
omorphic features are present in the modern yet unrelated cursorial birds and are equally developed in the Antarctic specimen. Considering the proximal femoral features, the bio-
geographical location and the presence of phororhacoids in the Eocene of Antarctica, then this specimen may represent a taxon which may be ancestral to both caramids and phororhacoids or it is the basal caramid which is then ancestral to the phororhacoids, rather than being their descendant.

Poster Session III

ON THE LEFT-RIGHT ASYMMETRY IN DINOSAURS
CASTANIHNA, Rui, Loures, Portugal; MATEUS, Octávio, Museu da Lourinhã & Universidade Nova de Lisboa, Lourinhã, Portugal
The study of different kinds of morphological left-right (L-R) asymmetries in all taxa is a very powerful tool to understand evolution since it is a way to measure the developmental stability of an organism against environmental perturbations. Excluding every pathologic or subtle asymmetry and all cases of taphonomic distortion, this work focuses only on two kinds of unambiguous asymmetries: fluctuating and adaptive asymmetry. There are sev-
eral cases of conspicuous left-right asymmetry in dinosaurs and is probably more common than previously thought. The presence of these systems of the body and sauropods are the most common cases reported. The shape (but not the occurrence) of pneumatic cavities might have been exposed to weak selective pressure becoming more ran-
dom than other body structures. Asymmetries are rarer in the appendicular bones possibly because it represents a strong handicap in the function of the limbs, consequently in the locomotion of the individual. Teeth counting show many exceptions to the typical L-R sym-
metry. Peculiar cases of adaptive asymmetry are related with the plates of stegosaurs and the ear displacement in the skull of the troodontids, which may have an important role in the physiology and ecology of the animals. The asymmetric displacement maximizes the surface exposure of the stegosaurs dorsal plates. This is an advantage, either the plates were used for thermoregulation, display or specific identification. Work in progress on the brain-
cases of some troodontids specimens shows asymmetric ear openings, which suggests that can be an analogy resulting from convergent evolution between troodontids and strigi-
siforms and birds for 3D directional acoustics. Asymmetries are more common in animals that develop under stress. Animals that lived under dramatic environmental changes peri-
ods—like mass-extinctions episodes are believed to be—should present more asymmetries. However, much more sampling and time accuracy is required in order to be able to relate dinosaur asymmetries to extinction episodes. Asymmetries show strong intra-individual variation and should be taken in consideration in taxonomical studies.

Poster Session II

ON THE PRESENCE OF THE DIRE WOLF CANIS DIRUS FROM THE VALEN-
QUILLO BASIN, PLEISTOCENE OF PUEBLA, CENTRAL MEXICO
CASTILLO, Jesus, Univ. Autón. Edo. Hidalgo, Pachuca, Hidalgo, Mexico; BRAVIL, James, Museo de Paleontología, Pachuca, Hidalgo, Mexico
Since the latest 19th century, several authors have reported on the Pleistocene megafauna from Vallesquillo as a very important fossiliferous region. The fossil material has been recovered from fluviolacustrine deposits with a faunal assemblage that indicates Rancholabrean and possibly Irvingtonian ages.

Recent paleontological work carried out on new localities from the Basin, allowed
recording scarce but significant specimens assignable to Canis dirus. The sample includes a partial skull with the right zygomatic arch, the posterior part of the left parietal, part of the sagittal crest, and a portion of the right maxilla with MI-3 as well as the posterior alveolus for the P4; a left mandible fragment with m1-2 and the alveolus for m3; and an isolated left M1.

This record gives additional information on the presence of these carnivores in Central Mexico. The Mexican record includes fossils from the states of Nuevo Leon, Mexico, Aguascalientes, Jalisco, San Luis Potosi and Puebla. Likewise, it constitutes one of the most southern occurrences of the group in North America.

Poster Session II
PRELIMINARY DEPOSITIONAL MODEL FOR AN UPPER CRETACEOUS EDMONTOSAURUS BONEBED

CHADWICK, Arthur, Southwestern Adventist Univ., Keene, TX; SPENCER, Lee, Southern Adventist Univ., Collegedale, TN; TURNER, Larry, Southwestern Adventist Univ., Keene, TX; RYAN, John, Univ. of Texas, Dallas, TX; TRAVAGLIA, Frank, American Museum of Natural History, New York, NY

GPS surveying and GIS mapping have enabled us to obtain accurate three dimensional data on the position and distribution of Edmontosaurus bones from an extensive monotypic bone bed in the Upper Cretaceous Lance Formation of eastern Wyoming. The bone bed occurs over an area in excess of one square kilometer, but bones appear to be concentrated in an area of about 40 hectares. While we do not yet have quantitative bone data covering the entire area, the main quarries and test quarries have yielded a consistent picture. Estimates based upon these quarries, extrapolated over the known extent of the 40 hectares, suggest the bones of 10,000 to 25,000 animals are interred here.

The bones occur as individual disarticulated elements or rarely, as partially disarticulated assemblages. The mass mortality event is preserved within a normally graded bed in a poorly consolidated claystone or mudstone with large limb bones at the base, grading upward to vertebrae and toe bones at all quarry sites. The bones universally exhibit little evidence of weathering: abrasion and other transport degradation are also conspicuously absent. The claystone is conformably overlain by a fine-grained, well-sorted immature sandstone showing evidence of rapid accumulation. We propose that a large population of ornithopods (greater than probable herd size) was catastrophically decimated and initially accumulated in a nearshore freshwater environment. Subsequently, the disarticulating remains were remobilized and transported basinalward to a deeper water setting as a graded bone bed.

Saturday 4:00
COMBINED LANDMARK AND OUTLINE MORPHOMETRIC APPROACHES FOR ANALYZING THE SHAPE OF ORGANISMS—FILLING A NEED WITH POWERFUL BUT INTUITIVE METHODS

CHAPMAN, Ralph, Pocatello, ID

A wide variety of quantitative approaches are available for the analysis of the shape of organisms and their parts. Each has its strengths and weaknesses. Outline and landmark approaches—often referred to as geometric morphometrics—especially illustrate this. Landmark methods are the most powerful but can really provide information only on the change of the landmark positions. This often leaves much of the structure in question unstudied. Outline methods can be applied more broadly but are often less powerful because they are not typically anchored with landmarks. Further, many outline methods rely on fitting complex mathematical functions to outlines (e.g., Fourier analysis) that can make the analytical procedures difficult to do and interpretation within biological contexts very complicated. A powerful alternative is to combine outline and landmark methods in a single analysis, taking advantage of the strengths of both approaches. Further, the outline methods used should be those that use the simpler algorithms, making interpretation easier. There are three methods that can provide such an approach. First, one the original forms of Procrustes analysis (least-square and resistant-fit) allows the carrying of associated outlines along with the landmark fit and should be seriously considered for many studies. Second, defining outlines as a series of pseudolandmarks—anchored by as many real landmarks within the outline as possible—provides a very powerful system for extracting detailed shape information. Finally, there is a simple and graphical outline method—the original Theta-Rho Analysis developed by Bookstein, 1997—which can provide an outline of a fitted data-set that contains both landmarks and outlines within polar coordinate space. Supplementing this with ordination and clustering models provides a powerful but easily understandable set of results. Examples will be given using these methods including analyses of dinosaur footprints and stegosaur plates.

Poster Session III
DEVELOPMENTAL PATTERNS OF THE JUVENILE CARBONIFEROUS COELACANTH RHABDODERMA EXIGUUM

CHAREST, France, CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QB, Canada

Studies about developmental patterns in fossil taxa are relatively rare owing to the scarcity of abundant well-preserved specimens, the anatomical incompleteness and rare ontogenetic series. More than 100 juvenile specimens of the actinistian Rhhabdoderma exiguum were found in the Middle Pennsylvanian deltaic paleoenvironment of the Mazon Creek area (Illinois). This size series (from 36 to 202 mm in total length) represents growth stages from egg to advanced juveniles including yolk-sac-bearing specimens. In order to describe developmental patterns of the postcrania skull, morphometric and meristic measures were taken and ossification sequences were described. Regressions and principal components analyses revealed allometric and isometric growth patterns. Ossification sequences show that: (1) most endoskeletal postcranial elements are ossified at the earliest growth stages, (2) the number of vertebra remains stable during ontogeny, whereas (3) the numbers of ossified branchial arches and lipodochia increase, and (4) basal plates ossifie after yolk sac resorption. Developmental patterns will be compared with other sarcopterygians including the living coelacanth Latimeria chalumnae.

Wednesday 2:15
A NEW FOSSIL LOON FROM THE LATE CRETACEOUS OF ANTARCTICA AND EARLY RADIATION OF FOOT-PROPELLED DIVING BIRDS

CHATTERJEE, Sankar, Texas Tech Univ., Lubbock, TX; MARTINI, D., Cadic-Coniet, Ushuaia, Argentina; NOVAS, F., Mus Argentina de Cs Naturales, Buenos Aires, Argentina; MUSSEL, F., Universidad de Buenos Aires, Buenos Aires, Argentina; TEM- PLIN, R., National Research Council, Ottawa, ON, Canada

Well-preserved skeletons of neognathous birds from the Cretaceous deposits are extremely rare worldwide. A new and gracile species of a fossil loon Polaronis from Upper Cretaceous strata on VEGA Island of Antarctica fills a critical gap in the origin and early evo- lution of neognathous birds. It is about the size of a red-throated loon and is considerably smaller and slender than its sympatric species Polaronis gregori. Polaronis was recog- nized previously as a foot-propelled diving bird but the intact wing material of the new species suggests that it had also developed sophisticated powered flight, indicating dual mode of locomotion. We calculate the flight performance of this new species of Polaronis (using mass = 1.2 kg; wingspan = 0.86 m; aspect ratio = 6.7; wing area = 0.11 m²; and wing loading = 107.3 N/m²) through a computer simulation model, indicating that it was capa- ble of continuous flapping flight. The hindlimbs were less specialized for diving than those of living loons, as indicated by its relatively long and slender femur and short tibial crest. Apparently the foot-propelled locomotion in loons were gradually superimposed on a body plan adapted for powered flight. The new species of Polaronis has striking similarity to the fossil and extant loons, displaying remarkable evolutionary stasis of Gaviidae over 65 mil- lion years. The most informative specimens of Late Cretaceous neognathes come from Antarctica including loons, as well fragmentary remains of anseriforms, and charadriiforms. Apparently Antarctica was the cradle of basal neognaths that survived the KT extinction and dispersed to lower latitudes during the early Tertiary. The new fossil loon is the only known example of modern bird that is sufficiently preserved from the age of dinosaurs to permit the study of flight performance. It provides another example of high latitude hete- rochrony and favors a Late Cretaceous origin of neognaths rather than an explosive radi- ation in the early Tertiary.

Poster Session III
BIODIVERSITY OF FOSSIL AND LIVING OSTARIOPHYTANS IN CHINA

CHEN, Pingfu, Lawrence, KS

In China, ostariophycean fishes are represented mostly by Cypriniformes and Siluriformes. Only 2 families, 2 genera and 2 species are recognized in Gonorynchiformes, and so far no fossil has been found yet. The order Cypriniformes is the most diversified with about 163 genera and 651 living species. Among cypriniformes, Cyprinidae and Cobitidae are the largest families. 122 genera and 451 species (or subspecies) are recognized in Cyprinidae in contrast to the 23 genera and about 131 species included in Cobitidae. Fossil representa- tives of Catostomidae have been recently reported from Eocene deposits of southern China, and fossil cyprinids of the subfamilies Barbininae, Cyprininae, Gobioninae, Leuciscinae, and Danioninae have also been found in Eocene deposits. Although the earliest fossils are of Eocene age, most fossil cyprinids have been recovered in Miocene or younger deposits. About 30 genera and 40 fossil species have been recognized in the Cyprinidae. About 15 genera and 100 species are recognized in Siluriformes in China, and fossil representatives are only found after Miocene. Characiformes and Gymnotiformes are not known in China.

Poster Session III
SPECIES INTERACTIONS AND HABITAT PREFERENCES IN THE EARLY EOCENE MAMMAL FAUNA OF THE CENTERAL BIGHORN BASIN, WY

CHEW, Amy, SUNY Stony Brook, Stony Brook, NY

Approximately 1000 fossil localities from the central Bighorn Basin, WY, have yielded a dense, well-studied sample of Early Eocene fossil mammals. Paleosols from nearly 700 of these localities have been analyzed and classified according to a scale of relative develop- ment from thick, immature stage 0 paleosols deposited rapidly near ancient stream channels to thin, mature stage 5 paleosols deposited far from stream channels on the ancient flood- plain. Laterally contiguous sets of fossil localities deposited nearly simultaneously and doc- umenting a progressive increase in paleosol maturity have been described as pedocafes, or lateral environmental transects from stream channel to distal floodplain. As there is no evi- dence of post-mortem transport in the central Bighorn Basin, faunal variation along the gra- dient of paleosol maturity in pedocafes may reflect species preferences for particular sub- habitats. Evidence both for and against relationships between relative paleosol development and faunal composition has been presented.

This analysis is based on total faunal composition across two previously described pedocafes as well as across a much larger sample of 43 coeval fossil localities. These results suggest a strong relationship between paleosol development and faunal composition, and
consistent patterns likely reflect both species interactions and preferences for particular sub-
habitats in the ancient environment. Across both pedofaunas, small species had highest rel-
ative abundances in the mature paleosols of channel-distal settings, while large species were
most abundant at an intermediate distance from ancient stream channels, and intermediate-
sized species were most abundant in the immature paleosols of channel-proximal areas. At
a higher taxonomic level, a basin-wide pattern in community composition was discovered
in which localities were dominated either by Equidae or by Hypsocodontidae, with relative-
ly large proportions of Adaptidae and Dichobunidae. Those communities dominated by
equids were found closest to the ancient stream channels, while those dominated by hypop-
sodontids, adapids and dichobunids tended to occur farther out on the floodplain.

**THE PHYLOGENETIC POSITION OF PYGMY RIGHT WHALES (MYSICTETI: NEOBALAENIDAE): SEPARATE AND COMBINED ANALYSES**

CHURCHILL, Morgan, BERTA, Annalisa, San Diego State Univ., San Diego, CA; DEMERE, Thomas, San Diego Natural History Museum, San Diego, CA

One of the most debated issues in mysticete phylogenetics concerns the position of
the extant pygmy right whale (*Caperea marginata*), a rare and little known species, and the sole
representative of Neobalaenidae. Previous analyses based on morphological data consist-
tently support this taxon as sister to right whales (*balaenids*), in the clade Balaenoida. In
contrast, molecular data supports a sister relationship withrorquals and gray whales
(*Balaenopteridae*).

To examine the systematic position of *Caperea*, phylogenetic analyses of mysticetes
were conducted using 100 morphological characters and a molecular data set containing
published nuclear and mitochondrial gene sequences. Bayesian, parsimony, and maximum
likelihood methods of phylogenetic inference were employed. Strong support for
Balaenidea was found in all morphological analyses, although weak support for this rela-
tionship was found in parsimony analyses of total evidence and molecular data sets. Weak
support for a sister relationship of *Caperea* with balaenopteroids was found using Bayesian
and maximum likelihood analyses of molecular data. A Bayesian total evidence analysis
resulted in mostly unresolved relationships.

Previous workers have suggested that morphological support for Balaenoida is due to
convergence in feeding styles between balaenids and neobalaenids. To test this hypothesis, characters functionally correlated with feeding were either deleted or given lesser weight in separate phylogenetic analyses. This resulted in a small decrease in support values. The addition or deletion of extant and fossil taxa also had no significant effect on analyses. Characters were also partitioned to examine phylogenetic signal. Strong support for a rela-
tionship with balaenids is found in characters of the skull and mandible, while characters of
the ear and postcraniaal skeleton support a sister relationship with balaenopteroids. Long-
branch attraction, due to the early and rapid radiation of mysticetes, is the most likely expla-
nation for incongruence in molecular and morphologic phylogenies, although a reliance on
skull characters in mysticete systematics may also have a detrimental effect.

**NEW TITANOSAURIFORM SAUROPOD WITH ABUNDANT SKULL MATERIAL FROM THE CEDAR MOUNTAIN FORMATION, DINOSAUR NATIONAL MONUMENT**

CHURE, Daniel, Jensen, UT; BRETT, Brooks, GREENHALGH, B., Brigham Young Univ., Provo, UT

The study of sauropods is hampered by a dearth of skulls. Most skulls pertain to Middle
and Late Jurassic taxa and the Cretaceous skull record is extremely limited. Here, we here
report a new titanosauriform represent by multiple skulls. The specimens were recovered
from a fluvial sandstone pinched in the middle of the Cedar Mountain Fm., 32 m above
the contact with the underlying Morrison Formation. Cranial materials include 1) a spectacu-
larly complete 3-D skull, 2) a nearly complete disarticulated skull, 3) the front one-third of
an articulated skull, and 4) a braincase. The skulls were found with associated postcranial
elements. This taxon is the best known Cretaceous sauropod for cranial material & has one of
the best skull records for the group.

Salient skull characters include an incomplete internarial bar, retracted and confluent external
naries, narial fossa absent, quadrate vertical, basipectoral processes short, dentary with
external mandibular fenestra and retroarticular process, unexpanded tooth crowns,
tooth to tooth wear, and low tooth count (4 pmin, 10 max, 13 dent). The cervical centra are
long, camellate, and bear elongate ribs spanning three centra. Dorsal rib heads have large
pneumatic foramina. The humerus is long and gracile.

Preliminary phylogenetic analysis places this sauropod as a basal titanosauriform. The
skull, however, differs markedly from those of basal macronarians (*Camarasaurus*,
*Brachiosaurus*, and *Euhelopus*) in 1) lacking a large arching internarial bar, 2) having
small, confluent external naries, and 3) lacking a narial fossa. In these features it more
closely resembles the skull in diplodocids and the titanosaurans *Rapetosaurus*,
*Nemegtosaurus*, and *Guaiazauria*. This suggests that the skull morphology of the basal
macronarians is derived and the similarity between diplodocids and titanosaurids did not evolve in parallel but instead represents the general skull architecture for the
Neosauropoda.

3D Imaging Symposium, Friday 8:15

ANATOMY OF THE VERY TINY: TOMOGRAPHIC INSIGHTS INTO MOR-
PHOLOGY OF EXTINCT AND PRESENT FISHES

CLAESSEN, Kerin, UT Austin, Austin, TX; LUNDBERG, John, Academy of Natural
Sciences, Philadelphia, PA; HAGADORN, Whity, Amherst College, Amherst, TX

Small size and sparse number of specimens raise difficulties for detailed examination of the
skeletal anatomy for several groups of fossil and extant fishes. Comparative morphologic
and phylogenetic research on these groups is thus rendered more difficult. Their inclusion
is potentially significant for studying central questions of evolutionary biology such as
mammarization.

In an effort to address these problems, we began an investigation of the potential of
microfocus X-ray computed tomography (microCT) for resolving osteological details nec-
essary for comparative anatomy and phylogeny studies. The initial phase of this research
centered on tiny (<20mm) extant species of catfish *Sarcoptolus simplex* (Siluriformes:*
Trichoc erytidae*). Previous analyses of this fish (and others like it) were minimal and
described only external and soft-tissue anatomy. CT revealed skeletal morphology, never
before examined without the need to dissect, disarticulate, or otherwise modify rare speci-
mens. Successful microCT analysis on extant fishes prompted examination of fossil taxa of
approximately the same size.

The next phase of our research centers on recognition and description of the convergent
morphologies present in other fishes and fish larvae of approximately the same size. We are
examining osteichthyian material from the Eocene (Teleostei), Pennsylvania (Paleonisciformes),
and Devonian (Dipnoi). Each specimen is under 30 mm standard length. Fossil specimens are contained within either limestone, sandstone, or shale matri-
ces. Our preliminary results suggest that microCT provides a useful tool for studying fossil
and recent osteology with comparable and complementary data sets.

Thursday 2:45

**EVOLUTION OF THE RESPIRATORY APPARATUS AND BREATHING MECHA-
NISMS IN PTEROSAURIA**

CLAESSENS, Leon, College of the Holy Cross, Worcester, MA; UNWIN, David, Museum
dier Naturkunde, Berlin, Germany; O’CONNOR, Patrick, Ohio Univ., Athens, OH

An analysis of the postcranial anatomy of basal and derived pterosaurs, including comput-
eted tomography (CT) of three-dimensionally preserved remains of the pterodylactid *Anhanguera santanae*, has identified numerous skeletal pulmonary specializations consistent
with a model for flow-through ventilation of the lungs, suggesting the capacity for highly
efficient gas exchange. Pneumatic postcranial bones in pterosaurs imply the existence of a
highly-heterogeneous pulmonary system, with both exchange and nonexchange (i.e., air
sacs) regions, similar to that known in extant birds and inferred in saurisichian dinosaurs.
The absence of intermediate ribs in pterosaurs, including basal forms such as *
Eudimorphodon* and derived pterodylactids such as *Pteranodon*, indicates a decrease in
the degrees of freedom of movement of the thorax relative to the basal diaphond condition.
The structure of the broad sternal ribs, which articulated with relatively immobile vertebral
ribs proximally and a large sternal plate ventrally, indicates that the largest volumetric
changes during lung ventilation occurred in the postverentral thoracolateral region. Posteroventral volumetric changes are further enhanced by a mobile neomorphic prepubis
that articulated with an elongate anteroverentral condyle on the pubicopubic plate. CT evi-
dence for the presence of pulmonary air sacs in pterosaurs, combined with estimates of the
likely range of expansion and contraction of the postverentral trunk region, supports a
skeletal kinematic model for ventilating a flow-through style pulmonary system, specifical-
ly adapted for active flapping flight. Pterodylactoid pterosaurs exhibit evidence of further
specialization of the respiratory apparatus, including increased fusion within the thoracic
skeleton and enhanced postcranial pneumaticity. Such pulmonary specializations likely
played a central role in the evolution and diversification of pterosaurs.

Friday 8:45

**THE FAUNA OF THE MIDDLE-UPPER JURASSIC SHISHIGOU FORMATION,
WESTERN CHINA**

CLARK, James, Washington, DC; XU, Xing, Institute of Vertebrate Paleontology and
Paleoanthropology, Beijing, China; FORSTER, Catherine, Stony Brook Univ., Stony
Brook, NY

Joint expeditions of the Institute of Vertebrate Paleontology and Paleoanthropology, Bejing,
and George Washington University from 2001-2005 collected a large number of fossil
vertebrates from the Shishugou Formation. As detailed in David Eberth’s presenta-
tion at this meeting, the Shishugou Formation comprises allivious and palatal deposits with
interbedded tuffs radiometrically dated at 161-159 Ma, spanning the Middle-Upper Jurassic
boundary. This suggests that a faunal transition within the formation is related to a dramat-
ic worldwide cooling event at the end of the Middle Jurassic followed by warming in the
earliest Late Jurassic.

Our most recent discoveries are mainly from the upper part of the formation at
Wucaiwan. These include the oldest known tyrannosaurid, *Guanlong wucaiwan*, represent-
ated by two nearly complete skeletons. This crested form pushes the record of this super-
family back to the early Late Jurassic and is one of the oldest cilosaurids represented by
relatively complete skeletons. A second new taxon from Wucaiwan is *Yinlong downsi*,
the oldest and most primitive known ceratopsian. *Yinlong* preserves features of both ceratop-
sians and pachycephalosaurs, providing new evidence for margoceraphalian monophyly.
Abundant small crocodyliforms from Wucaiwan represent two taxa of shartegosuchids, and comparison with material from the Late Jurassic Morrison Formation of Colorado demonstrates that it is also referable to this family.

Neoceti Symposium, Saturday 9:00

STABLE ISO TOPE EVIDENCE FOR THE EVOLUTION OF DIFFERENT FEEDING STRATEGIES WITHIN THE NEOCETI

CLEMENTZ, Mark, Univ. of Wyoming, Laramie, WY; FOX, David, EDWARDS, R., Univ. of Minnesota, Minneapolis, MN

The Eocene-Oligocene transition marks a major advance in cetacean evolution with the appearance of the earliest representatives of each of the modern groups of cetaceans, the Mysticeti and the Odontoceti. These two groups diverged rapidly during the Oligocene, adopting two distinct styles of feeding: mysticetes became bulk feeders, filtering plankton and small fish from seawater, whereas odontocetes adapted to locating and ingesting individual prey items including fish, squid, and other marine mammals. To determine when this divergence in feeding strategy occurred within the Neoceti, we have begun analysis of two complementary stable isotope systems preserved within cetacean bioapatite: carbon isotopes (δ13C) as a measure of nearshore vs. offshore foraging and calcium isotopes (δ44Ca) as a measure of trophic level within marine food webs. Extant cetaceans foraging in offshore foodwebs typically have lower δ13C values (< -10‰) than nearshore foragers (-9.0‰) as a result of differences in the mean δ13C values of primary producers in nearshore and offshore foodwebs. Analysis of δ44Ca in modern cetacean biocarbonate has found that species foraging at lower trophic levels yield values that are up to 2 ‰ greater than those for species foraging at much higher trophic positions. We have sampled enamel and bone from late Eocene archaeocetes and Oligocene odontocetes and mysticetes (both toothed and baleen-bearing species) for C and Ca isotope analysis. Archaeocete δ13C values (~ -8.0‰ VPD) are typically enriched in δ13C relative to later occurring neocetes, which shows that earlier, more basal whales were foraging in nearshore environments. This suggests that both offshore foraging may not have evolved until after the divergence of Neoceti. Calcium isotope results from archaeocetes and Oligocene mysticetes are pending, but values for fossil odontocetes are extremely low (~ -2.0‰) and comparable to values for extant species, supporting use of δ44Ca values as a proxy for trophic level within ancient marine foodwebs. When combined with the δ13C results, δ44Ca values provide a powerful tool for examining the evolution of cetacean dietary preferences and feeding strategies through time.

Saturday 9:00

SALUTATORY ONTOGENY AND DEVELOPMENTAL MODULARITY IN THE LATE DEVONIAN OSTEOLEPIFORM EUSTHENOPTERON FOORDI

CLOUTIER, Richard, LEBLANC, JoëL, Université du Québec à Rimouski, Rimouski, QB, Canada

Recent evidences suggest that the early development in living fishes is characterized by alternate periods of steady steps and rapid thresholds giving a salting ontogenetic trajectory. Such trajectories can be inferred based on sequences of ossification in living and extinct vertebrates. In addition, these developmental sequences provide empirical data to identify developmental patterns and processes (e.g., phenotypic modularity). Direction of ossification within anatomical systems (ventral vs. dorsal and median fins) has been used to describe patterning modules. The presence of all appendicular and axial bony elements (ca. 350 structures excluding the lepidotrichia) of the Late Devonian osteolepiform Eusthenopteron forordi (Miguasha, eastern Canada) were recorded for 65 specimens ranging from 27 to 270 mm in standard length. Different directions of ossification have been inferred for the appendicular skeleton: distal to proximal (all fins), posterior to anterior (pectoral and second dorsal fins), anterior to posterior (pelvic and anal fins), and bidirectional (caudal fin). The general pattern of ossification shows a salting ontogeny (i.e., sequence of steady steps (slow) and rapid thresholds (accelerated development)). The first threshold (standard length of 42 mm) is associated with the formation of the “dorsal + anal fins” and “caudal fin” modules as well as the branching of the lepidotrichia (ossification of the posterior propulsive system). The second threshold corresponds to the ossification of the anterior part of vertebral column (standard length of 160 mm). Recent actinopterygian developmental studies in living species (teleost and median fins) has been used to describe patterning modules. The presence of all appendicular and axial bony elements (ca. 350 structures excluding the lepidotrichia) of the Late Devonian actinopterygian (E. forordi). However, differences of ossification patterns in the paired and median fins suggest co-option or dissociation of modularity.

Poster Session II

A COMPLETE SKULL OF ALLODAPOCYSUCHUS PRECEDENS NOPCSA, 1928 (EUUSCHIA) AND A REASSESSMENT OF THE MORPHOLOGY OF THE TAXON BASED ON THE ROMANIAN REMAINS

CODREA, Vlad, Universitatea Babes-Bolyai, Cluj Napoca, Romania; FOLIE, Annelise, COLLEGE, Timothy, North Carolina State Univ., Lucama, NC

A new eusuchian skull from the Maastrichtian locality of Oarda de Jos in the southwestern shore foodwebs typically have lower δ13C values (< -10‰) than nearshore foragers (-9.0‰) as a result of differences in the mean δ13C values of primary producers in nearshore and offshore foodwebs. Analysis of δ44Ca in modern cetacean biocarbonate has found that species foraging at lower trophic levels yield values that are up to 2 ‰ greater than those for species foraging at much higher trophic positions. We have sampled enamel and bone from late Eocene archaeocetes and Oligocene odontocetes and mysticetes (both toothed and baleen-bearing species) for C and Ca isotope analysis. Archaeocete δ13C values (~ -8.0‰ VPD) are typically enriched in δ13C relative to later occurring neocetes, which shows that earlier, more basal whales were foraging in nearshore environments. This suggests that both offshore foraging may not have evolved until after the divergence of Neoceti. Calcium isotope results from archaeocetes and Oligocene mysticetes are pending, but values for fossil odontocetes are extremely low (~ -2.0‰) and comparable to values for extant species, supporting use of δ44Ca values as a proxy for trophic level within ancient marine foodwebs. When combined with the δ13C results, δ44Ca values provide a powerful tool for examining the evolution of cetacean dietary preferences and feeding strategies through time.

In Hateg Basin (Romania) as well as on putative con-specific remains from approximately coeval localities in Spain and France: *A. precedens* is the sister taxon of the crown-group Crocodylia. However, some relevant morphological traits differ from what was previously reported for this taxon: the external nares is large and antero-dorsally directed; the lateral profile of the skull is not festooned in dorsal view; the suborbital fenestrae reach the eight alveoli; the postorbital bars are lightly built and inset from the jugal margin; the skull table is approximately planar or medially concave; the skull table does not markedly overhangs the supratemporal fenestra; the exoccipitals are not significantly involved in the basioccipital tubera. Since the condition of most of these characters, unknown in the holotype, was previously evaluated on non-Romanian remains only, the morphological discrepancies between Romanian and western European fossil could suggest the presence of different taxa, possibly of infra-generic rank. *Allidapousuchus* and presumably *Hyaloconschia* are the only Eusuchians showing a laterally open craniouquadrate passage.

Friday 12:15

THE VERTEBRATE SKULL AS HABITAT FOR INVERTEBRATE ANIMALS

COLBERT, Matthew, EKDALE, Eric, Univ. of Texas, Austin, TX; EKDALE, Allan, Univ. of Utah, Salt Lake City, UT

The confined cavities and passageways within vertebrate skulls represent a unique sedimen-
tary environment. These limited spaces not only constrain the deposition of sediment but also constrain subsequent sediment modification by bioturbating organisms and diagenetic agents. High-resolution X-ray CT scanning (HRXCT) provides a method for non-destruc-
tive investigation of these cryptic features, allowing access to a hitherto unexplored aspect of vertebrate taphonomy. Here, we focus on the use of the vertebrate skull as a habitat exploited by invertebrate organisms. The presence of these invertebrates is inferred by the ichnofabric of traces that they leave when passing through the sediment. Analysis of these traces testifies to the often-complicated history of vertebrate animals after death and burial.

The use of the skull as habitat by invertebrates is illustrated here with several fossils that were recovered from terrestrial and marine depositional settings. We focus on the skull of a Cretaceous chelonioid turtle from the marine Bearpaw Formation of Alberta, Canada. While thorough bioturbation has obliterated any primary sedimentary features within this skull, HRXCT data reveal a complex ichnofabric that includes the following ichnotaxa: Zoophycos, Chondrites, Planolites, and possibly Taenidium and Arenicolites. Taking advan-
tage of the three-dimensional nature of the CT data, we isolated several of these traces revealing irregularly restricted, or stenomorphic morphologies—a consequence of their confining habitat. The distribution of these traces is reminiscent of the tiering of ichnosa-
nas that has been documented in other marine environments, and indicates the complexity of the ichnofabric. This ichnofabric, in conjunction with the confined setting, has influenced subsequent diagenetic cementation as indicated by X-ray attenuation. This illustrates the forensic potential of CT analysis for not only documenting the postmortem use of the skull by invertebrates, but also for revealing diagenetic aspects of fossilization and preservation.

Poster Session III

CHEMICAL ANALYSES OF RATITE BONE COMPOSITION: A BASELINE FOR COMPARISON TO THEROPOD FOSSILS

COLLIER, Timothy, North Carolina State Univ., Lucama, NC

As the extant taxon most closely related to dinosaurs, birds are commonly used to test many hypotheses regarding dinosaurian biology, including biomechanics, growth, and physiological strategies, including reproductive physiology. Ratites (ostriches, emus) are the most primitive extant avian taxon, and share more characteristics with dinosaurs than do more derived groups. Even though ratites are the most appropriate model for most aspects of dinosaur biology, there is a paucity of data, particularly biochemical data, relating to many of these characteristics. The goal of this study is to characterize chemical differences between medullary (reproductive) and compact bone tissues in ratites. Medullary bone is a gender-specific, highly vascular, well mineralized tissue, deposited on the endosteal surface of long bones only during ovulation. In galliformes (chickens, quails), the group for which most data exist, medullary has been shown to be biochemically distinct from compact and trabecular bone, but similar studies have not been conducted in ratites. We will apply a combination of spectroscopic techniques, including FTIR, immunological assays, and differential histochemistry (High-Iron Diamine, HID), to identify chemical components unique to medullary bone tissues of ratites. The presence of morphologically similar reproductive bone tissues in a well preserved *Tyrannosaurus rex* suggests the possibility of retrieving biochemical data for direct and objective comparison of non-avian theropods and extant birds.

Wednesday 8:45

A COMPLETE CRETACEOUS IGUANIAN (SQUAMATA) FROM THE GOBI CONRAD, Jack, NORELL, Mark, American Museum of Natural History, New York, NY

We describe a new Cretaceous iguanian from the Mongolian Gobi Djadokhta Formation. The new taxon is the earliest known complete skeleton of an iguanian and offers important insights into the historical skeletal morphology of Iguania. The only known specimen (IGM 3/858) is an articulated skeleton missing only parts of the right limb, the distal pedal pha-
langes, and tail tip. IGM 3/858 is diagnosed by a combination of character states including the presence of a frontoparietal fontanelle, absence of enlarged M. spinalis capitis fossae, and absence of flared tooth crowns, among others. We performed a phylogenetic analysis.
including 39 iguanian terminal taxa, 14 scleroglossans, and the outgroup Rhynchocephalia, scored for 202 informative morphological characters. A strict consensus of the 46 shortest trees reveals an endemically clad of five Cretaceous Gobi iguanians (including IGM 3/3858) diagnosed by strong median processes of the maxillae, a weakly inclined exoccipital, nasal process, medially forked postfrontal, mediolaterally elongate prefrontal, and absence of a dorsal process of the squamosal.

Our phylogenetic hypothesis places the Gobi clade in a nested position within Pleurodontia (Iguanidae sensu lato). This result is important because 1) most extant pleu-
dodontan radiations are primarily or exclusively North or South American; 2) exclusively fossil radiations of iguanians were previously limited to the accrodonian group Priscagamidae; 3) the new clad possesses plesiomorphic features unexpected in a nested pleurodontan clade. These data offer new insights into the paleobiogeography of iguanians, indicate a more complex story of character evolution, and suggest the appearance of numer-
ous radiations of pleurosaurians before the end of the Cretaceous.

Wednesday 12:15
PLESIOSAUR TAPHONOMY—FEEDING BEHAVIOURS AND STEINAL BAS-
KETS
COOK, Alex, Queenslend Museum, South Bank, Australia; McHENRY, Colin, Univ. of Newcasle, Callaghan, Australia; WROE, Stephen, Univ. of New: South Wales, Sydney, Australia; EVANS, Mark, New Walk Museum, Leicester, United Kingdom

Despite the importance of plesiosaurs in Jurassic and Cretaceous marine ecosystems, their ecologies remain much debated. How did long-necked plesiosaurs use their extraordinary neck in catching food? Were gigantic plesiosaurs capable of consuming truly large prey, or were they restricted to prey small enough to swallow whole?

Taphonomic and trace fossil evidence provide an invaluable complement to morpholo-
gy-based interpretations. Plesiosaur fossils from Lower Cretaceous deposits of Great Artesian Super Basin (GASB), Australia, are commonly preserved with stomach contents. Many specimens referable to Elasmosauridae preserve gastrooliths with exotic provenance, suggesting that they travelled some distance to obtain stomach stones. Elasmosaurids are usually described as nektan feeders, but preservation of hard shells benthic prey in two GASB specimens suggests that gastroliths may have had important digestive benefits, and that elasmosaurid diets were broader than has been supposed.

Two Kronosaurus contain marine reptile remains, confirming that these plesiosaurs were apical predators. The presence of a c. 1 tonne plesiosaur in one suggests that they could eat prey too large to be swallowed whole and were capable of shake or twist feeding.

Taphonomic evidence can also throw light upon basic questions regarding plesiosaur functional anatomy. The arrangement of the limbs, with two pairs of large hydrofoils pro-
viding thrust for swimming, is unique and thus there has been no consensus on the function-
al morphology of the limb, girdle, and trunk regions. Most reconstructions assume that ple-
siosaurs lacked a sternum, but the Nicholls and Russell model argues the presence of a ster-
nal basket based upon ontogenetic, functional and comparative phylogenetic evidence.

Taphonomic and morphological evidence from a number of plesiosaur families is consistent with this model, further suggesting that an assumption of absence of a sternum in ple-
siosaurs is problematic. The Nicholls and Russell model has important but relatively unex-
plored implications for the functional morphology of the plesiosaurian pectoral girdle.

Neoceti Symposium, Saturday 8:15
HETEROCHRONY IN GENE EXPRESSION IN EOCENE AND OLGOCENE CETACEANS
COOPER, Lisa, THEWISSEN, J.G.M, NEOUCOM, Rootstown, OH

Most mammals have a generalized phalangeal formula with two phalanges in the thumb and three in the remaining digits. Cetaceans are different and have more than three phalanges per digit (hyperphalangy). The functional reasons for evolving hyperphalangy are unknown. These reasons are probably unrelated to simple digit elongation, as bats have greatly elon-
gated fingers, but are not hyperphalangeous. Fossil evidence shows that Eocene archaeo-
cetes—typically patterned forelimbs, but hyperphalangy evolved during the Oligocene. Surprisingly, cetacean dentition also lost standard patterning during this time, giving rise to homodonty and polydonty in toothed whales, and baleen in some whales. These dental and phalangeal pattern changes may have been caused by altering the timing of expression of a developmental switch. Studies of gene expression during dolphin embryogenesis indicate that at least one protein, fgf-8, is active during dental and forelimb development. Specifically, it appears that the protein fgf-8 is expressed while the forelimb bud is project-
ing from the body wall up to the first or second month of gestation. Fgf-8 expression prob-
ably ceases as patterning of the digital rays, and subsequent digit elongation begins, unlike the generalized mammalian pattern, suggesting that heterochronous changes in timing of expression took place.

Poster Session III
LEPTOTRAGULINE DIVERSITY IN THE MIDDLE EOCENE UINTA FORMA-
TION, UTAH
COPE, Dana, College of Charleston, Charleston, SC; TOWNSEND, K, School of Medicine, Case Western Reserve Univ., Cleveland, OH

Leptotraguline artiodactyls are among the most abundant elements of the fossil mammal assemblage from the Uinta Formation. The two leptotragulines from this region, Leptotragulus and Leptotragulus, are known mainly from dental remains. Both taxa exhib-
it very similar molar morphologies yet are only distinguished at the generic level by differ-
ces in the lower P4. Because their molars are often not associated with lower premolars, most leptotraguline molars have been catalogued as Leptotragulina, leaving the impression that Leptotragulus is a rare species.

In this study, we evaluated molar characters for both Leptotragulus and Leptotragulus. We evaluated leptotraguline specimens with molars (N=48), most catalogued as Leptotragulina. Molar specimens of Leptotragulus were identified by an associated lower P4 that exhibits a sharp crest running the entire length of the tooth, small rather than bulbous cusps and a vertical rather than horizontal, lingual “talonid”. Two distinct molar morphs (A and B) were observed. In morph A, the cristid obliqua does not merge with the pro-
tocristid but instead curves back toward the entoconid. In morph B, the protocristid and cristid obliqua do merge near the metaconid and form a “bridge” linking the trigonid and talonid. Upper molars present an analogous dichotomy. In morph A, the postprotocrista and prehypocrista do not merge, in morph B they do. In specimens with more than one molar we found no cases where they did not appear as the same morph. With one excep-
tion, in 16 cases with associated molars and lower P4s, morph A is found in Leptotragulus and morph B is found in Leptotragulus. In the total sample there were only five cases where specimens could not be placed in this simple dichotomy. Although still less common than Leptotragulus, our results indicate that Leptotragulus was by no means a rare taxon.

Poster Session I
TWO NEW MANDIBLES OF RANGWAPITHECUS GORDONI FROM THE EARLY MIOCENE OF WESTERN KENYA
COTE, Susanne, Harvard Univ., Cambridge, MA; NENGO, Isaiah, DeAnza College, Cupertino, CA

Rangwapitheicus is an enigmatic and poorly known Early Miocene catarrhine. Originally named as a subgenus of Proconsul, Rangwapitheicus is now regarded as a separate genus. Features that distinguish Rangwapitheicus from all other Miocene catarrhines, including Proconsul, are the presence of mesiodistally elongated molars with long shearing crests, and an elongated P4. The only species, Rangwapithecus gordoni, is known from a single local-
ity: Songhor in Western Kenya. Songhor is located in the Kapurup Agglomerates and is radiometrically and biostratigraphically dated to between 19 and 20 Ma.

Here, we report two new mandibles that we assign to Rangwapithecus gordoni: KNM SO 22228 from Songhor; and KNM KK 31234 from a new locality. Lower Kapurup. Lower Kapurup is located 2 kilometers from Songhor and is thought to be roughly contempo-
aneous with the main Songhor deposits. Both sites are located in the same geological for-
mation (the Kapurup Agglomerates), and show no obvious differences in their fossil assemblages.

These new mandibles add substantially to our knowledge of the paleobiology of Rangwapithecus gordoni. First, they provide additional details on the mandibular mor-
phology of R. gordoni. For example, the mandible does show posteriorly, but to a lesser degree than Proconsul africansus. Second, they permit improved identification of isolated teeth previously assigned to Rangwapithecus and Proconsul—particularly the canines. Third, they demonstrate that Rangwapithecus gordoni is significantly more sexually dimor-
phic than had previously been assumed. KNM SO 22228 is inferred to be female, while KT 31234 is male. The canine of KNM SO 22228 is much smaller than those previously identi-
fied as Rangwapithecus female canines. Fourth, they provide further details on the degree
of intraspecific variation in size and morphology present in Rangwapipterus gordoni. In particular, KM KT 31234 shows interesting differences from other male Rangwapipterus mandibles including an uncharacteristically short P4. It also demonstrates that there is significant variation in male canine size, though not beyond the range of variation seen in modern carnivore species.

Poster Session II
PHOSPHATE OXYGEN ISOTOPE VARIATION IN MARINE TURTLE BONES AND ITS POTENTIAL ECOLOGICAL UTILITY
COULSON, Alan, Univ. of South Carolina, Columbia, SC

While stable isotope analyses of vertebrate fossils can provide palaeoclimatic information, it is important to first study modern analogs to better understand how the isotopic composition can vary within a living animal in order to avoid erroneous data interpretation. To this end, the oxygen isotope content of modern marine turtle bone is being studied to assess the utility of fossil marine turtle bone geochemistry for palaeoenvironmental reconstruction. Phosphorus has been the focus of analysis; given the strength of the phosphorus-oxygen bond, it offers the best chance for preservation of the original isotopic content of bone.

In accordance with CITES regulations, samples were taken from deceased loggerheads (Caretta caretta) and leatherbacks (Dermochelys coriacea) and are being analyzed to better understand how the bone phosphate oxygen isotopic signal varies within both a population and an individual animal. Preliminary data indicate that samples taken from bones near the body core of sub-adult and adult individuals may record the average seawater isotopic value experienced during bone growth, similar to the correlation found between the bone phosphate oxygen of certain non-marine turtle taxa and their ambient water. Variation in the data between distal and proximal skeletal elements may result from temperature gradients along the extremities. Different isotopic values between large- and small-sized individuals within a population may reflect differences in body water turnover rate or thermoregulatory capability. More data is forthcoming to test these hypotheses.

Wednesday 5:15
THE EARLY MICOCENE CHUCAL FAUNA, NORTHERN CHILE: NEW SPECIMENS AND A DESCRIPTION OF ITS XENARTHRANS
CROFT, Darin, Case Western Reserve Univ., Cleveland, OH; WYSS, André, Univ. of California—Santa Barbara, Santa Barbara, CA; BURNS, Megan, Case Western Reserve Univ., Cleveland, OH; FLYNIN, John, American Museum of Natural History, New York, NY; GRANA, Susan, Illinois Wesleyan U., Bloomington, IL

The late early Miocene Chucal Fauna of the Chilean Altiplano is the northernmost fauna referable to the Santacrucian South American Land Mammal “Age.” Located ca. 30° north of classic Patagonian Santacrucian localities, it presents a unique opportunity to examine South American provinciality during this interval. Presently, only the endemic ungulates of Chucal (Notoungulata and Litopterna) have been described in detail. We here describe the xenarthrans and discuss other important new specimens recovered during our most recent (2004) field season.

Xenarthrans are uncommon at Chucal and include only three cingulates (armored forms); in contrast, cingulates and pilosas (sloths) are speciose and abundant in contemporaneous Patagonian localities. For the most part, the Chucal individual, include a mandible, partial carpature, and articulated limb bones. The species is unique among glyptodontids in having a complex, imbricated anterior mandibular dentition (n1-3) and a carapace with relatively large central figures positioned along the posterior edge of each osteoderm. A dasyodoid roughly the size of the diminutive Procaecadius (Euphractini) is represented by several fragmentary specimens. It most closely resembles, but is much smaller than, Stemotatus (Eutatini) from Patagonia; its osteoderm bears three distinct longitudinal ridges and a distal row of prominent piliferous pits. Two isolated peltephilid osteoderms do not differ significantly from Patagonian Peltephilus. The large proportion of novel cingulates at Chucal (67%) and the apparent absence of sloths suggest a marked regional endemism during the early Miocene.

Specimens collected in 2004 abound additional material of the oldest known chinchilinoid rodent and document at least three previously unrecorded species: a small reed (C4) rat from the first Tertiary amphibian known from Chile, represented by at least two partial skeletons. The mammal fauna presently includes seven notoungulates, one litoptern, at least four rodents, three cingulates, at least one marsupial, and one tiny indeterminate specimen.

Poster Session II
UPPER PLEISTOCENE PLIOPLYSI LENKI (RONTENTIA, MAMMALIA) IN IBERIA: A TALE OF FICKERING EXTINCTION
CUENCA-BECÓS, Gloria, Univ. of Zaragoza, Zaragoza, Spain; GONZÁLEZ-MORALES, Manuel, Univ. of Cantabria, Santander, Spain; BARCO, Juan, Zaragoza Univ., Zaragoza, Spain; STRAUS, Lawrence, Univ. of New Mexico, Alburquerque, NM, Beside Neandertals, other mammal species vanished locally or totally in Europe during a short period—an instant in the geological time scale—between about 40-17 k BP. They did not disappear suddenly, but rather in waves of local withdrawals, Lazarus effect, that ultimately led them to final extinction. A good example is in the sequence in El Miron (Cantabria, North Spain), that yields a rich rodent collection, well 14C-dated, representing the time span of the middle upper Pleistocene (UP) through the mid-Holocene (41-2 k BP).

In El Miron, we can trace the extinction history of P. lenki, an arvicoline rodent that persist- ed in Iberia after its extirpation in the rest of Europe at the beginning of the UP. An initial disappearance from the El Miron occurs just above a level (L1) in which an arvicoline relative is well represented (late Mousterian, L130, 41 k BP) and coincides with a faunal turnover (post- Mousterian, L128, 27 k BP, and above) that also (presumably) includes the disappearance of the Neandertals in North Spain. The Lazarus effect is detected between El Miron levels 130-120, with P. lenki reappearing again in L120, dated between 17-19 k BP. Then it went extinct. Mousterian localities with Neandertals outside of Cantabria do have P. lenki, though in lesser frequencies. As in Cantabria, the species disappears for a short period, but then reappears in post-Mousterian times dated to roughly 20 k BP. For the moment, there is no record of this species in younger levels, thus indicating that its extinction did take place around this time. This in turn seems to suggest that conditions adequate for P. lenki existed at least in some areas of Iberia (although not in other regions of Europe) during the mid UP. The harsh conditions of late MIS3–early MIS2 probably forced its local, step-wise extirpa tion in anticipation of its final extinction. Something similar may have happened to the Neandertals some 10,000 years earlier.

Poster Session II
THREE-DIMENSIONAL RECONSTRUCTION OF THE SKULL OF RAPETO-SAURUS KRAUSEI (SAUROPODA: TITANOSAURIA)
CURRY ROGERS, Kristina, Science Museum of Minnesota, St. Paul, MN; HERTHEL, Janice, Research Casting International, Beamsville, ON, Canada; GROENKE, Joe, SUNY Stony Brook, Stony Brook, NY

Rapetosaurus krausei, a titanosaur from the Late Cretaceous Maevarano Formation of Madagascar is known from a sample of cranial and postcranial material. The holotype adult skull (UA 8698) includes paired and single elements that articulate precisely along sutural margins, and represent the rostrom, mandible, and basiarcualum. A referred juvenile skull (FMNH PR 2184-2192, 2194, 2196, 2197, 2209, 2210) preserves elements from the braincase and cranial vault, as well as isolated teeth, which also articulate precisely. Both skulls preserve pterygoids, basioccipital and paroccipital processes, quadrates, suranguloles, and teeth, all of which show autopomorphies that distinguish Rapetosaurus. A 3-D reconstruction of the skull of Rapetosaurus proves challenging given the ontogenetic variation in preserved bones and the lack of most contralateral elements in either skull. Here we utilize 3-D laser scanning and rapid prototype printing to clarify Rapetosaurus cranial morphology through three-dimensional reconstructions of juvenile and adult skulls.

Each of the Rapetosaurus elements were rendered with a Minolta Vivid 9i non-contact 3-D digitizer and Polyworks 9.1.6 software, and printed with a ZPrinter 310 rapid prototype printer. The point cloud manipulation software allowed us to compare the same bones in juveniles and adults in the same three dimensional space, digitally compare articulations, mirror scans to print missing contralateral elements, and digitally scale elements to fit each skull. The percentage of size change observed in overlapping bones (e.g., surangular, quadrato) informed the scaling of printed elements. Juvenile skulls were scaled by ~200% for articulation with preserved adult elements, and adult bones were scaled down by ~50% to articulate with preserved juvenile elements. In the final reconstructions of the skulls, prints were articulated, and only the articular, quadratojugal, postorbital, and pre-maxillae were sculpted. The articulated Rapetosaurus skulls indicate that the rostrum is “stepped,” the external naris are more laterally positioned, and the expanded antorbital fen estra is proportionally closer to those of other macronarians.

Marine Reptiles Symposium, Wednesday 5:30
A NEW PLOIPLATECARPINE MOSASAUR (SQUAMATA: MOSASAURIDAE) FROM THE PIERRE SHALE (LOWER CAMPANIAN) OF SOUTHWEST MONTANA
CUTHBERTSON, Robin, MALLON, Jordan, CAMPTONE, Nicolas, Carleton Univ., Ottawa, ON, Canada; HOLMES, Robert, Canadian Museum of Nature, Ottawa, ON, Canada

A new species of mosasaur from the Lower Campanian (Pembina Member, Pierre Shale Formation) of southwestern Manitoba is described. It shares with Platecarpus tympaniticus the following derived feature: a square median extension of the anterior margin of the pari- etal foramen that reaches the frontoparietal suture, but does not invade the frontal, an incipient process of the maxilla that wraps medially around the base of the postmaxillary, and rib shaft with a proximally circular cross section. Although the new taxon is clearly a platecarpincine mosasaur close to the Platecarpus-Plioplatecarpus clade, it cannot be accommodated in either genus as presently diagnosed.
Poster Session II

FOOTPRINT MORPHOLOGY AND BIOMECHANICS OF SMALL ORNITHISCHIAN DINOSAURS: AN INQUIRY INTO THEIR extinction.
Wednesday 4:30

EVOLUTIONARY TRENDS IN THEROPOD FORELIMB EVOLUTION

DECCICHI, T. Alexander, LARSSON, Hans, Redpath Museum, McGill Univ., Montreal, QB, Canada

The evolution of Aves from within Theropoda has been intensely researched in recent decades. Unfortunately the large-scale trends that shaped theropod evolution and constrained avian origins are less well studied. Much work has been done to generate large numbers of characters and a plethora of phylogenies that encompass nearly the entirety of theropod evolution. This vast body of work was used to compile a set of nearly two hundred osteological characters of the forelimb and pectoral girdle. These characters were scored for nearly one hundred and fifty fossil and extant theropod taxa. Distinctive analyses were used to examine the relative rates of evolutionary among all major theropod lineages. Characters were subdivided into modules to examine the evolutionary trends within the pectoral girdle, stelpodopod, zeugopodopod, and autopodopod independently and as a whole. Results indicate multiple short periods of relatively high rates of character change throughout the theropod evolution. These spikes reflected increased evolutionary rates within single modules that rarely coincided with spikes in other modules. This pattern indicates that the system did not evolve as a single unit, but in a punctuated manner focusing on different regions within the forelimb. The node Aves did not correlate with a large amount of novel character appearance, highlighting that the transition between Paraves and Aves was not a period of evolution in the forelimb osteology. This study indicates that the bau-plan for avian forelimbs predates the origin of the clade, but the evolutionary rates were punctuated at discrete non-avian theropod clades.

Friday 2:45

A REVISION OF DUBOIS CROCODILIANS: GAVIALIS BENGWAUANICUS AND CROCODYLIES OSSIFRAGUS FROM THE EARLY PLEISTOCENE HOCO BEDS OF JAVA

DELFINO, Massimo, Università di Firenze, Firenze, Italy; DE VOS, John, Naturalis, National Naturhistorisches Museum, Leiden, Netherlands

Along with the “Pithecanthropus erectus” remains that broadened the late nineteenth-century views about human evolution, the Dubois expeditions to Java discovered abundant fossil reptiles represented by crocodylians, turtles, monitors and pythons. In 1908, on the basis of the apparently preserved atlas and axial bones in the National Museum of Natural History of Java, Dubois described a new crocodylians, Crocodilus ossifragus and Garialis bengawanicus. Few years later, in a paper concerning the crocodilian remains from the same Homo-beds of Java and collected during the “Selena-Trin” expedition (now belonging to the Museum für Naturkunde of the Humboldt-Universität, Berlin), Janensch accepted the species created by Dubois.

The turtle remains have been afterwards revised by Das and referred to the extinct genus Mauremys, whereas a proper identification of the crocodylians has not been verified in recent times and the phylogenetic position of these taxa has not been assessed with a phylogenetic approach. At present, Crocodylus ossifragus is considered as a possible synonym of the living species C. siamensis while the name Garialis bengawanicus apparently disappeared from scientific literature.

The morphology of C. ossifragus does not allow to diagnose a new species and its identification as C. siamensis is supported by the presence of well developed "squamosal horns" despite the absence of an evident interorbital ridge. Conversely, G. bengawanicus can be considered a valid fossil species characterised by a shorter snout (smaller number of maxillary and dentary teeth), a modest maxillary process developed into the lacrimal, a W-shaped maxillo-palatine suture, a planar skull table and rather rounded supratemporal fossae.

3D Imaging Symposium, Friday 11:00

3D APPROACHES IN PALEONTOARCHAEOLOGY USING GEOMETRIC MORPHOMETRICS AND LASER SCANNING

DELSON, Eric, American Museum of Natural History and City Univ. of New York, New York, NY; WILEY, David, Univ. of California, Davis, Davis, CA; HARCOURT-SMITH, William, American Museum of Natural History and City Univ. of New York, New York, NY; FOSTER, Stephen, Univ. of Oregon, Eugene, OR; ROSENBERGER, Alfred, Brooklyn College/CUNY, Brooklyn, NY

The emergence of 3D GM (geometric morphometric) techniques as a way of quantifying
morphology has significant implications for 21st century paleontology. Not only is it possi-
ble to easily collect data in a true 3D sense, such as sets of homologous landmarks or com-
mplex 3D shapes, but it is also possible to access models created in increasingly complex and
more elegant ways that were computationally impossible even a few years ago. We present an
exciting new study that integrates techniques of 3D data collection with computer graphics
and computationally complex multivariate analyses to place biological shape change with-
in an evolutionary context. The basic aim of this project is to infer ("reconstruct") the 3D
cranial shape of hypothetical intermediate ("ancestral") taxa along an a priori evolutionary
tree. We focus on the papionin cercopithecids (Old World monkeys), a taxon well-represent-
ed in the fossil record which underwent a massive Pliocene-Pleistocene radiation in Africa.
Our baseline cladogram and its divergence dates are estimated using molecular data from
living papionins. The mean cranial shape of each taxon (separately by sex) is calculated
from a fragmentary lower left ?m2, represents

BQFR can be used for future studies of associations among different contemporaneous
species. This study will provide new insight into the paleoenvironmental interpretations. A recent quantitative study of a vertebrate microsite
in the Upper Pennsylvanian of Illinois (USGS IVPP, 2002) has yielded a surprising result: nearly 100% of the fossil association appears to be
herbivorous. We argue that this was due to the specific geological setting, the Upper Pennsylvanian
times, where the area was characterized by a series of small ponds and lakes. These conditions
created an environment that was ideal for herbivorous mammals to thrive. This study
highlights the importance of understanding the paleoenvironmental setting of fossil localities
when interpreting their taphonomic history.

**Poster Session I**

**STATISTICAL ANALYSES OF A VERTEBRATE MICROSITE FROM THE MESAVERDE FORMATION, WYOMING**

DEMAR, JR., David, CLEMENTZ, Mark, CASSILIANO, Michael, Dept. of Geology and
Geophysics, Univ. of Wyoming, Laramie, WY; BREITHAUPF, Brien, The Geological
Museum, Laramie, WY

A study of the Barwin Quarry/Fales Rocks (BQFR) vertebrate microsite in the Upper
Cretaceous (Campanian) Mesa Verde Formation of Wyoming was conducted to infer its
paleoenvironment based on the sedimentology, nonmammalian taxonomic diversity, and
known ecological niches of extant taxa. Results from this study suggest that BQFR was pri-
marily a subtropical, freshwater community. Current statistical analyses of BQFR encom-
passing rarefaction (an ecological statistical method which estimates the number of species
one might expect to find in a random sample of individuals from a community), minimum
number of individuals (MINI), numbers of elements per taxon, and relative abundances of
individuals (% total of MINI or species evenness) were used to supplement evidence for
paleoenvironmental interpretations. A recent quantitative study of a vertebrate microsite
(Bonebed 105 of the Oldman Formation, Alberta) using standardized sampling methodol-
y has shown that analysis of large samples yields no significant differences in diversity
and abundance when compared to data gathered through controlled subsampling.
Application of this methodology was used to compare previous results of species richness
(number of taxa in a community) at BQFR, as well as to determine species evenness.
Results were compared to Bonebed 105 (a similar sedimentologic and taxonomic geologic
unit) to determine common paleoecologic patterns.

In addition to newly identified nonmammalian taxa from BQFR, the presence of
_Eodelphis_ (Murinaeidae, Stenotomidae), including a species from the Late Oligocene of
Africa. Our baseline cladogram and divergence dates are estimated using molecular data from
diversity. We propose that these palatal foram- in the Upper Cretaceous of Wyoming was conducted to infer its
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A PHYSIOLOGY OF PLEOSAURIA (SAUROPTERYgia), WITH EMPHASIS ON THE SYSTEMATIC STATUS OF LepTocleidedus, ANDRews 1922

DRuCKENMILLer, Patrick, RUSSell, Anthony, Univ. of Calgary, Calgary, AB, Canada

Leptocleididae Andrews, 1922 is a poorly known plesiosaur genus from Lower Cretaceous successions of the UK, South Africa, and Australia. Historically, there has been little consensus regarding its phylogenetic position within Plesiosauria, largely due to its unusual combination of a relatively small skull and short neck. As a result, a diverse array of potential sister groups have been posited for Leptocleidus, including long-necked Cretaceous elasmosaurs, Early Jurassic "rhomaleosaurs", and Middle to Late Jurassic pliosaurs. A cladistic analysis including Leptocleidus, and a new, apparently morphologically similar specimen from Alberta, TMP 94.122.01, was undertaken to assess their phylogenetic position within Plesiosauria. A character-taxon matrix was assembled, consisting of 28 taxa sampled broadly among plesiosaurs, scored for 152 critically reanalyzed and redefined cranial and postcral- nial characters. The results indicate a basal dichotomy split into the traditionally recognized plesiosaurid plesiosaurs and pliosaurid clades. Nested within Pliosauroidea, a monophyletic Leptocleididae was recovered, consisting of L. superstes, L. capensis, and an unnamed Australian taxon on AM FM9574. In contrast to earlier suggestions, Leptocleidus neither clusters with Rhomaleosaurus, which was found to be paraplytic, nor with large-skulled pliosaurid taxa, such as Simolestes. Rather, a sister group relationship between Cretaceous Polycotylidae and Leptocleididae was recovered. Although TMP 94.122.01 is superficially similar to Leptocleidus, several discrete characters of the skull indicate that this new taxon is nested within Polycotylidae.

Poster Session II
TYPOMATIC PNEUMATICS IN ARCHOSAURIA: RECOGNIZING PATTERNS OF ORGANIZATION AND HOMOLOGy

DufEau, David, Witmer, Lawrence, Ohio Univ., Athens, OH

The tympanic cavity of archosaurs gives rise to a variety of epithelial diverticula that pneu- matize the bones of the braincase and supracranial cranial elements. This pneumaticity is not well understood with regard to its ontogeny, morphological variability, and phylogenetic distri- bution. Moreover, the relationship of true tympanic pneumaticity to other pharyngeal pneu- matic systems in the braincase has been completely unexplored. We present here a prelim- inary survey of braincase pneumaticity in Archosauria and tests of homologies of the asso- ciated pneumatic recesses. Methods include computed X-ray tomography (CT), microCT, and 3D visualization of the CT scan data, which together provide a detailed characterization of the pneumatic recesses relative to the skeleton, otic labyrinth, and brain cavity. Additionally, CT scans of extant taxa, coupled with dissection, give insight into the soft-tis- sue associations of the diverticula. To shed light on the highly derived condition of adult crocodilians, ontogeny of pneumatic sinuses is being traced via microCT in a growth series of American alligator. Morphological similarities between examined fossils and extant taxa were examined in a phylogenetic context, allowing tests of hypotheses of homology. Of par- ticular interest is the evolution of these two distinct cranial pneumatic systems in three distantly related archosaurs. Study of the avian condition is further advanced, and focal therocephal taxa include the ceratosaurs Majungasaurus, the allosauroids Aucasaurus acrocanthosaurus and Allosaurus, as well as nonavian coelurosaur taxa such as tyrannosaurs, oviraptorosaurs, ornithomimids, troodontids, and dromaeosaurs. Homologies of median pharyngeal sinuses in the basicran- nium of archosaurs remain equivocal. The rostral tympanic recess, however, is the most wide- ly distributed of the paratympanic sinuses whereas the dorsal tympanic recess may be more restricted to coelurosaur clades where it shows high levels of homoplasy.

3D Imaging Symposium, Friday 11:15
3D IMAGING AND BIOMECHANICS: BRINGING 3D FINITE ELEMENT MODELING TO COMPARATIVE BIOLOGY

Dumont, Elizabeth, Werle, Sean, Gross, Ian, UMass Amherst, Amherst, MA

The development of 3D imaging techniques has given comparative morphologists the ability to visualize and compare structures in exciting new ways. Work in our lab focuses on taking 3D data a step beyond imaging by transforming them into finite element models that serve as the basis of comparative biomechanical analyses. Finite element analysis (FEA) is a physics-based numerical technique routinely used by engineers to predict and optimize the behavior of engineered products. FEA is relatively new to functional morphology but clearly can provide highly novel, quantitative, as well as qualitative, perspective on form-func- tion relationships. In the engineering world, engineers use powerful computer aided design (CAD) tools to rapidly create a mathematically geometric model of the product that is required for FEA. However, in the biological world geometries of organic systems are high- ly irregular and not amenable to construction by CAD tools. Instead, the complex geome- tries of many biological structures must be digitally reconstructed from stacks of 2-D image scans. This digital reconstruction process from raw image data to 3-D mathematical geo- metric models is the most significant impediment to the widespread use of comparative FEA. Our lab has been working to simplify this process and thus make FEA more available to vertebrate morphologists. In this symposium, we present new, efficient methodologies which facilitate the development of finite element models of vertebrate structures. The development of these improved finite element modeling techniques are part of a larger research project to study the biomechanical links between cranial morphology, bite force and biting behavior in mammalian evolution.

Marine Reptiles Symposium, Wednesday 2:30
A PHYSIOLOGY OF PLEOSAURIA (SAUROPTERYgia), WITH EMPHASIS ON THE SYSTEMATIC STATUS OF LepTocleidedus, ANDRews 1922

DRuCKENMILLer, Patrick, RUSSell, Anthony, Univ. of Calgary, Calgary, AB, Canada

Leptocleididae Andrews, 1922 is a poorly known plesiosaur genus from Lower Cretaceous successions of the UK, South Africa, and Australia. Historically, there has been little consensus regarding its phylogenetic position within Plesiosauria, largely due to its unusual combination of a relatively small skull and short neck. As a result, a diverse array of potential sister groups have been posited for Leptocleidus, including long-necked Cretaceous elasmosaurs, Early Jurassic "rhomaleosaurs", and Middle to Late Jurassic pliosaurs. A cladistic analysis including Leptocleidus, and a new, apparently morphologically similar specimen from Alberta, TMP 94.122.01, was undertaken to assess their phylogenetic position within Plesiosauria. A character-taxon matrix was assembled, consisting of 28 taxa sampled broadly among plesiosaurs, scored for 152 critically reanalyzed and redefined cranial and postcral- nial characters. The results indicate a basal dichotomy split into the traditionally recognized plesiosaurid plesiosaurs and pliosaurid clades. Nested within Pliosauroidea, a monophyletic Leptocleididae was recovered, consisting of L. superstes, L. capensis, and an unnamed Australian taxon on AM FM9574. In contrast to earlier suggestions, Leptocleidus neither clusters with Rhomaleosaurus, which was found to be paraplytic, nor with large-skulled pliosaurid taxa, such as Simolestes. Rather, a sister group relationship between Cretaceous Polycotylidae and Leptocleididae was recovered. Although TMP 94.122.01 is superficially similar to Leptocleidus, several discrete characters of the skull indicate that this new taxon is nested within Polycotylidae.

Poster Session III
FRESHWATER HYBODONT SHARKS FROM THE LOWER CRETACEOUS OF SAFARA

Dutheil, Didier, Musée National d'Histoire Naturelle, Paris, France

The Elrhaz Formation (Aptian) of the Gadoufoua area in north-eastern Niger has yielded an abundant vertebrate fauna for around 40 years. Most of the taxa are terrestrial and they belong to turtles (Platycheilidae, Teneremys, Taxocetechelys), crocodiles (Anatosuchus, Sarcocrocuta, Stolobosuchus), and dinosaurs (Lurdasaurus, Ouranosaurus, Nigersaurus, Suchomimus). Freshwater taxa have also been recorded (Unionsidae, Mawsonia, Asiatoceratidae, Plotosuchidae).

Recent fieldwork in the Elrhaz Fm has focused on the research of microsities. Tons of raw sediment have been sampled via dry screening, underwater screen washing and heavy liquid separated. Thousands of fossil remains have been found and numerous teeth of elas- mobranchs have been sorted under binoculars. At least a hundred teeth of two taxa of hybodonts have been found. A first set of teeth have crowns with a principal low and rounded cusp. The occlusal face shows a crushing surface. The roots are wider than the crowns. A second set of teeth is more numerous (around 200). The crowns are striated. A complete one is 100 mm long. A phylogenetic analysis of these taxa, in situ. They are striated. A complete one is 100 mm long.
Fossil bird material is exceptionally rare in the Mesozioc of western Asia. With the notable exception of the Upper Cretaceous foot-propelled diving bird *Aiasihesperornis banchanovi* from northern Kazakhstan, the only bird fossils described from this region have been bone fragments from the Upper Cretaceous of Uzbekistan. We review all the material referred to the hesperornithiform *Aiasihesperornis* and present a re-description. In addition to the original collections from the holotype locality of Kushmurun, we add new postcranialean bones to this taxon. We also discuss the taxonomic history and likely affinities of this ocean-going bird. Records of *Aiasihesperornis* from Kushmurun corroborate the taxonomic distinctiveness of this taxon and provide further evidence for the terminal Cretaceous connection between the Arctic Ocean, the northern Siberian Sea, and the southern Tethys at this time. Outcrop sequences in both eastern Russia and Kazakhstan document the extent of the Turgay Strait in the Late Cretaceous, bounded by the Ural Mountains to the west and the Kazakhstan Shield to the east. Hesperornithiforms were wide-ranging: at maximum extent, the Late Cretaceous Turgay Strait is thought to have been more than 650 km in length and wider than 300 km. However, just as is the case in many extant ocean-going seabirds, hesperornithiforms appear to have been restricted to the northern hemisphere, although whether this truly represents the biogeography of these birds is open to question. By far the majority of hesperornithiform fossils have been found in marine, or marginal marine, sediments. Although it has been argued that this environmental bias may reflect a taphonomic effect, this is unlikely given the sampling extent of the non-neornithine Upper Cretaceous fossil record. Correlated with their foot-propelled swimming adaptations, it is more likely that hesperornithiforms were the dominant sea-going predatory birds during the Late Cretaceous.

Friday 9:00

THE DINOSAUR-BEARING SHISHUGOU FORMATION (JURASSIC, NORTH-WEST CHINA) REVEALED

EBERTH, David, Royal Tyrrell Museum, Drumheller, AB, Canada; XU, Xing, Institute of Paleontology and Palaeoanthropology, Beijing, China; CLARK, James, The George Washington Univ., Washington, DC; MACHLUS, Malka, HEMMING, Sidney, Lamont-Doherty Earth Observatory of Columbia Univ., Palisades, NY

The Shishugou Formation is exposed in northeastern Junggar Basin, Xinjiang, China, and is famous for fossils of vertebrates and wood. At Wucaian, an intensively studied area, the formation is 378 meter-thick, rests sharply on the Shixianfou Fm, and is unconformably overlain by sediments of suspected Cretaceous age. At Jiangjunmiao the formation is only partially preserved.

We recognize a lower, red, upward-fining interval; a thick, middle interval consisting of red-orange, upward-coarsening/fining successions; and an upper, orange-tan, upward-coarsening interval. Alluvial fan/plain facies in the lower half of the formation give way to calcite- and tuff-rich alluvial and paludal deposits in the upper half, recording an increase in volcanism, seasonal aridity, and a lowering of depositional slope. In the uppermost interval, calcites are rare, indicating less aridity, an increase in sediment supply, or both. The previously proposed Wucaian Formation is broadly equivalent to portions of the lower and middle intervals, but is not adequately defined.

Cm-scale bentonites occur through most of the formation, whereas m-scale, white-tan zeolitic tuffs are limited to the upper half. 40Ar/39Ar dating of sanidines yields an age range of 161-159 Ma for the upper half of the formation, and suggests that the Shishugou likely spans the M-U Jurassic boundary. The stratigraphic distribution of vertebrates indicates a faunal transition up through the middle of the formation, corresponding roughly to the inferred M-U Jurassic transition.

Vertebrates are preserved in a variety of taphonomic modes and underscores stratigraphic changes in sedimentology. Preservation quality is poor in the lower Shishugou, reflecting frequent exposure and reworking in paleochannels. In the middle, fossils are better preserved and occur often in massive mudstones, calcites and spaly deposits, indicating a bias for preservation in overbank settings and ephemeral water bodies. In the upper Shishugou, excellently preserved medium/small vertebrates, especially non-avian theropod dinosaurs, occur in massive, thick paludal deposits, suggesting rapid burial and limited reworking in wetland settings.

Student Poster Session

MORPHOLOGICAL AND FUNCTIONAL DIFFERENCES BETWEEN RHAMPHORHYNCHOID AND PTERODACTYLOID PTEROSAURS WITH EMPHASIS ON FLIGHT

EINARSSON, Elisabeth, Lund, Sweden

To explain how morphological differences between suborders Rhamporrhynchoidea and Pterodactyloidea affected flight performance and life styles wings and claws of pterosaurs from collections in Uppsala and Munich were measured. The measured specimens studied are from Jurassic limestones and shales in Solnhofen, Eichstätt and Holzmaden, and include the taxa *Dorygnathus, Campylognathoides, Rhamphorhynchus, Anurognathus, Pterodactylus, Germanodactylus* and *Gallodactylus*. Morphometric results indicate differences between Rhamphorhynchoida and Pterodactyloidea in wing construction and claw length. Moreover, differences in wing construction indicate different flight performance between the suborders. The shorter innermost part of the wing indicates flapping flight in Rhamphorhynchoida whereas the longer innermost part of the wing indicates soaring in Pterodactyloids. Calculation on the narrowness of the wing has been done on three different specimens of *Rhamphorhynchus*, demonstrating a narrow distal part of the wing that probably was wider towards the body. Variation and divergence from the general morphological pattern creates diversity within both suborders, suggesting three different flight performances in Rhamphorhynchoida and two in the Pterodactyloidea. The three flight performances proposed for Rhamphorhynchoida are (1) Mixed gliding and flapping flight with broad wings, (2) Flapping flight with narrow wings and (3) Flapping flight with elliptical wings. The two flight performances proposed for Pterodactyloidea are static and dynamic soaring. Measurements indicate that the claws of the finger and toes were of the same size in Rhamphorhynchoida, while the claws on the fingers were longer than those of the toes in Rhamphorhynchoida, indicating climbing abilities. Soaring flight, morphological characteristics similar to those in birds, and development of hollow bones are all indications that pterosaurs probably had air sacs that were primitive in Rhamphorhynchoida but well developed in Pterodactyloidea.

Poster Session III

NEW LATE PLOCENO BATS (CHIROPTERA) FROM AHI AL OUGHALAM, CASABLANCA, MOROCCO

EITING, Thomas, Univ. of Michigan, Ann Arbor, MI; GERAADS, Denis, CNRS, Paris, France; GUNNELL, Greg, Univ. of Michigan, Ann Arbor, MI

The 2.5 Ma site of Ahi al Oughalam near Casablanca in Morocco has produced a large collection of late Pliocene vertebrates including nearly 200 bats, the largest sample of North African fossil microchiropterans known. This sample can be compared with other late Pliocene localities such as the Shungura Formation, Omoo Valley, Ethiopia, and Weze 1, near Dziulszyn, Poland.

The Ahi al Oughalam sample contains at least six microchiropterans including three vespertilionids, an emballonurid, a hipposiderine, and a rhinolophid. The vespertilionids are similar in most respects to extant myotids *Myotis* and *Lasionycteris* although associated canines suggest that at least one of these taxa may instead be a vespermiotis. Based on comparisons with modern taxa, the three Moroccan vespertilionid ranged in size from about 6 to more than 25 grams.

The Morocon emballonurid has a prominent and anteriorly extended lower molar paraconid, typical of extant members of this family. Lower molar talonids are short relative to trigonids, a characteristic of some emballonurids such as *Emballonura*. Tooth size is consistent with that of *Coleura afr*, the smallest extant African emballonurid, although the Moroccan form has somewhat longer and narrower molars.

*Rhinolophus* from Ahi al Oughalam is the second most abundant chiropteran. Compared with extant *Rhinolophus*, the Moroccan form is relatively large with an estimated body weight of nearly 25 grams. The hipposiderine from Ahi al Oughalam is very rare but appears to have been of moderate size, smaller than those from Omo Shungura.

The Ahi al Oughalam sample compares well with the other contemporaneous sites in terms of species diversity, with at least six species present, but it consists of a distinct assemblage of microchiropterans. The Shungura sample contains five species but lacks vespertilionids completely, whereas they are the most abundant and diverse groups at Ahi al Oughalam. The Weze assemblage includes eight species and is also dominated by vespertilionids. However, no emballonurids or hipposiderines are known from Weze. These differences are probably the result of both ecological and historical factors.

Student Poster Session

VARIATION AMONG PROBOSCIDEAN PETROSAHS FROM A PLEISTOCENE DCAVE DEPOSIT IN TEXAS

EKDALE, Eric, The Univ. of Texas at Austin, Austin, TX

Isolated petrosals representing a minimum of 37 proboscidean individuals were recovered from Pleistocene deposits in Friesenhahn Cave, central Texas. This sample provides a unique opportunity to study variation within the ear region, as well as expand our knowledge of the anatomy of the middle ear of extinct elephants. The petrosals are identified as proboscidean by the confluence of the fenestra cochleae and cochlear canaliculuis, a feature characteristic of extant tethytheres. Both *Mammuthus* and *Mammut* are represented by teeth in the cave. The petrosals are provisionally assigned to *Mammuthus*, although they are not directly associated with any dental material.

The overall structure of the petros is consistent among all specimens in the sample, although minor morphological variation is observed. The variation includes shape of the fenestra vestibuli, closure of the facial canal, and connection between the crista fenestralis and the posterior aspect of the petrosal. The morphological differences may be the result of a biological factor, such as ontogeny or phylogeny, given that a growth series represented by teeth of both mammoths and mastodonts is preserved in the cave. Alternatively, the variation may reflect aspects of the taphonomic history of the specimens because Friesenhahn Cave was a former carnivorous den, and so some of the morphology of the petrosals may have been affected by postmortem damage.

Saturday 8:00

A NEW FAMILY OF HETEROSTRACANS (AGNATHA) FROM THE LATE SILURIAN OF THE CANADIAN ARCTIC

ELLIGOTT, David, Northern Arizona Univ., Flagstaff, AZ

Early vertebrates occur abundantly in the Boothia Uplift regions of Prince of Wales, Somerset, and Cornwallis islands ( Nunavut Territory). The Boothia Disturbance was active during the Late Silurian and Early Devonian and resulted in the formation of the clastic red-bed facies of the Peel Sound and Somerset Island formations close to the uplift and the

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marine carbonates of the Drake Bay Formation to the east where the influence of the uplift was slight. Early vertebrates were first reported from this area in 1955 and since then a large number of taxa, particularly heterostracans, have been described. Although the endemism of the fauna has made biogeographic analysis difficult this area does seem to have been a locus of adaptive radiation for a number of heterostracan taxa, with the best documented example to date being the Pteraspidiformes.

Recently recognized taxa from the Lower Member of the Peel Sound Formation and the Somerset Island Formation on Prince of Wales and Somerset islands represent a new taxon of advanced heterostracans related to the Pteraspidiformes. The new species are characterized by: a well-developed subrostral lamina; no separate branchial plates; a posteriorly directed branchial opening; ventrally directed lateral laminae; well-developed lateral brims; and a posterior median spine. New information on the cyathaspid Ariaspis indicates that this also shows the same suite of characters. Analysis of their relationship indicates that together with Ariaspis the new species form a sister-group to the Pteraspidiformes plus Listrapsis, providing further evidence that the Pteraspidiformes originated and developed initially in the Boothia Uplift region.

3D Imaging Symposium, Friday 10:15
RECONSTRUCTING DENTAL OCCLUSION IN 3D: FROM CARNIVORANS TO ASFALTOMYLOS
EVANS, Alistair, Univ. of Helsinki, Helsinki, Finland; MARTIN, Thomas, Forschungsinstitut Senckenberg, Frankfurt am Main, Germany; FORTELIUS, Mikael, JERNVAL, Jukka, Univ. of Helsinki, Helsinki, Finland
A longstanding problem in dental morphology has been how to visualize and represent how teeth fit together in occlusion. Comparison of wear facets, a widely-used method for interpreting occlusion, has generally been done in two dimensions. Furthermore, methods such as imbedding casts into probable positions of occlusion and sectioning often give only limited opportunities to grasp the full 3D position and movement of the occluding teeth. Here, we use 3D surface scans of mammal teeth in a virtual computer environment to examine occlusion between opposing tooth rows. With complete skulls available, the position and shape of the condyles can be used to more accurately reconstruct occlusion. This was done for a group of modern carnivorans. A comparison of the occlusal stroke directions and movements during occlusion show that the direction of tooth movement varied according to occlusal shape, with a more vertical movement of the lower jaw in felids compared with canids and mustelids.

The situation is more difficult, however, for most fossil material. We adapted the method to try to reconstruct the upper dentition and occlusion of Asfaltomylus (Australosphenida). 3D scans were taken of the lower molars. Then, using the 3D shape of lower molars we generated possible 3D shapes of occluding upper molars, which are unknown in the fossil record. This allows us to test hypotheses of upper molar 3D shape and the mode of occlusion between the opposing molar rows.

Saturday 9:00
HIGH-RESOLUTION LAMBEOSAURINE DINOSAUR BIOSTRATIGRAPHY, DINOSAUR PARK FORMATION, ALBERTA: SEXUAL DIMORPHISM RECONSIDERED
EVANS, David, Mississauga, ON, Canada; CURRIE, Philip, Univ. of Alberta, Edmonton, AB, Canada; EBERTH, David, Royal Tyrrell Museum, Drumheller, AB, Canada; RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH
Cranial crest morphotypes of the lambeosaurine hadrosaurids Corythosaurus and Lambeosaurus from the Campanian Dinosaur Park Formation are frequently cited as examples of sexual dimorphism in dinosaurs. Each taxon is known from over 15 skulls that comprise a series of fossils. Distinctive crest morphs at presumed maturity have been linked to sexual dimorphism, with sexes identified by the relative prominence of the crest. Employing new stratigraphic and GPS data we have established a biostratigraphic framework in which the sexual dimorphism hypotheses can be tested.

Creating a cladogram of each genus is not randomly distributed within the formation. The two Corythosaurus morphs are stratigraphically segregated and within the only large crested male described (originally named C. cassiarus) occurring stratigraphically below all specimens of the putative female morph (C. intermedius). Three adult-sized Lambeosaurus morphs have been recognized, but their interpretation is not consistent; L. claviritualis has been named as the female of L. lambei as well as L. magnicristatus. In addition, a high degree of crest variation makes the identification of some specimens difficult. Small-crested specimens that have a posteroventrally-directed spike cluster low in section relative to larger-crested specimens. L. magnicristatus, the largest crested morph, occurs stratigraphically higher than all other lambeosaurines.

The biostratigraphic succession of these cranial morphotypes is not consistent with previously proposed sexual dimorphism, and, instead, indicates that the Dinosaur Park Formation hosts a taxonomically diverse assemblage of lambeosaurines that form two distinct lineages. Morphological change within each lineage is concentrated in subtlestheses of crest shape, and is consistent with an anagenetic interpretation where temporal ranges do not overlap significantly.

Friday 10:15
CHANGING PATTERNS OF CARNIVORE MODIFICATION IN THE MODERN LANDSCAPE BONE ASSEMBLAGE OF AMBOSELI PARK, KENYA
FAITH, J. Tyler, George Washington Univ., Washington, DC; BEHRENSMEYER, Anna, Smithsonian Institution, Washington, DC
Carnivore modification of skeletal elements in fossil assemblages has been used as an indicator of taphonomic processes such as fluvial transport and carnivore destruction, based on observations and experimentation with modern bones. This study investigates landscape-scale skeletal part survival patterns in the modern bone assemblage in Amboseli Park, Kenya, comparing samples recorded in 1975 and 2002-04. Lions (Felis leo) were the dominant predator in Amboseli in the earlier sampling period, and spotted hyenas (Crocuta crocuta) were dominant in the later period. Changes in the abundances of these predators between the two sampling intervals were assessed: (1) Lions: a natural laboratory for assessing the taphonomic signal of carnivore-mediated bone consumption and destruction under ecological conditions and varying levels of inter- and intra-specific competition. The Amboseli surface bone assemblage documents variation in the patterning of carnivore modification to ungulate species of different size classes as well as within equivalent size classes. Changes in the proportions of axial vs. appendicular elements, patterns of differential destruction of limb ends, and the strength of the correlation between limb end abundance and bone mineral density all provide measures of the intensity of carnivore modification to the Amboseli assemblage. This increases our ability to infer levels of carnivore impact on fossil assemblages from limb element survival patterns and provides paleobiologists with enhanced ability to understand the taphonomic significance of skeletal elements in Cenozoic mammalian faunas. It also provides a basis for testing whether skeletal element survival patterns in the zoarcheological record likely relate to carnivore modification, hominin transport of appendicular elements, or both.

Saturday 2:15
EVOLUTION AND ANATOMIC ORIGIN OF THE FRONTAL SINUS COMPLEX IN CERATOPSISID DINOSAURS
FARKE, Andrew, Stony Brook Univ., Stony Brook, NY
Ceratopsid dinosaurs possess an unusual frontal sinus complex overlying the endoceranium and underlying the supraorbital horns. However, the developmental origin of this sinus is problematic in that no pneumatic source (e.g., nasal cavity, tympanic cavity, or pharynx) has been identified.

Shared morphological and developmental characteristics suggest homology of the frontal depression of non-ceratopsid nothronotopsids (e.g., Prenoceratops and Protoceratops) with the frontal sinuses of ceratopsids. Combined with developmental and anatomical data for ceratopsids, the fronto-parietal foramen (a connection between the endoceranium and frontal sinus) is autapomorphic for ceratopsids, and this foramen probably bears no relevance for inferring the origin or contents of the sinus. Thus, it is unlikely that the frontal sinus functioned primarily as a venous sinus. Furthermore, the extremely large size of the sinuses in many ceratopsids argues against glandular or other tissue(s) filling the sinus in its entirety. This suggests a pneumatic origin for the sinus, as commonly held.

Detailed morphological examinations and CT scans for a variety of taxa fail to disclose any foramen or canal which provides a direct connection between the sinus and nasal cavity or tympanic region. Thus, smooth-walled channels running between the supratemporal fenestrae and the sinus are here proposed as a possible path for the pneumatic source. These channels have been recognized for some time, but their function has proven enigmatic until now. The supratemporal channels qualify as a potential pneumatic path because: (1) they are present in some form or another in all ceratopsians with a frontal depression or frontal sinus; and (2) they are present throughout ontogeny. Although a nasal, tympanic or pharyngeal
source cannot be differentiated, it is likely that the pneumatic sac of the sinuses gained access to the skull roof by traveling alongside the aductor musculature. This inference suggests that the evolution of cranial pneumaticity in ornithischian dinosaurs is much more complex than previously thought.

Poster Session II
FOSSIL SNAKES FROM THE PIPE CREEK SINKHOLE (LATE HEMPHILLIAN, GRANT COUNTY, INDIANA)
FARLOW, James, Indiana-Purdue Univ., Fort Wayne, IN; HOLMAN, J., Michigan State Univ., East Lansing, MI; ARGAST, Anne, Indiana-Purdue Univ., Fort Wayne, IN
The Pipe Creek Sinkhole (PCS, Grant County, Indiana) preserves an abundant and diverse assemblage of late Tertiary plants and animals in a sinkhole pond deposit. The deposit is largely unconsolidated, and large numbers of vertebrate microfossils have been recovered by screen-washing. Among these are abundant snake vertebrae; more than 300 vertebrae have been recovered to date, and the final count could be considerably larger.

Despite the small size of the PCS pond, the snake assemblage is quite diverse: gognose snakes (Heterodon platirhinus and Paleoheterodon tihent), racers (Coluber constrictor and Paracoluber storeri), milksnake (Lampropeltis triangulum), greensnake (Opheodrys ver.

Extant representatives of PCS snakes occur in both aquatic (e.g. Nerodia, Sistrurus) and dryland (e.g. Heterodon, Coluber) habitats. Diets inferred for PCS snakes on the basis of their modern relatives are diverse, and in some cases consistent with the presence of other kinds of vertebrates in the fauna. The PCS opidian fauna most closely resembles those of the middle (Lemoyne Quarry) and late (Mailbox Prospect locality) Hempfield of Nebraska. Although the PCS mammalian fauna suggests an early Pliocene age for the PCS assemblage, the opidian fauna is more like that of the late Miocene.

Friday 1:30
EVOLUTION OF BIPEDALITY IN DINOSAURS
FECHNER, Regina, Bayerische Staatssammlung für Palaeontologie und Geologie, Muenchen, Germany
The success of dinosaurs is often explained by their locomotor capabilities. Thus, bipedalism was acquired in basal dinosauriform and improved in early dinosaur evolution. The assumption that basal dinosauriforms were bipedal is based on their elongated hindlimbs compared to relatively short forelimbs. However, detailed studies on the evolution of early dinosaur locomotion have not been done so far. In the study presented here, the evolution of the locomotor capabilities of basal dinosaurs were investigated on the basis of integrated data from osteology, myology, biomechanic, and trace fossils.

The hindlimb morphology of the basal dinosauriform Lagerpeton chanarensis equals the ancestral archosaurian condition and only the tarsus and pes were modified. The locomotor capabilities of L. chanarensis are reconstructed as habitual quadrupedal with the ability to run bipedal, comparable to recent lizards. In basal dinosauriforms, the hindlimb musculature began to modify significantly. The development or modification of the osteological correlates of musculature in Maarasuchus ilionensis, Pseudosuchus major, and basal dinosaurs demonstrate the increasing importance of abduction of the femur and the simple flexion and extension of the hindlimb. The significance of abduction and long axis rotation was reduced and the posture of the hindlimbs changed from semi-erect to erect.

Accordingly, bipedal locomotion has been developed gradually from dinosauriforms to basal dinosaurs. This conclusion corresponds perfectly with the trace fossil record of the Middle to Upper Triassic, where the gradual transition from quadrupedal dinosauriform traces to bipedal theropod traces can be observed.

Student Poster Session
A RICH BONE BED OF SAUROPODOMORPH DINOSAURS IN THE EARLY JURASSIC (HETTANGIAN) MCCOY BROOK FORMATION
FEDAK, Tim, Dalhousie Univ., Halifax, NS, Canada
A bone bed of basal sauropodomorph dinosaurs has been recently discovered in the Early Jurassic (Hettangian) McCoy Brook Formation, on the shores of the Minas Basin in Nova Scotia. The new specimens demonstrate the McCoy Brook sauropodomorph is distinct from the genus Ammosaurus; lacking the distinct elongate preacetabular process of the ilium and the foramen in the rib of the second sacral vertebra.

All specimens collected from the site are affected by varying degrees of compression and fault displacement deformation, attributable to syndepositional faulting and high sedimentation rate in this small half-graben basin, as well as minimal peneplanation of the fossil skeletons. Within the 10 m² area of strata that has been excavated, five fully and semi-articulated skeletons have been recovered, including one nearly complete and three partial large specimens, and a smaller articulated skeleton similar in size to the largest Ammosaurus specimen. Preliminary sedimentological evidence suggests the skeletons were buried rapidly by fluvid sediments after a short period of sub-aerial exposure. The McCoy Brook sauropodomorph taxon has an elongate postacetabular process, a five vertebrae sacrum, and several unique cranial features. These specimens represent the oldest dinosaur skeletons in Canada and the richest deposit of sauropodomorph dinosaurs in North America.

Friday 8:00
DISCRIMINATING LANDSCAPE USE IN HOLOCENE MAMMALS USING STRONTIUM ISOTOPES
FERANEZ, Robert, Albany, NY; HADELY, Elizabeth, PASYAN, Adina, Stanford Univ., Stanford, CA
One way to understand how projected global warming will affect extant mammals is to look at what effect climatic change had in the past. An important aspect of a species that generally has been difficult to examine in ancient mammals is landscape use. Here, landscape use is examined by analyzing strontium isotope values found in mammalian hard tissues. This study specifically examines: (1) do strontium isotopes identify larger scales of space use for larger species as predicted?; (2) do mammals adjust scale of space use with climatic change? Strontium isotope values were obtained from 46 specimens from the Holocene deposits of Lamar Cave and Waterfall Locality in Yellowstone National Park, as well as from 13 modern ungulate samples. 87Sr/86Sr values show medium and large-sized species having larger scale of space use than smaller species. Additionally, isotope values for specimens from both Lamar Cave and Waterfall Locality are similar across all stratigraphic levels suggesting no change in landscape use over the last 3000 years, even though climate is known to fluctuate at these sites over this time period. Climate change during the last part of the Holocene may not have been significant relative to the variation endured by species over the Pleistocene to cause landscape use changes. Further, this study verifies previous suggestions that the fossil localities derive from local fauna and that predator foraging radii have not changed during the late Holocene. Where bedrock geology is appropriate, the use of strontium isotope analyses appears a valuable tool for discerning home range, an important though generally difficult aspect of an ancient species niche to identify.

Marine Reptiles Symposium, Wednesday 4:15
PALEOBIOLOGICAL SIGNIFICANCE OF HYPERTROPHIED SALT-SECRETING GLANDS IN GEOSAURUS ARAUCANENSIS (CROCODYLIFORMES: METRORHYNCHIDAE)
FERNANDEZ, Marta, GASPARINI, Zulma, Museo de La Plata, La Plata, Argentina
The natural cast of salt-secerting glands, housed at the antorbital cavity of the skull, has been described in two adults of the Tithonian metriorhynchid Geosaurus araucanensis. This finding represented the first directed evidence of an extra-renal osmoregulatory system in extinct marine archosaurs. A juvenile specimen of G. araucanensis bearing similar antorbital structures as the two adults described before, has been recently found. The large gland size, and the number and sizes of the lobules found in G. araucanensis suggest that these glands had high secretory capacity. According to the model of gradual evolutionary specialization of marine reptiles from a freshwater ancestor, this metriorhynchid represents the final stage. The final stage implies hypertrophied salt-secreting glands allowing the maintenance of a constant plasma osmolality even when sea water and osmoconforming prey are ingested. In extinct reptiles this final stage is represented by sea turtles, marine igana and sea snake, but not crocodiles. We proposed that the salt-secreting glands of Geosaurus drained through the antorbital fenestra and that the antorbital fossa housed at least a portion of its ducts. The development of salt-secreting glands of high secretory capacity is also inferred in the other metriorhynchids Metriorhynchus and Dakosaurus. The size inferred of salt-secreting glands in the juvenile specimen, suggests that hatchlings had salt-secreting glands large enough to cope with the osmoregulatory demands of open sea life.

Wednesday 9:30
A POSSIBLE RECORD OF THE SOUTH AMERICAN MAMMAL ORDER LITOPTERNA IN MEXICO
FERRUQUOLA-VILLAFRANCA, Ismael, Instituto de Geologia, Universidad Nacional Autonoma de Mexico, Mexico City, Mexico; MALVIDO-ARRIAGA, Roberto, Mexico City, Mexico
A fortuitous find of fossil material during the construction of a warehouse in eastern Mexico City might be the possible first record of the South American order Litopterna not only in Mexico but in North America as well. The fossils were found in a ditch excavated on late Pleistocene strata of volcanoclastic, poorly consolidated clastics.

The material belonged to a ~bull-sized mammal, it includes an atlas, a thoracic vertebra, a sacrum fragment, and a lower molar; it is large [92 mm high, 58 mm long and 20 mm wide], inward curved, hypodont, rootless, and thickly enameled. The occlusal pattern consists of two subequal lobes, the anterior is roughly L-shaped with the short arm wide and antero-laterally directed; the long arm taperrs rearwardly (thus becoming wedge-like) and is set parallel to the molar medium plane; it shows a little bulge in the medial part, from the posterior lobe is a bit smaller, slightly postero-labially set with respect to the medium plane, and placed a little more labially than the anterior lobe; this displacement significantly increases downward; its outline is seleniform (more so downward), with a median concavity that corresponds to a shallow sulcus on the labial side. The tooth has grown lines (~12 to 14 per 1 cm), set as numerous fine strie alternating with a few thicker ones.

This molar built is unlike that of the perissodactyls and artiodactyls, but resembles that of the South American Pleistocene mammal tipoterno in being simple, hypodont, and formed by two, relatively narrow, semilunate molars; however, the Mexican specimen is more thickly-enamed and more hypodont than any macrauchenid. This taxon is well known in the late Pleistocene of South America, from Argentina to Venezuela, but has not
been recorded in Central America. If this specimen is indeed a litoptern, it would be the first record of this order in North America; its presence in Mexico would add to the recent discovery in Michoacan, Central Mexico, of another previously unrecorded South American mammal order, represented by a toxodont notulagale.

Poster Session I
PRIMATE DIVERSITY AND ABUNDANCE DURING THE EARLIEST EOCENE (BIGHORN BASIN, WYOMING)
FET, Elizabeth, STRAIGHT, Suzanne, Marshall University, Huntington, WV
The Bighorn Basin, Wyoming has yielded the most diverse and abundant Paleocene/Eocene fossil mammals in North America. Collecting in the Honeycombs region of the southeastern Bighorn Basin has resulted in the recovery of approximately 3,300 mammalian specimens from the basal Wasatchian NALMA (Wa-0 biochron). These Wa-0 localities occur within the Carbon Isotope Excursion (CIE) and the Paleocene/Eocene Thermal Maximum (PETM) and therefore this fauna is significant for examining patterns of faunal change in response to climatic warming. Over 90% of the specimens thus far collected are from a single screen wash location (UCMP V 99019, Castle Gardens). Additional specimens have been recovered from both surface prospecting and collection at hilltops. Primate taxa from this region show moderate diversity, with three species being recognized including, Cantius torresi, Arctodontomys sp. nov., and Niptomomys favorum. Both Cantius and Arctodontomys are merely represented by a single specimen each. Additionally, both of these taxa were collected from arthritic localities and none have been found in the 13 tons of matrix that has been processed from the main locality of Castle Gardens.
Approximately 80% of the mammals recovered from Castle Gardens have an estimated body mass of less than 350 grams. These small bodied taxa include species from Primates, Multituberculata, Lipotyphla, Marsupialia, Prototheria, and Apothecaria. The only primate known from Castle Gardens is N. favorum which is substantially smaller than either earlier and/or later occurring Niptomomys species. Although N. favorum was originally known from a single specimen, more than 300 isolated teeth have been now found. This primate comprises 11% of the Castle Gardens specimens; only the lipotyphlan Macrocranion janneti and the multitubulate Ectypodus tardus are more abundant at this locality. Niptomomys is typically very rare, even at other Paleocene/Eocene localities dominated by small-boded taxa. Given the abundance of this taxon, N. favorum may have responded favorably to the warm climactic conditions associated with Wa-0 and the PETM.

Thursday 2:15
AN EVALUATION OF BODY SIZE TRENDS IN NORTH AMERICAN, TERRES-
TRIAL CANINIFORM TAXA (CARNIVORA: MAMMALIA)
FINARELLI, John, Univ. of Chicago, Chicago, IL
Body size often has been described as the fundamental variable of organismal biology. Among modern mammals, body size has been correlated to a diverse suite of life history and ecological variables that are of interest to paleobiologists. A previous investigation into reconstructions of body size incorporating data from fossil taxa for the carnivoran subclade Caniniformia reconstructed small-bodied ancestors at the base of several clades that today are represented exclusively by large forms, implying parallel trends toward increasing body size in several clades. Evidence also was found for decreased body size among the mustelids.
Observe directional trends can be the result of both active and passive mechanisms. Here, an analysis of the underlying mechanisms for the observed trends in body size for terrestriai, North American carnivian taxa is undertaken. Fossils provide insight into the causal mechanisms of evolutionary trends, by increasing understanding of the timing of shifts in body size, and determining whether these are constant across lineage history or if change is episodic and accumulated coincident with presumed increases in competition or evacuation of niche space recorded in the fossil record.
First and last appearances and body mass estimates were compiled for 243 North American, terrestrial carnivian species, including 199 fossil taxa. With multiple independent trajectories of body size discovered, a simultaneous analysis across all Caniniformia is not likely to generate accurate results. As such, body masses were tabulated for monophyletic clades through sequential time slices. Using the multimonial function, likelihoods were calculated and determined the mass of change with the increase or decrease in both minimum and maximum size for each clade. Superficially similar patterns of increased body size are observed among several independent fossil caniform lineages (e.g., Borophaginae and Hesperocyoninae). However, preliminary analyses indicate that these are the result of different underlying mechanisms, and that trends observed in several lineages are not constant, but rather body size increases coincide with extrinsic biotic events.

Wednesday 5:15
DINOSAURIA AND AVES FOSSIL FOOTPRINTS FROM THE LOWER CANTWELL FORMATION (UPPER CRETACEOUS), DENALI NATIONAL PARK, ALASKA
FIORILLO, Anthony, Dallas Museum of Natural History, Dallas, TX; BREITHaupt, Brent, Univ. of Wyoming, Laramie, WY; McCARTHY, Paul, Univ. of Alaska, Fairbanks, AK
The Cantwell Formation (Upper Cretaceous to lower Tertiary) is a thick rock unit that crops out in much of the central part of Denali National Park. The lower part of this succession is dominantly comprised of fine-grained channel and floodplain sedimentary facies.
" Floodplain deposits contain abundant evidence of weak pedogenesis, including root traces, blocky structure, iron oxide motilles and nodules, suggesting widespread poorly drained conditions associated with slowly aggrading settings. The upper Cantwell fauna is largely volcanic. The lower Cantwell Formation correlates in age with the famous dinosaur-bearing rocks of the Prince Creek Formation of the North Slope of Alaska, as well as the dinosaur-bearing Chignik Formation of Aniakchak National Park in southwestern Alaska.
Three new vertebrate fossil sites have been discovered in Denali National Park. The first locality, located in the Igloo Creek drainage, yielded the natural cast of an isolated right pes of a medium-sized theropod. The track measures approximately 22 cm in length and 15 cm in width, which provides an estimated hip height of approximately 90 cm and a body length of approximately 3 m. A second site, located on Double Mountain, produced an impression of a theropod approximately the same size as the previous. The remaining locality, also on Double Mountain, is in a lacustrine facies and has yielded dozens of tracks attributable to medium-sized wading birds, approximately the size of a modern Willet or an American Avocet. The morphology of the tracks indicates the substrate was still very wet when these birds walked on the surface. There are also numerous small, nearly circular depressions, approximately 3 mm in diameter, on the same bedding plane. These features are likely the feeding traces of these shore birds. Combined, these tracks represent the first record of Late Cretaceous fossil vertebrates from Denali National Park as well as the Alaska Range.

Friday 2:45
TUSK CEMENTUM DEFECTS RECORD MUSTH BATTLES IN AMERICAN MASTODONS
FISHER, Daniel, Univ. of Michigan, Ann Arbor, MI
Combat between adult male American mastodons (Mammuthus americanus) has been hypothesized to explain cases of cranial injury that were evidently caused by an upwardly directed thrust of an opponent’s tusks tip. Additional injuries corroborated the inference of lethal combat. Bone changes and growth patterns of the tusks, along with evidence of musculoskeletal injuries with musth episodes. However, the only direct evidence of combat noted previously involved events causally related to death. A previously unrecognized type of recurring, anomalous structure in tusks seen as tusk dentin and cementum is here interpreted as a direct record of musth battles in prior years, long before death. Arcuate tectums of cementum defects parallel the growing margin of the tusk and the strike of peridurally incremental topography. These features occur in the proximal portion of tusks of adult males, along the outside curvature of the tusk. Arc-length of each feature varies, but is usually less than one third of tusk circumfer- ence. These cementum defects resemble dental hypoplasias, a phenomenon usually explained as due to an episode of physiological stress during tooth development. In thin section, externally visible pits and irregularities of the cementum surface can be followed as contorted and irregular cementum lamellae and subjacent tracts of sclerotic dentin. These anomalous histologic features are interpreted as produced by cementoblasts and odonto- blasts (respectively) damaged by mechanical trauma near the time of their differentiation, when they were located at the growing margin of the tusk. The inferred cause of this dam- age is rotational displacement of the tusk due to reaction forces produced by thrusting the tusk tip into an opponent during a musth battle. In normal use, the growing margin of the tusk is protected from impact with alveolar bone, but supercritical forces produced during musth battles displaced the tusk within its alveolus, causing localized damage to the margin along the outer curve of the tusk. Tracts of cementum defects record multiple prior bouts of combat in mid-spring to early summer, yielding a history of musth in adult males.

Poster Session II
DOCUMENTING THE ANATOMY OF AN ENIGMA: THE HIND LIMB MYOLO-
GY OF ALLIUS FULGENS
FISHER, Rebecca, HICKS, Michelle, ELROD, Clay, Midwestern Univ., Glendale, AZ
The red panda (Ailurus fulgens) is an endangered species living in the temperate forests of the Himalayas and southern China. Weighing 3-6 kg, red pandas are scurrying but feed primarily on the forest floor, subsisting largely on a diet of bamboo. Since the time of their initial description in 1821, the classification of the red panda has been the subject of much debate. Morphological and molecular studies have supported a wide range of possible tax- onomies, including close ties to ursids, procyonids, arctoids and pinnipeds, and musteloids (procyonids, mustelids, and mephitids).
This study provides additional morphological data, including muscle maps, for Ailurus. Three red panda cadavers from the Zoological Park National Park were dissected, including an adult male of unknown age and twelve year old and five month old females. In addition, two red panda skeletons from the NMNH were studied and digitally pho- tographed. The hind limb muscles of the three cadavers were dissected, described and dig- itally photographed. Points of origin and insertion were recorded on transparencies overlaying digital photos of each hind limb bone, producing muscle maps. In addition, moment arms, muscle mass, and muscle fiber length and angle were recorded for the right hind limb in the adults.
Dissections revealed a great deal of variation among the three red panda specimens, including fusion of adjacent muscle bellies, subdivision of muscle bellies, and tendon varia-
tions. A table comparing the morphology of the red panda to other carnivore species will be presented. Interesting findings include the presence of both glucosecomorals and abduc-
tor cruris caudalis, and the presence of a muscle located deep on the plantar pes and insert-
ing onto the metatarsophalangeal joint of digit one. This plantar muscle appears to be
unique to Altius. Additional dissections of the red panda forelimb, tail, and muscles of mastication are currently ongoing. Data from these dissections may shed further light on the phylogenetic relationships of this species. In addition, muscle maps generated by this project may prove useful to paleontologists studying related fossil carnivores.

Poster Session I

A NEW HUMERUS OF HOMUNCULUS FROM THE SANTA CRUZ FORMATION, (EARLY-MIDDLE MICOCENE, PATAGONIA)

FEAGLE, John, Dept. of Anatomical Sciences, Stony Brook, NY; KAY, Richard, Dept. of Biological Anthropology and Anatomy, Durham, NC

Postcranial bones of are particularly rare in the fossil record of platyrrhine primates and, when known, are most often fragmentary. A humerus from the Atlantic coastal Miocene deposits of Santa Cruz Formation found at Puesto Estancia La Costa (~51 degrees S) is the most completely preserved early Miocene (~16.5 Ma) primate humerus from South America. The only taxon known from this locality and level is Homunculus patagonicus. The proximal postcranial bones from this site include a femur, a fragment of the distal humerus, and a radius, all apparently associated with facial fragments, collected by Carlos Ameghino in the late 19th Century. The only other platyrrhine known from substantial parts of a skeleton is the pithecoid Cebupithecia from ~12 Ma in Colombia.

The distal end of the new humerus is virtually identical to the one collected by Ameghino and figured and described by Bluntschli, but now lost. The distal end is also similar to that of Cebupithecia but larger. The new humerus shows a unusual mix of features compared with many extant platyrrhines. The distal end has an entepicondylar foramen, a medially projecting medial epicondyle, a spool-shaped trochlea and rounded ventrally flexed capitulum. The olecranon fossa is shallow. Overall the distal end is most similar to that of pitheciids and very different from extant cebids or atelids. However, the proximal end is much broader and more robust that than of any extant platyrrhine and has a prominent distal end. The Z113 diatomyid differs greatly from Oligocene African anthropoids. Likewise, a strong supinator crest and broad brachialisch flange reaches almost halfway up the shaft resembling early anthropoids. The morphology of the humerus suggests arboreal quadrupedalism and the predominant locomotor mode with no evidence of adaptations for either clinging or suspensory behavior.

Wednesday 8:30

A REMARKABLE CONVERGENCE: INDEPENDENT EVOLUTION OF THE MURINE CHEVRON

FLYNN, Lawrence, Peabody Museum of Archaeology and Ethnology, Cambridge, MA

This year paleontologists documented the Lazarus Effect in rodents, discovering of a younger record of a taxon thought to be long extinct. Living Laonastes of Southeast Asia was recognized as a member of the Family Diatomyidae, first named for fossils and otherwise last known in the Miocene of Southern Asia. The Diatomyidae are a distinct group clustering with gundis as the sister taxon to Hystricognathi. Early diatomyids attributed to the Oligocene genus Fallomus are abundantly preserved primarily at Bugti in Baluchistan, Pakistan, and nearby to the northeast in the Zinda Pir Dome. Younger rocks near the Olg-Miocene boundary (loc. Z113) of the Zinda Pir Dome yield a new diatomyid. The Z113 diatomyid differs greatly from Fallomus. It has multicuspid and large premolars dominating the molar tooth rows. Accessory cusps on the upper deciduous premolar form an arcade resembling the chevron of murines. Analysis of abrasion patterns shows the presence of the individual cusps in some detail. Function differs from that of true murines, still, the upper deciduous premolar is remarkably similar to the murine M1 in having a chevron (like the murine second cheek) composed of the entoectomy, protocone, and paracone. There are many differences in the teeth of the Z113 diatomyid from those of Murinae. Still, the Z113 genus demonstrates independent development of a complex dental structure: the murine chevron. The murine chevron has been accepted as a synapomorphy for Muridae, but recent molecular data cluster gerbils, which lack chevrons, with them. Under this hypothesis both chevrons developed more than once, or gerbils lost chevrons. The Z113 diatomyid shows that features similar to chevrons can arise independently, although significant differences from true murine structures remain. Conflict in character distribution disappears, given careful definition and detail.

Wednesday 8:15

ORIGIN OF THE AMPHIBIAEAN LIZARDS IN EUROPE

FOLI, Annelies SMITH, Richard, SMITH, Thierry, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; SIGÉ, Bernard, Université Claude Bernard-Lyon 1, Villeurbanne, France

Amphibians are burrowing, wormlike limbless lizards characterized by a strong skull and by short, reduced jaws with usually five to nine teeth in modern forms. Their origin is thought to be in the Jurassic of Gondwana, based on the abundance of amphibians in Africa and South America today. In Europe, the oldest clearly identified amphibian is known from the Campanian of Lallo (Spain), although this record is only based on vertebral. The first amphibian jaws were found in the middle Paleocene of Haingn (Belgium), a locality that has yielded the oldest Cenozoic mammalian fauna of Europe (reference-level MP1-5). These jaws present primitive characters and differ from those of modern amphibians by having proportionally longer, straight dentaries bearing twelve teeth. A similar form is present in the late Paleocene of Cernay (MP6, France). Conversely, in the earliest Eocene Dormoral fauna (MP7, Belgium), an amphibian jaw with a short, anteriorly curved jaw, bearing eight to nine labio-lingually compressed teeth is abundantly present, representing the earliest modern European amphibian. Similar taxa also occur in the middle early Eocene of Condé-en-Brie (MP8-9, France) and the late early Eocene of Prémontré (MP10, France). This suggests that modern amphibians first migrated into Europe around the Paleocene-Eocene boundary. Because the contemporaneous North American amphibians are exclusively composed of the morphologically different rhineurids, with strong longitudinal suture and a denticulate posterior border of the neural arch on the vertebrae in dorsal view, North America is unlikely to be the region of origin for the European modern amphibians.

Neoceti Symposium, Saturday 11-45

AN UNEXPLORED DIVERSITY OF BASAL BALEEN WHALES: LATE Oligocene EOMYSTICETIDAE FROM NEW ZEALAND

FORDYCE, Ewan, Univ. of Otago, Dunedin, New Zealand

New species of late Oligocene Mysticeti from New Zealand help revise and expand the archaic family Eomysticetidae, with implications for mysticete phylogeny. The fossils (Geology Museum, University of Otago) are from the mid-outer shelf Kokoamu Greensand and Otekaike Limestone (~24-28 Ma) of the Waitaki Valley region, South Island. Specimens with associated skulls, jaws, and carapaces include juveniles (OU12918, OU22163) and adults (OU22204, OU22235), and the holotype of “Mauicetus” lophocephalus Marples. Other less-complete specimens, including the holotype of “Mauicetus” waitaiensis Marples, have tympanoperiotics and associated elements. In OU22204 (cl ~1.80 m) and 22235 (~1.95 m), the rostrum is long (70-75 % of cl), narrow, and toothless, with few ventral “baleen” grooves. Long nasals (~25% of cl) indicate the presence of baleen show. Large lateral foreshortened jaws, with a probable trend toward development of a single upper chin notch, may provide a clue to the many species at the intertemporal region imply large temporal muscles. Frontals are delicate without temporalis origins. Zygomatic processes are long, large and grooved medially. Each temporal fossa is separated by large, long, posteri- er temporal fossae, with strong longitudinal striae and a denticulate posterior border of the neural arch on the vertebrae in dorsal view, North America is unlikely to be the region of origin for the European modern amphibians.

Poster Session III

PICK YOUR POISON: THE DISTRIBUTION OF CANINE GROOVES IN VERTE- BRATES AND INFERENCE OF VENOM DELIVERY IN EXTINCT TAXA

FOLINSBEE, Kaila, REISZ, Robert, Univ. of Toronto at Mississauga, Mississauga, ON; MÜLLER, Johannes, Humboldt-Universität, Berlin, Germany Venom has evolved in most animal lineages for defense, food procurement and chemical pre-digestion. In terrestrial vertebrates, a venom delivery system (VDS) is defined as modified teeth connected to specialized venom glands. The presence of grooved teeth has been used to infer the presence of VDSs in various extinct reptiles and synapsids. However, canine grooves are widely present in extant non-venomous taxa including cсероподевices monkeys, suids, and hippos. In cсероподевices for example, deep grooves extending into the root occur on the anterior face of the upper canine. Wear commonly occurs along the edges of the groove where the lower canine occludes anterior to the upper, and along the distal edge where the upper canine is honed against the upper third premolar. Hippos and suids show similar grooved canines. In gundis, the lower canine is honed against the upper on the mesial edge and the groove occurs on the opposite (dorsal) side. In extinct taxa, the presence of grooved dentition alone provides insufficient justification for inferring a complex VDS in the absence of a strong phylogenetic association supporting homology (e.g. fossil snake fang indicates the presence of venom in extinct vipers and elapid snakes).

In extinct taxa, inference of venomous capability requires either multiple skeletal indicators of a VDS to be present (i.e. grooved teeth and a duct or pocket in jaw) or phyloge- netic proximity to extant venomous taxa. There are several fossil terrestrial vertebrates that possess correlated skeletal and dental indicators of venom (e.g. Euchambersia, a South African theropod Canyon and Ulavichthonot, a North American Triassic reptile). Alternative hypotheses for the function of canine grooves in fossil and extant mammals include: storage of bacteria laden saliva (analogous to the Komodo dragon), increasing the structural strength of the tooth during bites or occlusion of the canines are honed against the opposing teeth, or permitting rapid puncture and withdrawal of the tooth after biting. The latter hypotheses will be tested using stress-analysis techniques.
be mostly an artefact of stratigraphic incongruence. Exceptions are two biogeographically distinct chasmosaurine lineages present in the Judithian, and the presence of sauropods in the Horseshoe Canyon, the north during the Edmontonian. Contrary to much recent work, stratigraphy and new material tentatively supports a single anagenetic lineage for centrosaurines. Most Late Cretaceous sauropod material from North America is attributed to *Alamosaurus sanjuanensis* and this has been used to infer same-age relationships for *Alamosaurus*-bearing strata. There is little evidence to support this. The form taxon *Alamosaurus* is unknown before the Maastrichtian, but is otherwise shown to be stratigraphically uninformative. We should not expect all ceratopsids found in formations bearing *Alamosaurus* to be the same taxon. If the pattern of speciation seen in the Campanian is followed, it is likely that many more species of chasmosaurine remain to be discovered from 70.5-66 Ma. Rapid stepwise acquisition of characters in ceratopsids suggests that careful analysis of ceratopsid taxonomy and distribution presents them as the best biostatigraphic markers to be used where radiometric dates are not available.

Friday 8/4

CARBON AND NITROGEN ISOTOPIC RECONSTRUCTION OF TROPHIC RELATIONSHIPS BETWEEN HERBIVOROUS MAMMALS FROM SALTVILLE, VIRGINIA

FRANCE, Christine, Univ. of Maryland, College Park, MD; ZELENKO, Paula, Lehigh Univ., Bethlehem, PA; KAUFMAN, Alan, HOLTZ, Thomas, Univ. of Maryland, College Park, MD

Stable isotopic data from terrestrial herbivores in the Saltville Quarry, Virginia (late Rancholabrean) indicates a range of potential feeding strategies and digestive mechanisms. Nitrogen isotopic values of bone collagen are used to indicate trophic relationships while carbon isotopic values examine partitioning between browsers and grazers. Observations include a range of δ¹⁵N values with the two most common herbivorous digestive mechanisms (i.e. ruminants and non-ruminants) clustering in two groups. A group with ground sloth exhibits isotopic values indicative of a non-ruminant herbivorous feeding strategy as opposed to alternate hypotheses of carnivorous or omnivorous strategies. A mammoth juvenile exhibited a relatively high δ¹⁵N value which may be due to the previously noted nitrogen isotopic enrichment of mammalian milk. The δ¹⁴C values indicate a dominance of C-3 plant browsers which may imply the absence of extensive or open C-4 grasslands in this region. This study, combined with currently ongoing analyses of Pliocene and Pleistocene specimens from Florida and California, will be used to examine trophic collapse at the end of the Pleistocene. The larger data set produced by these additional sites in conjunction with the Saltville data will provide new insight into the end Pleistocene mass extinction and the controversy between the human-driven versus the climate-driven hypotheses governing this event.

Poster Session II

THE FIRST RECORD OF *COAHOMASUCHUS* (ARCHOSAURIA: STAGONOLEPIDIDS) FROM THE CARNIAN OF EASTERN NORTH AMERICA

FRASER, Nicholas, Virginia Museum of Natural History, Martinsville, VA; HECKERT, Andrew, Appalachian State Univ., Boone, NC; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM; SCHNEIDER, Vincent, North Carolina Museum of Natural Sciences, Raleigh, NC

A partial, articulated aetosaur that preserves a large portion of the bony armor, and more than 20 isolated osteoderms from a quarry in the Pekin Formation, (Carnian) of the Deep River basin of North Carolina most closely resemble the Carnian aetosaur *Coahomasuchus*. This genus was previously described from a single specimen from the Colorado City Formation (Otischalkian) of Texas. The sculpturing pattern in the new material is similar to *Coahomasuchus*, particularly in the largest paramedics, and exhibits a pattern of faint, sub-parallel grooves on the anterior dorsal paramedics and a better-developed “starburst” radiating pattern of pits and grooves on more posterior osteoderms. The overall proportions of the new osteoderms, the absence of spikes on the lateral osteoderms and the lack of prominent bosses on the paramedian osteoderms, are also consistent with *Coahomasuchus*. Further preparation needs to be performed on the articulated specimen before a definitive species diagnosis is possible, so the North Carolina material is referred to *Coahomasuchus* sp. A second taxon is represented by a handful of associated caudal osteoderms, and they are referred to *Longosuchus*. Finally a caudal paramedian and a caudal lateral osteoderm in relative hard green-gray siltstones and clayslones; Type II, characterized by thick layers of sparse accumulations of articulated to disarticulated microvertebrates in light gray to gray clayslones (sometimes with minor silt); and Type III, characterized by thick layers of moderately dense accumulations of disarticulated microvertebrates in soft green-gray clayslones that screen-wash to produce abundant fragmentary remains. Type I deposits are exemplified by Quarry 9 at Como Bluff, the Little Houston Quarry, and the Small Quarry; Type II by the Fruita Paleontological Area sites, Rainbow Park 96, and the Wolf Creek Quarry; and Type III by Ninemile Hill and Mile 175. Rainbow Park 94 may be a Type II/III locality. The differences in frequency of articulation and in bone deposit density between deposits of Types I and II are striking. One likely would never mistake matrix with bone from Quarry 9, Small, or Little Houston as coming from the Fruita Palea Area or Wolf Creek, for example; and in fact, in hand sample, matrix from Little Houston and the Small Quarry can be literally indis-tinguishable. Environments of preservation for the different modes include abandoned channels and levee/spays for Type I, and overbank deposits for II and III. These modes sug-gest possible lithologies in which to find new microvertebrate sites and, along with environ-mental interpretations, may provide clues as to the reasons for preservation of microverte-breates in certain conditions at different sites.

Poster Session III

TERRESTRIAL LATE CRETAEOUS STRATIGRAPHY OF NORTH AMERICA AND THE USEFULLNESS OF CERATOPSIDS IN BIOSTRATIGRAPHY

FOWLER, Denver, Stockport, United Kingdom

A comprehensive stratigraphy is presented for the terrestrial Late Cretaceous units of North America. This combines published radiometric dates, magnetostratigraphy, and reviews ranges of known taxa, paying particular attention to ceratopsids. While the stratigraphic relationship between Campanian strata are well constrained, the majority of the Maastrichtian is still largely unresolved. In the Campanian, integrity of the recently proposed Kirtlandian age is maintained. Uppermost deposits of the Two Medicine Fm, Montana, are demonstrated as being the Kirtlandian in age. Purported north-south provinciality of dinosaurs is shown to occur.

Saturday 3/45

DATA QUALITY, SIGNAL DETECTION, AND METHODOLOGICAL ROBUSTICITY IN THE ANALYSIS OF LARGE FOSSIL DATASETS

FORTELIUS, Mikael, University of Helsinki, Helsinki, Finland; PUOLAMÄKI, Kai, Helsinki University of Technology, Espoo, Finland; JERNVALL, Jukka, MANNILA, Heikki, GIONIS, Aristides, Univ. of Helsinki, Helsinki, Finland

The development and increasing use of public fossil databases in paleontological research draws attention to issues of data quality, detection of signals in noisy datasets, and robusticity of results with respect to analytical methods employed. Here we address issues arising in the analysis of fossil data compiled from disparate sources, using examples drawn from the NOW database of Old World Neogene land mammals (http://www.helsinki.fi/science/now/).

In the NOW data, several of the main spatial and temporal patterns were already detectable in a small dataset (1996, 511 loci) and have subsequently been found in analyses using updated and eventually much larger datasets (1753 loci for the same area in 2006). Among these robust patterns are the development in the Middle Miocene of Europe a contrast between a humid West and a dry East, the confinement of the abrupt turnover of the Vallesian Crisis in the early Late Miocene to western Europe, and several trends involving trophic level, body size and ecomorphology. However, increased sampling and improved methodology has also revealed significant additional detail as well as general trends not originally detected.

One of the main issues in the analysis of fossil data concerns stratigraphic resolution and correlation between local zonations. Recent work on computational biostatigraphy has revealed that techniques based on entirely different principles, such as Appearance Event Ordination, Spectral Ordering, Monte Carlo Markov Chain methods, and Finding Partial Order, all generate broadly similar temporal patterns based on taxon occurrence alone, especially when only the most common taxa are included. The results correspond well to those based on recorded ‘database age’, derived from subjective assignment to time units or direct geochronological data, but appear to have somewhat better time resolution. As an example we present a detailed study of how soon extinction of a taxon follows a decline in its observed commonness, using multiple, independently computed chronologies and two different versions of the NOW data.

Wednesday 11:00

MICROVERTEBRATE SITES IN THE MORRISON FORMATION (UPPER JURASSIC) OF THE WESTERN UNITED STATES: DEFINITION OF TAPHONOMIC MODES

FOSTER, John, Museum of Western Colorado, Grand Junction, CO; CARRANO, Matthew, Smithsonian Institution, Washington, DC; TRUJILLO, Kelli, Univ. of Wyoming Geological Museum, Laramie, WY; MADEJEN, Scott, Dinosaur National Monument, Jensen, UT

In the Morrison Formation of western North America (Late Jurassic), microvertebrate spec-imens are known from a number of localities, but nine sites in particular have yielded abundant fossils. These nine sites combine for a vertebrate sample of 5000+ specimens and range in represented diversity from as few as 10 to as many as 45 taxa. The taphonomic and litho-logic characteristics of some sites and their fossil material seem to be consistent and define three taphonomic modes of microvertebrate occurrence: Type I, characterized by thin, dense accumulations of abundant and disarticulated microvertebrates in relatively hard green-gray siltstones and clayslones; Type II, characterized by thicker layers of sparse accumulations of articulated to disarticulated microvertebrates in light gray to gray clayslones (sometimes with minor silt); and Type III, characterized by thick layers of moderately dense accumulations of disarticulated microvertebrates in soft green-gray clayslones that screen-wash to produce abundant fragmentary remains. Type I deposits are exemplified by Quarry 9 at Como Bluff, the Little Houston Quarry, and the Small Quarry; Type II by the Fruita Paleontological Area sites, Rainbow Park 96, and the Wolf Creek Quarry; and Type III by Ninemile Hill and Mile 175. Rainbow Park 94 may be a Type II/III locality. The differences in frequency of articulation and in bone deposit density between deposits of Types I and II are striking. One likely would never mistake matrix with bone from Quarry 9, Small, or Little Houston as coming from the Fruita Paleo Area or Wolf Creek, for example; and in fact, in hand sample, matrix from Little Houston and the Small Quarry can be literally indis-tinguishable. Environments of preservation for the different modes include abandoned channels and levee/spays for Type I, and overbank deposits for II and III. These modes sug-gest possible lithologies in which to find new microvertebrate sites and, along with environ-mental interpretations, may provide clues as to the reasons for preservation of microverte-breates in certain conditions at different sites.
ties across time and space, but with little consideration of the taphonomic biases caused by different hydraulic equivalents of skeletal elements. In this study, four Judith River Formation assemblages were screenwashed and two Hell Creek Formation assemblages were quarried for microvertebrate remains. Statistical analyses show that population comparisons are possible between assemblages when comparing taphonomically similar elements of morphologically similar organisms, such as the scales of ganoid fish or the vertebrae of caudates. First applied to microvertebrate assemblages from the Maastrichtian Hell Creek Formation, this methodology was then tested on similar assemblages from the Campanian Judith River Formation. In both cases, taphonomically similar elements are not significantly different within the respective formations. Because there is a large carry-over of taxa from the Campanian to the Maastrichtian of the Northern Great Plains, direct population comparisons are possible between the paleocommunities. Chi-squared tests of taphonomically similar elements show significant differences within ornithischian, sauropsidian, and caudate abundances between the two formations. Turtles and ganoid scale-bearing fish abundances are not significantly different between assemblages. In Q-mode eigenanalysis, assemblages cluster by formation, indicating significant differences in faunal abundances between the Judith River and Hell Creek Formations. This study shows that analyses of taphonomically similar elements can be used to compare intraformational assemblages as well as trace population changes between formations, providing a new avenue for future paleoecological research.

Saturday 3:45

NEW PERSPECTIVES ON THE EVOLUTIONARY RADIATION OF ACANTHOMORPH TELEOSTS

FRIEDMAN, Matt, Chicago, IL

Although a major component of modern marine ichthyofaunas, acanthomorphs were uncommon until the early Paleogene, by which point they had diversified prolifically. While the magnitude of the acanthomorph radiation is unquestionable, its tempo has been unclear due to the paucity of fossil material from the Maastrichtian and Danian. New investigations have helped to illuminate this critical interval of acanthomorph history. The Maastrichtian acanthomorphs of Holland include polymixiids and ‘berycoids’, while the Danian acanthomorphs of Europe include polymixiids and a new species of basal therapsid distinct from

Friday 1:45

A NEW BASAL THERAPSID FROM THE MIDDLE PERMIAN MEZEN COMPLEX OF RUSSIA AND THE EARLY DIVERSIFICATION OF THERAPSIDA

FROEBISCH, Joerg, REISZ, Robert, Univ. of Toronto at Mississauga, Mississauga, ON, Canada

The Late Paleozoic documents a drastic faunal shift in the terrestrial realm from ‘polyosaur’-dominated faunas in the Early Permian to therapsid-dominated faunas of the Middle and Late Permian. The transition between these faunas is best represented by the Mezen Complex in the northern Fore-Ural region of European Russia. The Mezen vertebrate fauna exclusively contains amniotes and is characteristically dominated in numbers by parareptilian taxa such as Nyciphrurus, Macroleter, Nycterolette, Lanthaniscus, and Bashkoleter. However, this fauna also includes an exceptionally diverse synapsid fauna, including the varanopids Mesosaurus and Pzyxia as well as the caseid Enantiornatus. Therapsids are represented by five distinct taxa, the enigmatic nikkasurids Nkikasaurus tatarinovi, Rezzia gubini, and R. tippula, the possible basal dinoccephalian Nifatiasuchus zekheli, and the basal biarmosuchian Biarmosuchus tagax. Although less abundant, the therapsids always co-occur with basal synapsids in nine localities straddling the Kazanian-Tatarian boundary, although the Mezen Complex covers a wider time range of about 10 Ma. Undescribed new material from the Mezen Complex represents a basal therapsid and is referable to what has previously been described as Biarmosuchus tagax. The holotype of this species consists of a fragmentary skull that preserves the posterior half of the skull and lacks most of the snout, occiput, lower jaws, and all teeth. It was assigned to the genus Biarmosuchus based on the overall similarity to varying degree from the type species B. tagax in the shape of the orbit and temporal opening. The new material comprises an almost complete skull and lower jaws with associated postcranial. The skull is laterally compressed, but reveals important anatomical structures including the snout, palate, and dentition. The middle part of the bone is an almost complete skull and lower jaw with associated postcranial. The skull is laterally compressed, but reveals important anatomical structures including the snout, palate, and dentition. Most importantly, the new specimen exhibits an almost complete tooth row that clearly shows interlocking incisors, lacks a large canine form, and has tricuspid cheek teeth. The combination of these dental characters and the presence of a preapical indication that “B. tagax” represents a basal therapsid distinct from Biarmosuchus.

Romer Prize Session, Thursday 8:45

THE EVOLUTION OF PREAXIAL DOMINANCE IN TETRAPOD LIMB DEVELOPMENT

FROEBISCH, Nadia, McGill Univ., Montreal, QB, Canada

Limbs adapted for terrestrial locomotion are a hallmark of the tetrapod body plan. Despite the wide range of shapes and sizes that accompany a vast variety of limb functions, their development follows a very conservative pattern of preaxial dominance, branching, and segmentation. Development of the zeugopodium and digital arch typically occurs in a posterior to anterior sequence, referred to as postaxial dominance, with a digital sequence of IV–III–V–II–I. The only exception to this pattern in all of living Tetrapoda can be found in salamanders, which display a preaxial dominance in limb development, a de novo condensation of a basale commune (distal clavalar/s1 +2) and a preoccipital condensation of digits 1 and 2. These divergent patterns have puzzled researchers for over a century leading to various explanatory hypotheses, but despite many advances in research on tetrapod limb development, the divergent evolution of these two different pathways and their causes are still not understood.

An examination of more than 600 specimens of the branchnosaurus Aptosteg (Tanystropheus) from a wide range of ontogenetic stages formed the basis for the investigation of the pattern in its limb development. The exceptional preservation of the specimens allowed for the reconstruction of ossification sequences in the fore- and hind limbs and their comparison with the patterns found in extant tetrapod taxa. The results show that preaxial
dominance in limb development, a character previously considered to be unique and derived for modern salamanders, was already established in branchiostegalians in the Upper Carboniferous. When considered in the framework of competing hypotheses of basal tetrapod relationships, the evolution of this character provides new data for the discussion of the highly controversial relationships of the three modern amphibian groups among the possible Paleozoic antecedents, as well as the time of the divergence of these lineages.

Student Poster Session

COSTAL FUNCTIONS OF QUADRUPEDS FOR BODY SUPPORT AND RECONSTRUCTION OF THE SCAPULAR POSITION

FUJWARA, Shin-ichi, Tokyo, Japan

Extant archosaur and mammal scapulae do not have the skeletal joint with the vertebral column, and therefore it is hard to reconstruct their position. In extant quadruped archosaurs and mammals, the trunk is suspended between the forelimbs when standing on each forelimb by the serratus ventralis muscle. The muscle originates from each lateral side of dorsal and cervical ribs, and inserts to the proximal portion of the medial side of the shoulder blade. Therefore, not only the forelimbs, but also parts of the cervical and dorsal ribs are supposed to have mechanical adaptation to body support. The following hypotheses can be proposed:

(1) the ribs of quadrupeds are situated further from the scapulae to have stronger compression of the posterior ribs;
(2) the scapulae of the most robust ribs;
(3) thoracic ribs of bipeds have no significant difference in their strength like quadrupeds.

To calculate the strength of ribs and validate these hypotheses, two-dimensional finite-element analysis is carried out for the costal morphology. Materials examined of several extant taxa, such as crocodiles, aves, and mammals, are stored in the National Science Museum, Tokyo, and Graduate School of Medicine, The University of Tokyo. The geometry of ribs and corresponding vertebrae are outlined in its articulation. As a boundary condition, the vertebral body and spinoous process are fixed, and a compressive load is applied vertically to the distal end of each rib. The maximum equivalent stress in the rib, and inversely the load-compressive force on the rib is estimated. The analyses suggest that anterior ribs of quadrupeds are stronger than the posterior ribs which have no origin of the muscle. The arrangements of ribs with stronger stress suggest the arrangement of the serratus and also the most probable position of the proximal portions of scapulae. Ribs of bipeds do not have the significant correlation with the scapulae. Thus, the significant role of anterior ribs in quadrupeds is suggested, and the reliable scapular positions in quadrupeds are reconstructed by comparing the strength of the series of ribs from mechanical point.

Saturday 2:30

CRANIAL MORPHOLOGY OF EARLY CRETACEOUS MONJUROSUCHID CHORISTODERES (REPTILIA: DIAPSIDA) FROM LIAOProING PROVINCE, CHINA, AND EVOLUTION OF THE CHORISTODERAN PALATE

GAO, Ke-Qin, Peking Univ., Beijing, China; DUAN, Ye, HU, Dongyu, LI, Li, Shenyang Normal Univ., Shenyang, China; KSEPKA, Daniel, American Museum of Natural History, New York, NY

The Monjurosuchidae are a small clade of medium-sized, blunt-nosed choristoderes, known only from two closely related genera (Monjurosuchus, Phylodinusaurus) from the Early Cretaceous (Barremian-Aptian), western Liaoning Province, China. The occurrence of fully articulated monjurosuchid fossils in lacustrine deposits, along with superb preservation of soft tissue impressions of webbed feet in some Monjurosuchus specimens, implies an aquatic or semi-aquatic lifestyle for these animals. Though monjurosuchids have been known for more than 60 years, only recently have new discoveries revealed details of their anatomy. New specimens of Phylodinosaurus from the Early Cretaceous Chifontang Formation near Chaoyang provide useful data on palatal structure, virtually unknown before in monjurosuchids. Study of the new specimens indicates that many purported synapomorphies of the Neochoristodera were acquired earlier in choristoderan history, and thus, are diagnostic of a more inclusive clade. These features include an extensive vomer-maxilla contact, a long midline contact of the pterygoids, and presence of a distinct nasopatral trough. Comparison of the palate in major choristodere subclades with that in basal diapsids shows that the choristoderan palate has become progressively adapted to an aquatic way of life. Significant modifications include elongation of the vomers, posterior basal diapsids shows that the choristoderan palate has become progressively adapted to an aquatic way of life. Significant modifications include elongation of the vomers, posterior shift of the choanae, development of the nasopatral trough, opening of the palatal fora- men at the juncture of the three palatal elements, and reduction and posterior location of the interpterygoid vacuity. The available evidence strongly supports the monophyly of Monjurosuchidae and the placement of this clade closer to Neochoristodera than to Monjurosuchidae. The discovery of Monjurosuchus in southern Utah expands the known geographic range of this taxon roughly 2000 km relative to contemporaneous occurrences of G. notabilis. The latter finding is in keeping with taxonomic variation in body size among other late Campanian hadrosaurines from the Western Interior Basin, which tend to be significantly larger in the southern portion of the basin than in the north. The discovery of G. notabilis in southern Utah expands the known geographic range of this taxon roughly 2000 km relative to contemporaneous occurrences of G. notabilis and G. incurvimimus in Alberta, making this genus one of the most widespread Campanian hadrosaurids. Nevertheless, the presence of a distinct taxon at the species level is consistent with the pattern observed for the Late Cretaceous monjurosuchid clades found in both northern and southern portions of the Western Interior Basin, supporting the provincialism hypothesis.

Saturday 8:45

A NEW SPECIES OF GRYPSO SAURUS (DINOSAURIA: HADROSAURIDAe) FROM THE UPPER CAMPANIAN KAIPAROWITS FORMATION OF UTAH

GATES, Terry, SAMPSON, Scott, Utah Museum of Natural History, Salt Lake City, UT

Gryposaurus is a non-crested (hadrosaurine) hadrosaur characterized by a deep and massive skull possessing an arched nasal “hump” anterior to the orbits. Three species are currently recognized, G. notabilis, G. incurvimimus, and G. latidens, based on the relative position of the nasal hump, shape of the posterior nares, and relative size of the dentition. Recent work in the Kaiparowits Formation, exposed within Grand Staircase-Escalante National Monument, south-central Utah, has yielded a fourth Gryposaurus species, making this genus the most diverse within Hadrosauridae. The new species, represented by multiple skull and postcranial specimens, is differentiated from its congeners by the following characters: relatively deep, hyperbust skull; anteroposteriorly narrow infratemporal fenestra; subcircular supratemporal fenestrae; and elongate, narrow paroccipital process. The overall shape of the skull, as well as the morphology of the nasal, most closely resembles that of G. notabilis. Collected skeletal remains demonstrate this new species is by far the largest known member of Gryposaurus. The latter finding is in keeping with taxonomic variation in body size among other late Campanian hadrosaurines from the Western Interior Basin, which tend to be significantly larger in the southern portion of the basin than in the north.
HOW T. REX DIDN’T MOVE: CONSTRAINT-BASED EXCLUSION OF LIMB POSITIONS FOR RECONSTRUCTING DINOSAUR LOCOMOTION

GATESY, Stephen, Brown Univ., Providence, RI; BAKER, Martin, Institut für Werkstoffe, Braunschweig, Germany; HUTCHINSON, John, Royal Veterinary College, Herts, United Kingdom

Animation and simulation software allows paleobiologists to tackle fundamental questions about dinosaur locomotion using digital models. Yet the power of these computational tools to generate motion creates a new problem—how to choose among countless hypotheses? The skeleton provides crucial evidence, but bones alone are insufficient for determining how a dinosaur positioned and coordinated its joints to stand or move. Redundancy of limb segments precludes a unique solution, yielding a wide spectrum of potential hip heights and poses. One option is to reduce the number of choices by arbitrarily selecting a pose or by invoking simplifying geometric rules. We prefer a second alternative, in which demonstrably realistic constraints are used to exclude, rather than include, possible limb motions. Before attempting to reconstruct complete strides, we begin with a midstance pose at high speed, a time when the musculoskeletal system is most stressed. The goal is to constrain the “configuration space” of midstance poses as narrowly as possible using kinematic (motion-based) and kinetic (force-based) criteria from extant animals.

We undertook a case study in 2-D using Tyrannosaurus rex. Sensitivity analyses vary the center of mass, center of pressure, muscle mass, co-contraction of knee flexors, and ground reaction force magnitude converge on similar regions of configuration space. Very crouched poses can be excluded based on insufficient extensor muscle mass. Exceedingly erect running poses unrealistically position the knee behind the ground reaction force vector, limit limb excursion, and preclude higher hip heights during walking. A family of viable poses remains between these extremes. These feasible alternatives are starting points for more speculative sequences of poses reconstructing full stance phases and strides.

Neoceti Symposium, Saturday 10:15

A NEW BASAL ODONTOCETE (MAMMALIA: CETACEA) FROM THE ASHLEY FORMATION (RUPELIAN) OF SOUTH CAROLINA AND ITS PLACE IN ODONTOCETE PHYLOGENY

GEISLER, Jonathan, Statesboro, GA; SANDERS, Albert, The Charleston Museum, Charleston, SC

In 1985, James Malcom, a volunteer with the Charleston Museum, collected a partial skull of a primitive odontocete from the banks of the Ashley River near Charleston, SC. The specimen was found in the Ashley Formation (Rupelian), and its geographic position, near the center of a structural high, suggests that it is from the lower part of this formation. Although incomplete, this skull represents a new genus that is not referable to any described family. Unique features include parietal forming much of the postero medial part of the temporal ridge, region between the external nares and supraoccipital is flat, occipital condyles lack necks, and pachyostotic basioccipital. Other characters indicate that this taxon is one of the most archaic odontocetes ever discovered, including nasal opening well anterior to orbits, supraorbital process of frontal not completely overlapped by maxilla, supraorbital process only slightly overhangs the temporal fossa, and long intertemporal region. We added this new taxon and the late Oligocene odontocete Simocetus to our previously published data matrix, and compared results to those employed by these other aquatic crocodilians.

The unusual morphology of the otic region of the dyrosaurid

DYROSAURID INNER EAR MORPHOLOGY AS EVIDENCE FOR LOCOMOTOR BEHAVIOR

GEOGRI, Justin, Stony Brook Univ., Stony Brook, NY

The unusual morphology of the otic region of the dyrosaurid Rhabdognathus is examined via x-ray computed tomography (CT). It is shown that the drastic expansion of the otic regions of the lateral braincase wall results solely from an elaboration of the vestibular region of the inner ear. Comparison of the dyrosaurid inner ear to other aquatic crocodilians and a broad array of anapsids and aquatic diapsids suggests a novel hypothesis of locomotion in these forms.

No similar elaboration of the vestibular region is found in any other crocodyliform. In particular, this morphology is absent in other fully or mostly aquatic forms such as the telesaurosaurs, metriorhynchids or Gavialis. This suggests that the inner ear of Rhabdognathus is adapted to the sensory requirements of a mode of locomotion different from those employed by these other aquatic crocodilians.

A degree of vestibular expansion analogous to that seen in dyrosaurids can be found in several groups of aquatic turtles. Within the chelid family, there are several instances of dramatic vestibular expansion such as Chelus linherius, and Chelodina longicollis. Examples of vestibular expansion also can be found within cryptodiran taxa such as Chelydra serpentina and Macrochelys temmincki. All these turtles with expanded vestibular regions exhibit only moderate to poor swimming capability and preferentially locomote along the floor of their aquatic habitats. In contrast, capable swimmers, such as the chelonids, do not show a similar degree of vestibular expansion.

The presence of analogous elaboration of the vestibular region of the inner ear in the dyrosaurid Rhabdognathus and bottom walking turtles suggests that the dyrosaur’s equilib- rium and balance sensation was adapted for walking along the sea floor, not for swimming. This hypothesis of dyrosaurid locomotion may help explain many other aspects of their morphology including the absence of paddle-like limbs and the absence of a heterocercal tail.

Poster Session II

PALEONTOLOGY IN A LEGAL CONTEXT: THE VICTORIA BY THE BAY PROJECT, HERCULES, CALIFORNIA

GERIKE, Christian, MATZEN, Benjamin, LSA Associates, Inc., Pt. Richmond, CA

Paleontological research, best known as an academic pursuit of universities and museums, also exists in the realm of legislation designed to preserve paleontological resources for future study. The California Environmental Quality Act (CEQA) requires the implementation of mitigation measures to protect significant, nonrenewable paleontological resources at state and local levels. In this study, the General Plan of the City of Hercules, Contra Costa County, California, required the Victoria by the Bay housing development project to monitor ground disturbance to locate and recover paleontological resources and associated environmental data in paleontologically sensitive Late Pleistocene sediments within the project area. LSA Associates, Inc. (LSA) was retained by the Santa Clara Valley Housing Group (SCVHG) to address the requirements and conditions of CEQA and of the City of Hercules Planning Department regarding impact to paleontological resources for this project. LSA submitted a project specific paleontological resources impact mitigation plan guided by the Society of Vertebrate Paleontology 1995 conformable impact mitigation guidelines. Specimens recovered by LSA during monitoring of project ground disturbance were prepared, identified, described in a report of findings, and curated into the California Museum of Paleontology collections. By undertaking these tasks to comply with CEQA and the City of Hercules legal requirements, the SCVHG mitigated the projects impact to paleontologi- cal resources.

Monitoring activities recovered the large mammals Mammutthus sp., near columb, and Bison sp. In addition, 486 kilograms of sediment was processed for microvertebrate fossils, which yielded 163 specimens, 16 of which were diagnostic. Similar Late Pleistocene fossil localities near the project area allowed a comparison of taxonomic lists. This study describes one new taxon, the chipmunk Eutamias sp., and noted that certain taxa known from nearby localities, such as Reithrodontomys raviventris, the Salt Marsh Harvest Mouse, were absent. This different taxa and presence of fish and ray teeth suggest the project area was a near-shore delta environment as recently as the Late Pleistocene, though the project area is now at 60 meters elevation above sea level with no stream flow. As the Victoria by the Bay project shows, the implementation of environmental legislation designed to protect significant, non-renewable paleontological resources preserves fossils and contributes past environmental data to our field of study.

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COLLECTION AND USE OF TAPHONOMIC DATA FROM VERTEBRATE LOCALITIES: LESSONS FROM SIX YEARS OF PALEONTOLOGICAL INVENTORY AND EXCAVATION IN GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, UTAH
GETTY, Mike, LOEWEN, Mark, Utah Museum of Natural History, SLC, UT; ROBERTS, Eric, Univ. of the Witwatersrand, Johannesburg, South Africa
Since 2001, the Utah Museum of Natural History (UMNH) has been working in a collaborative agreement with the BLM to conduct paleontological surveys of the Late Cretaceous Kaiparowits and Wahweap formations of Grand Staircase-Escalante National Monument. In the course of this project, the UMNH has made field collections from more than 350 vertebrate localities and conducted extensive excavations at 10 of these sites. While a number of significant specimens have been collected and are being described as a result of this project, broader paleoenvironmental and paleoecological questions are now also being addressed as a result of taphonomic analysis of the data collected in association with these specimens. The field inventory of vertebrate localities involves the collection of considerable ancillary data along with the specimens themselves, which are collectively referred to as taphonomic data. Taphonomic data found to be most relevant in this type of survey include the sedimentologic and stratigraphic context of the locality; spatial and geographically contextual of the specimens obtained through excavation mapping; and categorization of localities according to their biological and preservational attributes (taphonomic modes). Additional taphonomic features observed on individual specimens following detailed preparation include: soft tissue preservation, weathering, traces of insect activity, trampling, and tooth marks. If collected systematically, taphonomic data reveal more detailed insights into the character of the paleoenvironments and paleoecology of the formations in question. Additionally, these data enable evolutionary and ecological interpretation beyond what is possible from the collection and study of the specimens alone.

Poster Session I
A NEW EUTHERIAN MAMMAL FROM THE CRETACEOUS OF MONGOLIA
GIALLOMBARDO, Andres, NOVACEK, Michael, American Museum of Natural History, New York, NY
Much of the debate about the placential mammal radiation focuses on the time of origin of extant placental orders, with competing hypotheses placing the origin of these groups either before or after the K/T boundary. Because of the critical period in mammalian evolution it represents, any finding of Cretaceous eutherian is crucial for understanding the early diversification of modern orders. Here we present a new eutherian from the Khugenetslavkant sandstone facies (Dorngobi Aimag, Eastern Gobi, Mongolia). As with most of the continental deposits of Central Asia, the stratigraphy of the Khugenetslavkant sandstone facies is poorly constrained, but an Albian-Aptian (upper part of the Early Cretaceous) has been suggested based on faunistic correlation. The new taxon is represented by one fragmentary skull with associated jaws and postcranium, a second fragmentary skull, and two fragments of maxilla. The skull has a long and narrow snout, with the nasals wider posteriorly. The dental formula is 14(13)/14, C1/c1, P5/p5, M1/m1. The dental formula is 4:4 and the p5 are molariform teeth. The anterior lower incisors are hypertrophied and procumbent, with the enamel interrupted on the postero-lateral side. The lower premolar is multipartite, the lower molars have a compressed trigonid and a fully basinated talonid. The fibula is slender and distally fused to the tibia from the mid-shaft to the end. The astragalus has a bulbous crown. A cladistic analysis places Kuehneotherium as a more basal, more plesiomorphic eutherian.

A preliminary phylogenetic analysis places the Khugenetslavkant sandstone facies (Dorngobi Aimag, Eastern Gobi, Mongolia) as the sister of Zalambdalestidae or Zalambdalestidae as the sister taxon of Zalambdalestidae. The Zalambdalestidae is known from the late Turonian-early Campanian (Late Cretaceous), and have been alternatively proposed to be close relatives to Glires (rabbits and rodents), or they have been placed as a stem group of eutherians, outside the placential radiation. A detailed phylogenetic study is underway to establish the interrelationships among early eutherians in light of this new taxon.

Poster Session II
HEALTH HAZARDS OF THE RODENT-BORNE HANTAVIRUS. HOW TO DEAL WITH POTENTIALLY INFECTED STORAGE SIGHTS AT THE WYOMING DINOSAUR CENTER
GIBBELL, John, WAHL, William, Wyoming Dinosaur Center, Thermopolis, WY
Hantavirus pulmonary syndrome (HPS) is deadly and exhibits itself as cold or flu-like symptoms. It is generally agreed that three basic procedures are necessary to deal with this virus when cleaning. 1. Wear gloves and mask, 2.Use disposable rags rather than vacuuming or sweeping. 3. Spray dust with bleach solution of one cup per gallon of water. Also suggest is the procedure of airing out structures and exposure to sunlight any potentially infected areas. As the quarries at the Wyoming Dinosaur Center are open to the public, there is the potential of infection and transport. Though the chances of having a contaminated rodent with structures may seem remote, there have been known cases of person to person transfer, it is still a very deadly disease. Although the best way to prevent hantavirus is to use whatever means to keep rodents out, reliable sanitation is the best defense.

Vertebrate Development Symposium, Wednesday 10:30
HOW TURTLES FORM SHELLS: HETEROTOPY AND HETEROCHRONY
GILBERT, Scott, CEBRA-THOMAS, Judith, Swarthmore College, Swarthmore, PA
The turtle shell is an evolutionary novelty that constitutes the basal synapomorphy for Chelonia. It is composed of two main parts, the dorsal carapace and the ventral plastron. The carapace forms by the displacement of the ribs into the dorsal dermis rather than their forming a rib cage. Our evidence suggests that FG signaling directs the rib precursor cells into the dorsal dermis of the carapacial ridges. Once in the dorsal dermis, each rib acts as a signaling center that ossifies the surrounding dermal cells. The dermis ossifies in both directions from the rib, forming the costal bones of the carapace. Bone morphogenetic proteins (BMPs) appear to be the major signaling molecules in this ossification. Such proteins are made during the normal endochondral ossification of the rib. Thus, once ribs enter the dermis, a shell might be easily accomplished. The plastron forms much like the skull and the facial bones, by intramembranous ossification. INK-1 staining and Dil labeling evidence that these bone-forming cells are derived from the trunk neural crest. We hypothesize that a population of trunk neural crest cells stays in a “staging area” above the neural tube, loses Hox gene expression, and becomes capable of forming bone. Thus we propose a mesoderm to mesoderm contribution (changing the placement of the mesodermal structures) which plastron formation may involve heterochrony (changing the timing of events.) Preliminary results suggest that alligator gastralia are also INK-1 positive, suggesting a similar origin.

Romer Prize Session, Thursday 9:00
KUECHNEOTHIERIUM: ENIGMATIC STEM MAMMAL FROM THE MESOZOIC FISSURES OF SOUTH WALES
GILL, Pamela, Univ. of Bristol, Bristol, United Kingdom
The Late Triassic–Early Jurassic Kuechneothierium is one of the earliest known mammalans but, in spite of its importance to mammalian phylogeny, it has not previously been fully described due to the fragmentary nature of the material. The largest collections are from fissure deposits in South Wales, comprising approximately 1,000 isolated teeth and jaws. The dental formula of Kuechneothierium is i2/2, c1, p4, m3. The postcanines are the most robust teeth for each locus. The lower dental formula is 57 1 6 6. The upper tooth is assumed to be similar. There is unexpected taxonomic diversity in the Welsh fissure samples and new species are proposed. Kuechneothierium is fully diaphyodont, with differentiated premolars and molars and a consistent alveolar row. There is evidence that this had been only recently established, including a suppressed third replacement wave and continuum of form between the deciduous premolars and molar molars. Initial uncertainty in reconstructing the dentition centred on a number of small pleisomorpic molars, some of which are similar to the teeth of a derived cynodont, with less crown triangulation and incompletely divided roots. These teeth are the postcanines of a different kuechneothieridi and in one fissure there is continuity of form between them and Kuechneothierium. Conservatism in the form of the dentary but wide variation in molar crown triangulation suggests that the latter may have evolved more than once. The molar occlusion is reinterpreted to argue that effective shearing occurs without crown remodelling. The wear seen on the more pleisomorpic kuechneothierid molars is compared with that on molars of Kuechneothierium suggests that improvements in shearing efficiency may have driven selection for divided roots and a less bulbous crown. A cladistic analysis places Kuechneothierium within the mammalian crown.
group which would support to the possibility that both the molar cusp triangulation and the separation of the middle ear from the dentary are homoplastic.

Friday 1:30

EARLY WHALES ICTHYOLESTES AND PAKICETUS (MAMMALIA, CETACEA): TERRESTRIAL, AQUATIC, OR BOTH? CAVET EMPTOR!

GINGERICH, Philip, Univ. of Michigan, Ann Arbor, MI

Icthyolestes was named in 1958, based on a maxilla from the early middle Eocene of Pakistan with teeth interpreted to represent a fish-eating mesonychid. A second larger genus Pakicetus was named in 1981 from the same provenance, based on an archaeocete skull with both aquatic and terrestrial characteristics. These are classified as Pakicetidae, and from 1983 were interpreted to be an amphibious stage in the evolutionary transition of whales from land to sea. Some later studies interpreted pakicetids as fully aquatic, or fully terrestrial, but neither extreme is justified.

Evidence favoring a terrestrial habitat for pakicetids includes (1) preservation with land mammals in continental red beds; and (2) retention of a periotic integrated in the basicranium, multiple contacts between the tympanic and basioccipital, small mandibular foramen, unreduced crus longum of the incus, tympanic annulus and membrane, and semicircular canals of large radius. Evidence favoring an aquatic habitat includes (1) sharply pointed teeth and an elongated rostrum for feeding on fish; (2) a tympanic involucrum, sigmoid process on the bulla, and inflated incus for inward hearing in water; and (3) tooth enamel with δ13C values of low variability. Features shared by artiodactyls and later semiaquatic protocetids are not informative, but short cervical vertebrae enhancing hydrodynamic stability, and a short ilium minimizing any gluteal contribution to extension of the femur complicate a fully terrestrial interpretation.

Aquatic or terrestrial? The type specimen of the type species of the type genus of Pakicetidae has clear evidence for both, and new evidence from isotopes, periotics, and postcranial corroborates that pakicetids were semiaquatic. When a representative skeleton is found, it will indicate how pakicetids swam and how they should be exhibited. In the meantime, caveat emptor. Journalists write what they think we want to hear, and dealers sell what they think we will buy. Most of us are educators, in some capacity, and we should do our homework before we believe or buy extreme interpretations.

Nesoceti Symposium, Saturday 10:30

ARAEODELPHIS NATATOR KELLOGG, 1957, THE most PRIMITIVE KNOWN MEMBER OF THE PLATANISTIOIDEA (ODONTOCETI, CETACEA), AND RELATIONSHIPS TO OTHER CLADES WITHIN THE PLATANISTIOIDEA

GODFREY, Stephen, Calvert Marine Museum, Solomons, MD; BARNES, Lawrence, L.A. County Museum of Natural History, Los Angeles, CA; BOHASKA, David, Smithsonian Institution, Washington, DC

The extant river dolphins in the family Platanistidae, Platanista minor and P. gangeticus, are amongst the most highly derived odontocetes. In contrast to Platanista, stem-ward Miocene platanistids like Prepomatosdelphis, Zarhachis, and Pomatosdelphis, are more diverse anatomically, more widespread geographically, and are marine in habitus. A partial cranium (USNM 526604) from the Plum Point Member that is low in the marine Calvert Formation (Early Miocene, Burdigalian) in Calvert Cliffs, Maryland, is identified as Araeodelphis natator Kellogg, 1957. Preliminary study of this specimen shows a suite of plesiomorphies providing a clearer picture of the cranial morphology for stem Platanistia. Synapomorphies of A. natator that define the Platanistidae are: asymmetrical cranial vertex; frontals extended between mesethmoid and nasals on the posterior wall of naris; elongate and narrow rostrum; mesorostral groove closed over dorsally on the anterior half of the rostrum by a meeting of the premaxillae at the sagittal plane; premaxillae and maxillae both reaching the anterior rostral extremity; distal ends of premaxillae and maxilae fused at the rostral extremity; posterior ends of premaxillae expanded posterolaterally; posterior maxillary foramina located far posteriorly; thickened frontals and maxillae compressing incipient supraorbital crests; zygomatic process of the squamosal flattened transversely and expanded dorsosagitally; and zygomatic process having a broad connection to the dorsosagittal ridge that reduces the orbital process of the frontal. Synapomorphies shared by Araeodelphis and other platanistid families (Squalodontidae, Waipatiidae, Squalodelphinidae, and possibly Dalpiaziniidae) are presence of a foramen spinosum, and loss of the coracoid process and supraspinatus fossa on the scapula. The Squalodelphinidae is the apparent sister taxon of the Platanistidae.

Poster Session III

IMAGING THE Otic CAPSULES OF A PIlosAUS

GOMEZ-PEREZ, Marcela, Univ. of Cambridge, Cambridge, United Kingdom; NOE, Leslie, NORMAN, David, The Sedgwick Museum, Cambridge, United Kingdom

Well-preserved pliosaurs (Reptilia: Sauropterygia) are rare, and those with high-quality braincase material are extremely uncommon. A new and undescribed genus and species of pliosaur from the Lower Cretaceous of Colombia, South America, is one of the few very pliosaur specimens which preserves the otic capsules and braincase substantially complete, articulated and uncrusched. The 3-D cranium of this new specimen has been acid-prepared, revealing the otic capsules and details of the internal osseous labyrinth. However, the bones surrounding the osseous labyrinth are fused and extremely fragile, so understanding the detailed osteology and visualising the precise morphology of the semicircular canals is challenging. In order to obtain the fullest possible information from the fossil, the otic capsules were CT scanned and the images manipulated with the software MIMICS to produce a virtual 3-D ‘cast’ of the semicircular canals. The generation of this 3-D computer model of the otic capsules and the osseous labyrinth of this pliosaur, displays for the first time the full details of this region of the cranium in a sauropterygian marine reptile. Reconstructions of the osseous labyrinth are presented and the 3-D digital ‘endocast’ suggests that the balance and angular acceleration sensory system in this group of marine reptiles was developed so as to be equally sensitive in all three planes of space.

Postier Session I

DISCOVERY OF AN IMPORTANT HOMINID TRACKSITE, ?EARLY HOLOCENE OF COAHUILA, MEXICO

GONZALEZ, Arturo, LOPEZ, Jose, Laboratorio de Paleontologia, Saltillo, Mexico; ROJAS, Carmen, INAH, Saltillo, Mexico; LOCKLEY, Martin, Dinosaur Tracks Museum, Denver, CO

The Museo del Desierto (MUD) collections include two well-preserved Holocene hominid tracks, with a previously obscure history. Although collected from a ‘tufa-like’ deposit near Cuatro Cienegas, Coahuila, in 1961, since then, until 2006, the locality of origin was unknown. We report the discovery of a dozen hominid tracks in a similar ‘tufa-like’ deposit associated with the famous underground springs and pools from this same region. The new site, previously excavated for building stone, may be the same locality from which the original tracks were collected. The two MUD tracks, a right and a left, are 24 cm long, 10 cm wide, and may be from the same trackway. They are well-preserved showing heel, ball, and all five toe impressions. The new discovery includes an incomplete trackway of 11 footprints, of which 6 are also well-preserved, mostly with clear toe impressions. These tracks are 25 cm long and 10 cm wide with steps from 74-81 cm. Another area reveals another clear track on a trampled surface. Hominid (presumably H. sapiens) tracks from the Americas have rarely been mentioned because of controversial claims of purported prehistoric Mexican tracks that may date to 40,000 years. With the exception of one track from Chile dated at about 1.5-2 million years, the oldest well-documented and well-preserved hominid tracks are from Nicaragua, California and Argentina and date to about 6-7,000,000 years BP. The Coahuila tracks are not yet dated, but it is well known that early humans were very active in this region around 9,000-10,000 BP.

Poster Session III

MUHI QUARRY, HIDALGO IN CENTRAL MEXICO, A POSSIBLE BREEDING AND NESTING SITE FOR LATE CRETACEOUS FISHES

GONZALEZ-RODRIGUEZ, Katia, BRAVO-CUEVAS, Victor, Museo de Paleontologia, Universidad Autonoma del Estado de Hidalgo, Pachuca, Hidalgo, Mexico; FIELITZ, Christopher, Emory & Henry College, Virginia, VA

Mesozoic calcareous rocks belonging to El Doctor Formation (Albian-Cenomanian) outcrop in the northwestern portion of the State of Hidalgo, Central Mexico. The lower part of this Cretaceous unit consists of thinly to medium bedded light gray micritic limestones and black flint bands intertongued by fine-grain sandstone and marls, deposited in a pelagic environment above the continental shelf. From strata of this composition, an important marine fish community including over 400 specimens of sharks and teiotes has been recovered.

Although the complete diversity of the locality is unknown because of the newness of the discovery, it is surprising to find a diversity of small size fishes representing juvenile specimens of enchodontids, dercetids, ichthyodectids, beryciforms, and other taxa not identified. A new species of Enchodus, which is the most numerous fish in the locality includes many small individuals of different sizes, the smallest having a mandible length of 1.5 cm and the largest with a mandible measuring of 7.5 cm. Adult ichthyodectids are represented by only two specimens (one head and one incomplete trunk), but two complete juveniles have been found. Dercetids include five incomplete adult specimens and a complete juvenile. A new species of beryciform includes three juveniles and an adult specimen. This finding suggests that the site where the specimens were deposited was a breeding or nesting ground. Possible anoxic events followed by rapid burial allowed for the preservation of such small specimens.

Vertebrate Development Symposium, Wednesday 11:30

MODULARITY AND MORPHOLOGICAL DIVERSITY IN THE MAMMALIAN CRANIUM

GOSWAMI, Anjali, The Natural History Museum, London, United Kingdom

Variation is the raw material of evolution, but there is little understanding of how variation on a microevolutionary scale relates to large-scale evolutionary patterns. In particular, trait correlations have often been invoked as a possible constraint on variation, and thus a major influence on evolutionary change, but there are few empirical studies of the relationship between trait correlations and morphological evolution. The study of modules, autonomous sets of highly-correlated traits, allows for broad comparisons of trait correlations between trait correlations and morphological evolution. The study of modules, autonomous sets of highly-correlated traits, allows for broad comparisons of trait correlations and morphological evolution. The study of modules, autonomous sets of highly-correlated traits, allows for broad comparisons of trait correlations...
cранial modularity. Monoremtes display only two cranial modules, while theraiens (marsupials and placental mammals) display six. Within theraiens, there are significant differences among modules associated with taxa in the strength of within-module correlations. These differences show that modularity evolves, but it leaves open the question: “What is the evolutionary significance of modularity?”

I will present results from two approaches to addressing this fundamental question. First, do modules show significant differences in morphological disparity? As mentioned above, some modules are highly integrated (high trait correlations), and others are more weakly integrated. If trait correlations constrain variation, it may be expected that less integrated modules show greater disparity. I use data from over 100 species from the theraian orders Primates, Carnivora, Dasyuromphia, Peramelia, and Diprotodontia to compare disparity, measured with Procrustes distance, in each of the six modules observed in theraiens. Second, I conduct stochastic computer simulations of cranial shape evolution using different empirically-derived covariance matrices to demonstrate how different patterns of cranial modularity may influence long-term patterns of morphological diversity.

**Friday 10:45**

**LANDSCAPE TAPHONOMY: BONES GALORE—A LATEST EOCENE SITE IN NORTHERN COLORADO**

**GRAHAM, Russell, Penn State Univ., University Park, PA; EVANOFF, Emmett, Univ. of Northern Colorado, Greeley, CO; WEIS, Bart, Denver Museum of Nature & Science, Denver, CO**

The Bones Galore site, in the uppermost Eocene White River Group of northeastern Colorado, contained fifteen separate bone clusters. Block excavations (ca. 240 m² and 144 m²) were conducted at two clusters about 100 m apart. A single stratigraphic unit that represents a splay deposit extended across the site and contained most of the bones in both clusters. All specimens larger than 5 cm were piece plotted in a 2 m x 2 m grid system with regards to their 3D position. Orientation and inclination was recorded for specimens with long axes. Laboratory studies included taxon identification, skeletal element identification and completeness, bone surface modification including weathering stage, fracture patterns and population demographics of rhinos and bovids. Analyses of these data and those collected during excavation suggest that one cluster represented an ephemeral waterhole (perhaps a brackish water source) that collected bones over an extended period of time. Extensive scavenging was also apparent. The other cluster appears to have been a flood plain surface with several scattered and incomplete bone clusters that were covered quickly by the splay deposits. Scavenging was not a major factor. Although both clusters occur in the same stratigraphic horizon and on the same landscape, interpretations of paleoecology and/or biogeography based upon species composition of a single cluster would have been erroneous. To fully understand this record, and ones like it, large excavations must be conducted to effectively sample as many landscape facies as possible.

**Poster Session III**

**IMPLICATIONS OF *SCAPANORYRHYNCHUS* TOOTH SIZE IN A CAMPANIAN (CRETACEOUS) ESTUARY AT ELLISDALE, NJ**

**GRAVES, Walter, Univ of Illinois at Chicago, Chicago, IL**

The fossil genus *Scapanorhynchus* is the most common shark preserved in the Ellisdale Local Fauna. The Cretaceous fauna from outcrop at Ellisdale is dominated by small individuals. This is most notable in *Scapanorhynchus*; 65% of complete teeth (crown plus roots) recovered from outcrop are &lt; 2 cm in total height, with 24% of all teeth recovered being &lt; 1 cm in total height. Since the Ellisdale Site does preserve large teeth (approaching 5 cm in total height) there does not appear to be a taphonomic bias toward preservation of only small teeth at this site. The relative abundance of small *Scapanorhynchus* teeth at Ellisdale suggests a large proportion of small (juvenile) individuals in the fauna, and may indicate that this nearshore shark used the estuary as a nursery ground.
elongs over evolutionary time, the relative sizes of the jaw closing muscles will also change to reorient the muscle vector so that it is anteriorly inclined. That increases the length of the projection of the posterior region of the jaw, keeps the 3:7 ratio in tact, and so maintains the efficiency of the jaw mechanism.

Student Poster Session

PRELIMINARY ANALYSIS OF MICROWEAR IN EXTANT XEANTHRANS: CAN DENTIN MICROWEAR INDICATE PALEODIET?

GREEN, Jeremy, North Carolina State Univ., Raleigh, NC

Dental microwear is a well-established, quantitative method for analyzing paleodiet in extinct animals through direct comparison with extant taxa. However, previous research has focused predominately on food scar patterns in enamel. The question of whether microwear in dentin can indicate diet in extant or extinct animals has not been addressed. This issue particularly affects extant and extinct xenarthran taxa, as their teeth are comprised solely of dentin, and no enamel is present. Quantitative analyses of microwear patterns in extant xenarthran taxa (for which primary diet is known), will allow inference of functional composition of paleodiet in extinct xenarthran and other vertebrates such as dicynodonts (Therapsida, Anomodontia), which do not possess enamel. Microscopic scar topography features were analyzed in a large sample of teeth (n=47) from three extant xenarthran families (Brachypodidae, Dasyopodidae, Megalonychidae), using the new low-magnification light stereomicroscopy method. Features including number of small/large pits, fine/coarse scratches, presence/absence of cross scratches and puncture pits, and other features were recorded. A database correlating dentin microwear patterns with known primary diet for each respective taxon was established. Ecological morphologies such as insectivore, leaf-browser, fruit-browser, etc. were created using this database. Microwear patterns in several extinct xenarthran taxa (i.e., Eremotherium, Glyptodon) were then analyzed and compared to this database to test the validity of dentin microwear in assessing paleodiet. The results of this study are significant not only in determining the significance of dentin microwear features in interpreting palaeodiet, but also in allowing the most comprehensive comparison of dentin microwear with previous accounts of enamel microwear in order to gain a broader understanding of the mechanics of foodscarring on different dental tissues.

Poster Session III

PELVIC AND HIND LIMB MUSCULATURE OF STAURIKOSAURUS PRICEI COLBERT, 1979 (DINOSAURIA, SURAISCHIA)

GRILLO, Orlando, AZEVEDO, Sergio, Museu Nacional/UFRJ, Rio de Janeiro, Brazil

The study of pelvis and hind limb bones and muscles in primitive dinosaurs is important to understand the early evolution of bipedal locomotion in Saurischia. We reconstructed these features in Staurikosaurus pricei (Santa Maria Formation, Late Triassic of Rio Grande do Sul, Brazil) aiming to create a 3D model and to evaluate the movement capabilities of this primitive saurischian. The “extant phylogenetic bracket” method was used to infer which muscles were present in Staurikosaurus and its origin and insertion, and homologies of bone surfaces between extant taxa (Crocodylia and Aves) and Staurikosaurus was inferred based on phylogenetic information. In contrast to crocodylians, Staurikosaurus possesses a larger area for muscle origin in the ilium, the M. iliobifemoralis (IF) is divided (anterior trochanter present but small). Two large depressions in the lateral surface of the ilium are the origin for the M. iliobifemoralis lateralis and medialis posteriorly, posteriorly. The preacetabular iliac border may be used to determine the anterior limit of ITC and IF since it is a feature of Aves, Crocodylia, and Lepidosauromorpha. The M. biceps immersed onto the pubic tubercle as in extant Aves. This tubercle has been figured as absent in Staurikosaurus, but it was preserved in the left pubis (all current reconstructions are based on the right pubis) and is identical to that of Herrerasaurus and Saurusaurus. The origin of the Mm. puboischiofemorales internus (PIIF) is similar to Crocodylia, but Staurikosaurus has only the point of insertion for PIIF2 in the anterior margin of the proximal femur. This suggests that during archosaurian evolution PIIF2 lost its posterior insertion point and, later, in Theropoda, was divided in Mm. ilioventralis cranialis and medialis. The Mm. caudofemoralis are similar to Crocodylia, but Staurikosaurus is unique in bearing a surface (medial blade of the reduced tubercle) posteriorly projected for the insertion of the M. caudofemoralis brevis which increases the moment arm of this muscle.

Saturday 10:30

DELPHYDONOSACRIFORMES, REVISITED. NEW INFORMATION ON BABY MEAN-TEETH, A BEAR GULCH CHONDRICHYTHAN


The Bear Gulch fauna (Serpukhovian, Heath Formation of Montana) is especially notable in the high diversity of chondrichthyans that it records. Delphysodontosaciformes Lund 1980, from which this material emanated, was originally described on the basis of two fetal specimens as a new species of holoc relevant, the latter having since been described as the crown group of the Euchondrocephali (Class Chondrichthyes, Subclass Elasmobranchii and Subclass Eucarchodontii). Six additional specimens (male and female, including mature forms) have now been recovered, thereby offering additional information on the ontogenetic and phylogenetic status of Delphysodontosaciformes. All specimens are entirely placid in squamation and exhibit a tear-drop shaped body with a single, aspinous, long, low, scale covered dorsal fin. Dorsal and ventral lobes of the weak caudal fin are evident. The endoskeletal mineralization conforms to a mode of tesserate mineralization that has been noted among chondrichthyans. The neurocranium presents with two cranial fissures and regularly preserved sutures in addition to unfused, autotolithic palatoquadrate and cranially-subtended, crestal branchial arches. Neither the palatoquadrate nor Meckel’s cartilage bear teeth. Rather, tooth whorl-bearing premandibular and symphysial cartilages formed the functioning oral margin. Observations confirm that whorls are generated as denticulate “tooth cusps” incrementally add to a fundamental scale-like whorl unit. The design of Delphysodontosaciform’s shoulder girdle is consistent with that of Debevrius and other euchondrocephali, thus presenting as a plesiomorphic to primitive condition with the exception of a articulart structure. The phylogenetic position of Delphysodontosaciformes, although unresolved at this time, will be discussed with regard to the suite of such characters.

Vertebrate Development Symposium, Wednesday 11:00

HETEROCHRONIC INFLUENCES ON THE DEVELOPMENT OF POSTCRA-NIAL CHARACTERS IN HADROSAURID DINOSAURS

GUENTHER, Merrilee, Univ. of Pennsylvania, Philadelphia, PA

A goal of modern dinosaur paleobiology is to synthesize our understanding of dinosaurian development and phylogeny. However, evolutionary change can be difficult to study in taxa for which only fossils remain. Heterochrony is a potential mechanism for evolutionary change, but a difficult one to test with certain fossil groups. Methods have recently been developed in an attempt to utilize fossil data fully. This began with the development of “event pairing,” which allows for the analysis of ontogenetic sequences by pairing developmental events and subsequently comparing their relative timing. Though it began as a qualitative rather than quantitative method, the event-pairing methodology has been quantified through “event-pair cracking.”

The data set represented by the Hadrosauridae presents one of the greatest opportunities to study the ontology of a dinosaur group and apply the event-pairing methodology. Given the known ontogeny of the most complete hadrosaurid, Edmontosaurus annectens, a pectoral pebble ram, which is included in this study. The use of this taxon, among others, allows for an analysis of the developmental differences within the Hadrosauridae and its two subfamilies, Hadrosaurinae and Lambeosaurinae, and with more basal iguanodontians. The study involves comparing the developmental sequences of several hadrosaurid taxa, including Maiasaura, Hypacrosaurus, Corythosaurus and Lambeosaurus, among others, with more basal iguanodontian taxa such as the hadrosaurid, Telmatosaurus, and the iguanodontid, Iguanodon, among others.

Phylogenetically significant postcranial characters have been previously identified through a qualitative and descriptive study of the Hadrosauridae. Within the postcranial skeleton of hadrosaurs, characters can be used for taxonomic differentiation at the subfamily and, at times, generic level. The appearances of these characteristics throughout ontogeny serve as the basis for the developmental events that are “paired” in this method. The focus in this study has been on postcranial elements and the most distinctive characters have been identified among the appendicular and pelvic elements.

Poster Session III

RENEWED FRANCO-AMERICAN RESEARCH AT THE LATE VILLAFRANCHIAN LAKE OF SENÈZE (HAUTE-LOIRE, FRANCE)

GUÉRIN, Claude, Université Claude Bernard-Lyon I, Villeurbanne, France; FAURE, Martine, Université Lumiére-Lyon 2, Lyon, France; MONGUILLON, Angélique, DEBAR, Evelyn, Université Claude Bernard-Lyon I, Villeurbanne, France; DELSON, Eric, American Museum of Natural History and City Univ. of New York, New York, NY

The fossil site of Senèze, located in the Auvergne volcanic province of the French Massif Central, is well-known for its mammalian fauna and its role as the reference locality for the Late Villafranchean time interval, MN 18. This site is a filled-in volcanic explosion-crater lake (maar) where fossils are found in volcaniclastic sediments interfingering with lacustrine deposits at the lake margin. The Senèze mammals are generally considered to date between 2.2-1.5 Ma, but some have suggested that the local fauna is composed of two associations of different age. Moreover, little has been published about the geological setting or the processes of site formation. We are re-examining Senèze for the first time in 60 years with the following goals: 1) to clarify the local geology (stratigraphy, mineralogy), and to define this complex site and determine the taphonomic history of the fossil remains; 2) to utilize a combination of methods (argon and ESR dating; taphrochronological and paleomagnetic correlation) to definitively establish the age of the site and its fauna; and 3) to collect additional mammalian fossils (especially of rare animals such as carnivores, primates and rodents) and samples of the non-mammalian biota, including vertebrates (e.g., birds and fishes), terrestrial and lacustrine invertebrates, pollen and diatoms from known points within the revised and dated stratigraphy. Well-preserved, mostly articulated skeletons of Dicerorhinus erucus, Eulacoceros toxioides, and Alophopus stenios zemeni zemeni have been recovered, in addition to more fragmentary remains of “Cervus” philisi, Mammuthus meridionalis, Pachyeropectus perrieri, Acinonyx pardinensis, and (for the first time at the site) Mimomsys ptymyodes and a castorida. The bones present few if any indications of carnivore ravaging, and a taphonomic working hypothesis is that periodoc mudflows down the inside crater wall may have preserved the large mammals and rolled them into the lake in anoxic situation. Argon dating suggests that the main fossiliferous level (which can be traced over a wide area despite faulting) postdates 2.1 Ma. Additional paleomagnetic profiles should allow tighter chronological calibration.
NEW PRIMATES (MAMMALIA) FROM GANDHERA QUARRY, EARLY EOCENE, BALOCHISTAN PROVINCE, PAKISTAN

GUNNELL, Gregg, Ann Arbor, MI; UL-HAQ, Munir, Geological Survey of Pakistan, Quetta, Pakistan; GINGERICH, Philip, Univ. of Michigan, Ann Arbor, MI; BLOCH, Jonathan, Univ. of Florida, Gainesville, FL; CLYDE, William, Univ. of New Hampshire, Durham, NH

Fieldwork conducted in Balochistan, western Pakistan, led to the discovery of Gandhera Quarry in the upper part of the Ghazij Formation. Sequence stratigraphy indicates that the Ghazij Formation spans the early Eocene (Ypresian). Gandhera Quarry dates to approximately 50 Ma with the lower Ghazij stretching to approximately 54.5 Ma. Thousands of vertebrate specimens have been recovered from Gandhera, thirty of which represent euprimates, including at least two new adapiforms and one omomyiform. The best represented adapiform is a new species of the primitive cercamomine Panobius. Panobius differs from all other cercamomines except European Domnouanna in retaining paraconids on lower molars—features from Domnouanna in lacking distinct paraconid and metastylid on P4, m1-2 with higher paraconids, higher para- and protostylids, and straight cristid oblique, and m1 with trigonid more open lingually. Another adapiform most commonly resembles Eocene Anchomomys from Europe and Oligocene Bugtilemur from Dera Bugti, Pakistan. It differs from Anchomomys in being smaller, having a complete parastylet cleft off the trigonid, a stronger preprotoxystylid, higher and shorter entoconid and a relatively shorter and broader talonid. It differs from Bugtilemur in being smaller, having a more lingually angled cristid obliqua, a preprotoxystylid, and a weaker protostylid and hypoconulid. Bugtilemur is a purported lemuriform, however its similarities to this new Gandhera taxon indicate that it may have had an adapiform ancestry, traceable to the early Eocene. The Gandhera omomyiform is smaller than other known omomyomorphs with the exception of enigmatic Altanius. It differs from Altanius in having upper molars with broader and deeper trigon basins, more robust, bulbous, and marginally placed conules, having poorly developed pre-, postpara- and intercristae, protrudes more anteriorly placed and lingually extending, lacking a postprotoxyslingulid, and having a small but distinct cingular hypolype. This taxon is primitive in lacking an upper molar postprotoxystylid but does not share much in common with other omomyomorphs that lack this feature.

Poster Session I

THE CETACEANS FROM BAHIA INGLESA FORMATION (ATACAMA, CHILE): TAPHONOMIC APPROACH AND PALEOGEOGRAPHICAL IMPLICATIONS

GUTSTEIN, Carolina, Caldera, Chile; SUAREZ, Mario, Museo Paleontologico de Caldera, Caledra, Region de Atacama, Chile

The cetacean fossils are abundant and diverse at the bonebed of Bahia Ingleza Formation (Northern Chile), a sequence of phosphatic beds belonging to upper Miocene. The cetaceans taxa include very fragmentary baleen whales (Mysticeti indet.), and toothed whales (Physeteridae indet., Phocoenidae indet., Pontoporiidae: Pliopontos sp., Brachydelphis maezazi, cf. Brachydelphis n. form, Pontistes sp.).

The most productive site is called “Mina Fosforita” where the bonebed is well exposed. The sequence of this deposit is part of a major transgressive-regressive cycle, in this site marked by the presence of coquina intercalated with sandstones culminating in the bonebed. These taphonomic and lithologic features, together with the presence of a bonebed (different types of phosphatic conglomerates), field observations revealed that the fossils were originated from different layers, composed by a great abundance of fossils including approximately 70 taxa of vertebrates. These taxa include very fragmentary baleen whales (Mysticeti indet.), and toothed whales (Physeteridae indet., Phocoenidae indet., Pontoporiidae: Pliopontos sp., Brachydelphis maezazi, cf. Brachydelphis n. form, Pontistes sp.).

Wednesday 11:45

BOVINAE (ARTIODACTYLA: BOVIDAE) FROM MIO-PLIOCENE DEPOSITS OF THE MIDDLE AWASH, ETHIOPIA

HADLY, Elizabeth, Stanford Univ., Stanford, CA

Rare species are commonly viewed as the species most likely to become extinct. Explanations for this include population fragmentation, decreased connectivity between populations, and reduction of genetic diversity due to population bottlenecks. In order to investigate the properties of commonness and rarity at various taxonomic scales, data from fossil assemblages of mammalian communities across almost 1,000,000 years and 3,500 km in North America were assembled. These data demonstrate a remarkable similarity of community composition across these vast scales of space and time. The use of Hubbell’s neutral theory demonstrates that empirical communities show greater inertia than neutrally modeled communities, in large part due to the persistence of “rare” taxa. Rare species maintain their abundance in mammalian communities much longer than the neutral model predicts. These species are always rare, but are found throughout 1,000,000 years and across 3500 km, while other species remain common at these scales of space and time. These results demonstrate that individual species and their roles in communities are persistent, yet distinct. Thus, although species are threatened by population size reduction due to the myriad of human-induced global impacts, the property of rarity itself may not necessarily lead to extinction. This distinction is a critical consideration as scientists try to predict the effects of climate change on biotic communities.

Saturday 9:45

A NEW SPECIES OF THURSIUS (SARCOPTERYGII: OSTEOLEPIDIFORMES) AND ITS IMPLICATIONS ON MIDDLE DEVONIAN OSTEOLEPID RELATIONSHIPS

HALL, Patricia, ELLIOTT, David, Northern Arizona Univ., Flagstaff, AZ

A new species of the osteolepid Tharsius is represented by completely articulated individuals from the Water Canyon Formation of northern Utah. This discovery is the first report more informative than length ratios for determining behavior and locomotion. Here I present a focused study on the structural characteristics of the limbs in falconiform and strigiform birds, as well as members of distantly related groups convergent with raptors.

This study demonstrates that measures of bending and torsional strength in the forelimb and hindlimb (and the ratios between them) carry signals related to hunting behavior. These structural ratios predict behavior more accurately than ratios of bone lengths, and do so using only a single pair of proximal limb bones per animal. This approach is highly applicable to fossil taxa. I include several fossil species in my analysis, such as a giant tytonid owl from Haiti (Tyto ostologa), and I compare these fossil taxa to their extant relatives.

By examining species that are not closely related to each other, but are behaviorally similar, I am able to quantify the differing degrees to which phylogeny and functional traits determine several aspects of osteological structure. In addition, I have found that, in some cases, a difference in hindlimb bone strength may exist between raptors and owls of similar size, possibly related to differences in talon form.
of osteolepisforms in the western region of the US. The genus was previously known only from the Middle Devonian of Scotland and China, making this find both morphologically and biogeographically significant. Although closely related to Osteolepis, Tharsius differs by having a more posteriorly positioned first dorsal fin, a deeper orbital notch, and a variety of distinct cranial features. Tharsius sp. nov. differs from other previously described species within the genus by possessing a squamosal, quadratojugal, and preoperculom ound bone, a postorbital with a pronounced anterodorsal process and strongly convex pos- terior articulation with the compound bone, a lachrymal with a strongly convex anterior margin, and a distinct set of cranial morphometric ratios. The new species appears to be most closely related to Tharsius wudiantensis based on the array of bones within the skull roof, presence of the compound bone in the cheekplate, and sensory canal patterns, sharing these last two characteristics with Kenichthys, Povichthys, and Youngolepis. Relationships among the ‘Osteolepisforms’ are still debated and the placement of basal forms such as Kenichthys remain problematic. The discovery of shared characteristics between Tharsius sp. nov., Tharsius wudiantensis, Kenichthys, and Povichthys may help to strengthen previous evidence that these forms are perhaps closely related. In addition, apparently intermediate forms such as Tharsius sp. nov. and Tharsius wudiantensis may pro- vide evidence that Tharsius provides a tentative link between the more basal Kenichthys and the more derived Osteolepis. In previous cladistic analyses Osteolepis, Tharsius, and Kenichthys were either equally related or Tharsius and Kenichthys formed a sister group to Osteolepis. New information gleaned from the fully-articulated material of Tharsius sp. nov. may provide more characters to help clarify the placement of this genus within the Osteolepididae.

Poster Session III

MULTIPLE NEW DINOSAUR TRACKSITES FROM THE KAYENTA FORMATION, WASHINGTON COUNTY, SOUTHWESTERN UTAH

HAMBLIN, Alden, Cedar City, UT; LOCKLEY, Martin, Dinosaur Tracks Museum, Denver, CO; MILNER, Andrew, St. George Dinosaur Discovery Site, St. George, UT

At least a dozen new tracksites have been discovered in the Kayenta Formation within 40 km radius of the city of St. George, Utah. At least five sites are large (up to 1000 m²) with dozens of trackways of theropod dinosaurs. Trackways occur at the top of the Springdale Sandstone, which may represent a megatracksite surface, on locally, laterally-persistent sandstones 10-20 m above the Springdale and at other higher horizons in a predominantly fining upward sequence. The majority of theropod tracks are large (ichnogenus Euichnus) and deeply impressed on surfaces that are not suitable for preservation of small tracks. On some of these surfaces deep tracks reveal long heel traces or deep elongate impressions with no clear track mor- phology. At several sites parallel progression trackways of similar depth and regular inter- trackway spacing suggest gregarious behavior and a preferred trend to the W and SW. Other sites with better preservation have smaller Gavallas and possibly Kayentapus tracks. One site provides evidence of a large running theropod (Euichnus type) moving at an estima- ted 41 km/hr. This is the fastest speed estimate for a Lower Jurassic theropod and is close to the record speeds estimated for lower Cretaceous tracks from Texas and China.

Poster Session III

FELIX: A LATE PLEISTOCENE WHITE WHALE (DELPHINAPTERUS LEUCAS) SKELETON FROM CHAMPLAIN SEA DEPOSITS IN QUEBEC

HARINGTON, C. Richard, Canadian Museum of Nature, Ottawa, ON, Canada; PAIEMENT, Maxime, LEBEL, Serge, DE VERNAL, Anne, Université de Québec a Montreal, Montreal, QB, Canada

A nearly complete, articulated skeleton of an old white whale from Champlain Sea deposits at Saint-Félix-de-Valois, Quebec is the best preserved specimen of its kind recorded from North America. It is one of 21 white whale specimens known from the Champlain Sea (an arm of the Atlantic Ocean that covered the St. Lawrence Lowland from about 12,000 to 10,000 BP). Collagen from a vertebra yielded an Accelerator Mass Spectrometer radiocar- bon date of 10,700 ± 90 BP, which, with stratigraphic and paleoenvironmental data, is in accord with our knowledge of the past distribution of this species, its known habitat and habits. This study quantitatively traces regional sea-surface temperature, salinity and ice cover based on analyses of a series of samples from bottom to top of a section at the fossil site. Dinocysts indicate a change from cool to cold conditions in surface water during that period corresponding to the withdrawal of ice and the beginning of the Holocene.

Wednesday 2:00

NEW SPECIMENS OF THE ORNITHUANTHIRD BIRD GANSUS YUMENENSIS FROM THE XIAGOU FORMATION (LOWER CRETACEOUS) OF GANSU PROVINCE, CHINA

HARRIS, Jerald, Dixie State College, St. George, UT; YOU, Haixu, Ji, Qiang, Chinese Academy of Geological Sciences, Beijing, China; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA

Spectacular avian fossils from the Lower Cretaceous Jehol Group in NE China have provided spectacular avian fossils from the Lower Cretaceous Jehol Group in NE China have provided evidence of a large running theropod (Osteolepis). New information gleaned from the fully-articulated material of Tharsius sp. nov. may provide more characters to help clarify the placement of this genus within the Osteolepididae.

Poster Session III

EVOLUTION OF AMNIOTE OSSIFICATION PATTERNS: A NOVEL APPROACH TO INFERRING ANCESTRAL DEVELOPMENTAL SEQUENCES

HARRISON, Luke, LARSSON, Hans, Redpath Museum, Montreal, QB, Canada

Heterochrony or changes in developmental timing are thought to be a major component of macroevolutionary change. However, the analysis of temporal developmental sequences in a phylogenetic context is difficult due to the lack of an absolute time scale for comparisons. The inference of ancestral developmental sequences is not only critical for the analysis of sequence evolution in a phylogenetic context but also allows hypothesizing developmental sequences for extinct taxa. Event pairing has been used as a method to represent developmental sequences and to analyze the relationships between them. Previously, developmental sequences were coded into event pairs and parsimony with ACCTRAN and DELTRAN optimizations had been used to infer the ancestral developmental sequences so that changes between sequences could be analyzed along branches of the phylogeny. Parsimony, however, assumes that the highly non-independent event-pair data is independent: this leads to erroneous reconstructions at internal nodes, particularly under ACCTRAN and DELTRAN optimization. Here a novel method is demonstrated that makes no such assumptions. A genetic approach is taken, using the previously available Parsimon program as a scoring function to evolve optimal ancestral developmental sequences at internal nodes. The new method, Parsimov-Scored Genetic Ancestral Inference Method [PGAIM] was applied to a dataset of amniote post-cranial ossification sequences including therian and metatherian mammals as well as reptiles. For this dataset PGAIM assigns ancestral sequences that yield an approximately 30% shorter tree when compared to either optimization of parsimony. Timing shifts are concentrated more towards the root of the phylogeny. Interestingly, ther- ian mammal sequences are almost as divergent from reptilian sequences as they are from metatherian mammal sequences. Finally, within this new framework, unlike parsimony-based analyses, hypotheses of developmental modularity, incorporating multiple sequence elements, may be investigated.

Saturday 3:00

TAXONOMY AND PALEOBIOLOGY OF FOSSIL CERCOPITHECIDS FROM THE PLOIOCENE OF LAETOLI, TANZANIA

HARRISON, Terry, New York Univ., New York, NY

Renewed investigations at the Plioene site of Laetoli in northern Tanzania have succeeded in recovering a large sample of additional fossil cercopithecids. The new specimens were recovered from the Upper Laetolil Beds, dated radiometrically to ~3.5-3.8 Ma. Previously, the cercopithecids from Laetoli have been referred to four species: Parapapio ado, cf. Paracolobus sp., Colobinae gen. et sp. indet. and cf. Papio sp. The majority of new speci- mens are isolated teeth, but a number of cranial, mandibular, and postcranial remains have also been recovered. These new finds allow a reassessment of the taxonomic relationships and paleobiology of the Laetoli monkeys. Parapapio ado is the most abundant species at Laetoli, and appears to be common at penecontemporaneous sites in East Africa. A newly recovered mandible, of an aged male individual, is the most complete specimen from the type locality of Laetoli. The large colobine, provisionally referred to Paracolobus, is cur- rently considered to belong to a previously unrecognized taxon. The small species of colobine from Laetoli, provisionally known only from a few isolated teeth and postcranial ele- ments, is now much better known, and is represented by a partial mandible, as well as addi- tional teeth and postcranial specimens. Comparable material is known from other localities in East Africa, but this species has not yet been formally named. No additional specimens of cf. Papio sp. were recovered. The fossil cercopithecids at Laetoli are associated with what is inferred to have been a predominantly woodland and savanna setting. The postcran- nial remains attributed to Parapapio and “Paracolobus” indicate that these species were semi-arboreal monkeys that lacked the highly derived specializations for terrestriality seen in most Plio-Pleistocene papionins and colobines. The smaller colobine was probably more committed to arboreal locomotion. The age structure of the individuals and the predominance of cranio-dental specimens relative to postcranials indicate that, like the fossil
hominins from Laetoli, the cercopithecoid assemblage was heavily influenced by carnivore predation and scavenging.

Poster Session I

ESTIMATING OSTEOLOGICAL NEUTRAL POSITION IN SAUROPOD AXIAL SKELETONS: COMPARING TWO-DIMENSIONAL AND THREE-DIMENSIONAL METHODS OF ANALYSIS

HARTMAN, Scott, SHLINKE, Levi, Wyoming Dinosaur Center, Thermopolis, WY

Recent attempts to reconstruct the posture and potential range of motion of sauropod dinosaurs have focused on estimating the undeflected state, or osteological neutral position (ONP) of sauropod axial columns. While the correlation between ONP and habitual posture is a subject of debate, determining ONP should provide a repeatable point of departure for additional functional analyses.

To date, the most common method of assessment of ONP has been composing illustrations of presacral vertebrae in photo-manipulation software, such as Adobe’s Photoshop. To check the repeatability of this method, Photoshop composites were created of Apatosaurus louisae CM 3018, Diplodocus carnegi CM 84, and Mamenchisaurus youngi ZDM0083, and the recovered ONP was compared with previously published results. Significant discrepancies were found only in the composite of Mamenchisaurus, and may be due to particularly strong postmortem distortion. Photoshop compositing of illustrations of Apatosaurus and Diplodocus recovered essentially the same ONP reconstructed by previous researchers. To test the reliability of using illustrated vertebrae to recover ONP, a Photoshop composite was made of photographs of the vertebral series of CM 84. The resulting ONP diverged strongly from ONP recovered from the composite of illustrations of CM 84.

High-resolution three-dimensional data was acquired by laser scanning two specimens of Camarasaurus sp. As with previous findings, limb proportions and back posture had strong effects on neck elevation in ONP. Contrary to some reports, ONP of the axial column showed the neck somewhat elevated above horizontal, though less than the degree of neck elevation seen in extant giraffes. Importantly, ONP of Photoshop composites made from photographs of the same specimen compared well with the ONP estimated from the three-dimensional data set.

These findings suggest caution must be taken in the use of illustrated vertebrae in assessing ONP, regardless of how convincing the illustrations appear. Composites of photographs reasonably approximate the ONP found with three-dimensional laser scans of axial columns, suggesting that photographic evidence is sufficient in cases where bones are too large or fragile to scan and/or physically manipulate.

Poster Session I

EVIDENCE FOR A PREHENSILE TAIL IN A LATE PLEISTOCENE PORCUPINE SKELETON FROM NORTH-CENTRAL FLORIDA

HASTINGS, Alexander, BLOCH, Jonathan, HULBERT, Richard, Univ. of Florida, Gainesville, FL

The extant North American porcupine, Erethizon, is thought to have emigrated from South America during the Great American Biotic Interchange ~2.8 Ma. Central and South American Coendou has been proposed as its sister taxon, having diverged from a common ancestor prior to the arrival of Erethizon in North America. Coendou is more arboreal than Erethizon, with many species having a prehensile tail, a feature absent in Erethizon. The first occurrence of Erethizon in western North America is in the late Blancan (~2.5 Ma) of Arizona. Erethizon poyeri appears slightly later in eastern North America, in the late Blancan (~2.0 Ma) of Florida. Prior to a recent find, early Erethizon has mostly been known from dental and fragmentary cranial material. A newly discovered partial skeleton of E. poyeri from the late Blancan Haile 70 locality in north-central Florida includes a crushed skull with a complete upper dentition, a complete mandible, most limb bones, 28 vertebrae, and elements of both hands and feet. In a previous ontogenetic revision, 18 cranial characters were quantified for distinguishing between Coendou and Erethizon. Eight are preserved well enough in this new specimen for study and all plot within the range of Erethizon. However, the caudal vertebrae of E. poyeri resemble those of Coendou. Distal caudal elements of extant Erethizon have a single pair of transverse processes while Coendou has two pairs, a feature also found in ateline prehensile-tailed monkeys. These dual transverse process sets are present in E. poyeri. Another common theme of prehensile tails is that they have a greater number of vertebrae. Extant Erethizon has 13–18 caudal vertebrae, whereas Coendou has 28–33. While only 11 were recovered, we infer that E. poyeri had between 26 and 32 caudal vertebrae. We conclude that E. poyeri, while craniodentally similar to extant Erethizon, differs from this taxon in being more arboreal with a prehensile tail like extant Coendou.

Poster Session III

WALKING IN THE FOOTSTEPS OF BARNUM BROWN AND R.S. LULL: THE TRICERATOPS OF RED BUTTE

HATCHER, Joseph, Garfield County Museum, Jordan, MT

Located within the Trumbo Ranch USGS Quadrangle, Section 35, at N 47° 32’ 26”, W 107° 03’ 48”, east of the ranch road and approximately one mile south of the type locality for Tyrannosaurus rex (CMNH 9380), is a large table-shaped landmark unofficially named Red Butte by Barnum Brown and R.S. Lull during the 1902 AMNH expedition to Hell Creek, Montana. Stratigraphic layering topped with red igneous pumice and scoria, Red Butte is an easily distinguishable landmark in the Hell Creek badlands. Writing in the 1907 USGS Monograph on the Ceratopsia, R.S. Lull discusses the collection of one Triceratops specimen from jointed clay at the base of Red Butte and originally ascribed to T. seratus (AMNH No. 971).

Over one hundred years later, two additional Triceratops specimens were collected at the base of the north and south sides of Red Butte, respectively, by our field team during the 2005 field season in Garfield County, Montana. Specimens GCM 105 & GCM 106 have been ascribed to T. horridus, located at an average distance of 24 stratigraphic meters below the K/T Boundary. The two GCM specimens consist primarily of cranial material, while the AMNH specimen includes postcranial and postcranial material, including a humerus, radius, fibula, and four phalanges. The preservational matrix of the two GCM specimens was composed of bentonite-rich, fluvo-lacustrine sediments of fine grained mud and siltstones. This is consistent with Lull’s notes on the preservational matrix of AMNH No. 971, thus revealing a regional pattern of preservation, indicative of a specific environment of deposition favorable to this taxon.

Student Poster Session

PORASPIDIDS FROM THE MOTH LOCALITY, MACKENZIE MOUNTAINS, NWT, CANADA: ANATOMY AND PHYLOGENY

HAWTHORN, Jessica, Univ. of Alberta, Edmonton, AB, Canada

The phylogenetic affinities of the cyathaspidiform heterostrocan clade Poraspididae are poorly known. This project will investigate the relevance of poraspidid specimens from the Man On The Hill (MOTH) locality in the Mackenzie Mountains in the Northwest Territories of Canada to the systematics and origins of early vertebrates, based on phylogenetic reconstruction. I will extensively describe and illustrate the anatomy of the fossil vertebrate specimens. Morphological characters will be assessed to determine the species to which each specimen should be assigned and utilized in phylogenetic analysis. These data will be combined with biogeographic and temporal factors to explore the evolutionary history of poraspidids and early vertebrates.

Poster Session II

OSTEODERM HISTOLOGY OF STEGOSAURUS STENOPS (ORNITHISCHIA: THYREOPOHORA): IMPLICATIONS FOR PLATE AND SPIKE GROWTH

HAYASHI, Shoji, Hokkaido Univ., Sapporo, Japan; CARPENTER, Kenneth, Denver Museum of Nature & Science, Denver, CO

Stegosaurus stenops has characteristic plates and spikes. Previously, the internal structures of Stegosaurus plates and spikes have been studied, and their functions have been discussed (plates for thermal regulation or display and spikes for weapon). Stegosaurus skeletons with different ontogenetic stages have been discovered from the Upper Jurassic Morrison Formation of Colorado and Wyoming, but the ontogenetic variations of plates and spikes have never been studied. In this study, the ontogenetic variations of the osteoderm internal structures of juvenile (DMNH 33359), sub-adult (NSM PV 20380) and adult (DMNH 1483) individuals are examined using thin sections and the digital images of CT scan.

The spikes of a sub-adult individual are transversely flat and similar to plates in shape, whereas those of an adult are cylindrical. The bone histology of all plates and spikes show fibrolamellar tissue without LAGs. Remodeling of bone tissue is extensive only in DMNH 1483 and DMNH 20380, which is an adult specimen. It has an extensive vascular network in the sub-adult plates of the juvenile. The vascular network is absent in the juvenile plates, and an extensive vascular network, extending from the base of plates toward the edge, is present in the sub-adult plates. This network is absent in the spikes of the sub-adult and adult specimens although a previous study suggested its presence in Stegosaurus spikes. The ontogenetic changes from the juvenile to sub-adult individuals occur only in the plate structures. The acquisition of the extensive vascular network in the sub-adult stage may indicate the network is used for thermal regulation and/or nutrient supply. The structures of the spikes change in its shape (flat to cylindrical), the thickness of cortical bones (thin to thick) and the medullary cavity (absent to present) from the sub-adult to adult forms. This suggests that the spikes may be used as weapon for defense in the late ontogenetic stage.

Vertebrate Development Symposium, Wednesday 9:30

DEVELOPMENTAL MECHANISMS IN THE EVOLUTION OF THE POSTCRA-NIAL SKELETON IN SNAKES

HEAD, Jason, Univ. of Toronto at Mississauga, Mississauga, ON, Canada; POLLY, Paul, Indiana Univ., Bloomington, IN

Multiple developmental mechanisms, including Hox domain shifts and postembryonic heterochrony, are recognized as agents of body plan evolution in animals. The postcranial skeletons of snakes is an important example of body plan change driven by changes in developmental processes; however, evolution of the axial skeleton within the clade is poorly understood. We examined the evolution of intracranial variation in vertebral morphology across snake phylogeny to determine whether changes are consistent with a single developmental mechanism. Vertebral morphology was sampled with Procrustes realigned landmark coordinates at regular intervals in the precoaclusal skeletons of representative taxa from all higher-order snake lineages. The variance in shape along each vertebral column, derived from PCA ordination of realigned coordinates, was used as an index of regionalization. The evo-
lutionary changes in the variance index were tested against changes in Hot-mediated regional differentiation between snakes and other squamates, and changes in regionalization during snake ontogeny. Evolutionary trends in regional variation within snakes are analyzed by plotting the change in the variance index for each terminal and square-change parsimony reconstructed ancestral taxon against patristic distance from the base of the snake phylogenetic tree. Variance along the first principal component decreases with patristic distance for ancestral values, consistent with a hypothesis of decreasing regionalization throughout snake phylogeny. The pattern of change in intracollarum variance suggests that heterochronic changes rather than Hot domain shifts were the primary mechanisms of body plan evolution. Calibration to stratigraphic first occurrences suggests an approximately continuous history of decreasing axial variability as opposed to dramatic transitions associated with ecological specializations or radiation of a particular clade.

Poster Session I

GEOMETRIC MORPHOMETRICS WORKS ON SAUROPODS TOO? CRANIAL AND VERTEBRAL LANDMARK ANALYSES OF THE SAUROPODOMORPHA

HEATHCOTE, Julia, Isleworth, United Kingdom

Phylogenetic systematics is a useful tool in palaeontological studies and descriptive papers seldom appear without a “token” cladogram. However, attention is rarely paid to the quality of the characters and their relative objectivity. Characters are selected, a decision is made about what constitutes “0” and “1” and a state is assigned to a given feature of a taxon. This process necessarily involves the subjective input of a human being, whose experience in the field may vary greatly. Geometric morphometrics can bring a greater degree of objectivity to the selection of characters, and even assist in the formation of phylogenetic hypotheses.

Five homologous landmarks and 25 sliding semilandmarks were used to delimit the jugal bone of 11 prosauropod and seven sauropod skulls in lateral view. The jugal bone was selected for its lack of importance in sauriscomorph systematics, featuring in just three of 95 sauropod cranial characters. The landmarks were analysed using standard Procrustes techniques, and these results compared with those obtained for reptile studies using the premaxilla and dentary. In each instance, the Sauropoda and Prosauropoda clustered in distinct groups with little or no continuous variation between the clades, suggesting a monophyletic origin of the Prosauropoda. Clearly this needs to be reproduced in many more studies of cranial and postcranial elements before any formal conclusions can be drawn.

However, a major problem with sauropod cranial features is the lack of preservation associated with the delicate bones of the skull. A series of 26 caudal vertebrae from Cetiosaurus stewarti were analysed to investigate the application of morphometrics to postcranial features. The increased errors of using real bones rather than illustrations were apparent, and so the number of landmarks was reduced in favour of more sliding semilandmarks to mimic an eigenshape analysis. Continuous variation between each vertebra could be seen in the relative warp analyses. This has important implications for vertebral characters in cladistic studies, as well as the potential for ontogenetic analyses and digital identification of isolated elements.

Poster Session II

A DIVERSE NEW MICROVERTEBRATE FAUNA FROM THE UPPER TRIASSIC (REVUELANIAN) NORIAN CUMNOCK FORMATION, SANDBUSHE, NORTH CAROLINA

HECKERT, Andrew, CAMP, Jessica, Dept. of Geology, Boone, NC; SCHNEIDER, Vince, North Carolina Museum of Natural Sciences, Raleigh, NC; OLSEN, Paul, NESBITT, Sterling, Lamont Doherty Earth Observatory, Palisades, NY

Screenwashing yields a diverse microvertebrate assemblage from exposures of the Upper Triassic Cumnock Formation near Moncure, NC. This locality (NCSM 1904) yields abundant ostechthyan fossils and raucous, but diverse, amniotes. Strata exposed at NCSM 1904 consist of 33 m of “red-bed” siliciclastics—mudstone and thin lenses of siltstone and sandstone—previously mapped as the Sanford Fm but laterally equivalent to Cumnock Fm strata elsewhere in the basin. The fossiliferous horizon is a lens of purplish gray, pedogenically modified siltsiltstone, ~19 m above the base of local exposure. The fauna appears somewhat time-averaged, and is exceptionally diverse taxonomically, preserving a dozen taxa identified to the family level or lower as well as numerous specimens that probably represent other, less-well-known taxa. Osteichthyan fossils dominate the assemblage, including palaeoniscoid, redfieldiid, and semionotid scales as well as the first dipnoan teeth reported from the Cumnock Fm.

For the first time it is possible to present a partial but widely spaced, ontogenetic growth series of the skull of the amphibian Seymouria sanjuanensis based on specimens from the Lower Permian Tambach Formation of the well-known Bromacker quarry locality in central Germany. The growth series, the first to be documented for any Seymouriid, is based on five skulls with midline skull lengths of 19.0, 20.0, 56.0, 87.9, and 94.6 mm. The series exhibits the expected, well-documented cranial transformations of proportions and structures, such as lengthening of the preorbital region, relative decrease in orbit length, closing of the nasal-lacrimal canal, increased degree of dermal sculpturing, etc. Only the skull growth series 56.0 mm, and 87.9 and 94.6 mm can be regarded confidently as representing subadult and fully mature individuals, respectively. The two smallest skulls, on the other hand, display a suite of characters typically ascribed to temnospondyl amphibians at either a late larval stage or undergoing metamorphosis. This confusion is not unexpected, because metamorphosis involves a large series of parallel but non-synchronous structural transformations occurring over a relatively short period of time and, therefore, cannot be delimited precisely at either end.

Although assignment of the two smallest skulls to one or the other growth stage may be problematical, the combination of small size and possession of numerous features typically recognized as middle to late metamorphic suggests that Seymouria reached and accelerated through metamorphosis at a very early growth stage, particularly in comparison to the dissosauroid Seymouriamorphs. Seymouria has long been considered highly adapted to a terrestrial existence, and an early, accelerated metamorphosis would have conferred on it the added adaptive advantage over the majority of Paleozoic amphibians the ability to tolerate highly ephemeral climatic conditions.

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THE IMPORTANCE OF CT SCAN IN TESTUDINES TAPHONOMIC ANALYSES—A CASE STUDY IN PIRAPOZINHO SITE, SÃO PAULO, BRAZIL

HERNÁNDEZ FERNANDEZ, Manuel, Universidad Complutense de Madrid, Madrid, Spain; MORENO BOFARRULL, Ana, ARIAS ROYO, Anton, Universidad Autónoma de Madrid, Cantoblanco, Spain; LUNA, Belen, Universidad de Castilla-La Mancha, Toledo, Spain; VRBA, Elisabeth, Yale Univ., New Haven, CT

Vb’s resource-use hypothesis, developed after the study of the mammalian fossil record from Africa, predicts that generalist species have lower specialization and extinction rates than specialists. We test several subsidiary predictions of this hypothesis using the biotic specialization index (BSI) for each mammal species, which is based on its geographical range within different climate zones. This index can be used globally allowing intercontinental and intertaxa comparisons. Our results, based on the study of extant African (A), South American (SA) and European (E) mammals, are consistent with the axioms of the resource-use hypothesis, which predicts (1) a high frequency of stenobiomic species, (2) that carnivores are more eurybiomic than herbivore clades, (3) that the higher incidence of biomic specialists in the tropical rainforest, desert, steppe and tundra biomes, and (4) that the fact that carnvores are more eurybiomic than herbivore clades, (3) that the higher incidence of biomic specialists. We test several subsidiary predictions of this hypothesis using the biotic specialization index (BSI) for each mammal species, which is based on its geographical range within different climate zones. This index can be used globally allowing intercontinental and intertaxa comparisons. Our results, based on the study of extant African (A), South American (SA) and European (E) mammals, are consistent with the axioms of the resource-use hypothesis, which predicts (1) a high frequency of stenobiomic species, (2) that carnivores are more eurybiomic than herbivore clades, (3) that the higher incidence of biomic specialists, (3) that the higher incidence of biomic specialists, which is due to either the large size of these biomes or the higher incidence of climatic cycles on them. These results can be explained within the premises of the resource-use hypothesis. The low incidence of tundra specialists in Europe might be due to the reduced extent of this biome in the continent. Other deviations from some predictions of the evolutionary hypothesis tested here are probably due to the high incidence of mountainous terrain on ecological specialization in European and South American mammals, or to the influence of the Pleistocene Great American Biotic Interchange. The resource-use hypothesis and related habitat-theory suggest that a key to present-day macroecological patterns is found in the past: in the long term history of turnover (speciation, extinction) of clades, and in the palaeoclimatic and other geological changes of the areas in which the clades evolved. As a result, it could be determined to the Pirapozinho Site eight taphonomic classes, enclosing completely articulated to disarticulated elements: class I—articulated and complete skeleton, including skull and mandible; class II—partially articulated skeleton with no skull and/or mandible; class III—articulated skull and mandible isolated from the post-cranium elements; class IV—isolated skull or isolated mandible; class V—carapace/plastron with a reduced or without internal bone material; class VI—isolated carapace or isolated plastron; class VII—isolated post-cranium material; and class VIII—high degree of bone fragmentation. The taphonomic data together with sedimentary ones indicate both slowly and catastrophic events. They also indicate a reworking and a time-averaging processes. The present model postulates a multi-episodic event to the Pirapozinho Site, with a total of ten different moments of humidity and drought registered.

MACROEVOLUTIONARY INSIGHTS BASED ON BIONIC SPECIALIZATION OF MAMMALIAN ASSEMBLAGES: INTERCONTINENTAL COMPARISON AMONG AFRICA, SOUTH AMERICA AND EUROPE

HIGGINS, Pennilyn, Univ. of Rochester, Rochester, NY

Several orders of ungulate mammals have arisen and become extinct on the continent of South America. The biology of these South American ungulate mammals is enigmatic, since there are obvious convergences in body form with many modern ungulates (including those that now live natively in South America), and yet no extinct members of the South American ungulate orders exist. Most interpretations of the biology of South American ungulates are based upon the general morphology of teeth, skulls, and limbs. New advances in geochemistry allow for further investigation into the habitats of the animals. We have conducted isotopic analysis of 15 teeth or tooth fragments from members of the Notoungulata, Pyrotheria, and Lipotteria, representing at least 11 individuals. Ten of the specimens were sampled serially, to examine annual variation in stable oxygen and carbon isotopes. The data provide insight into seasonal variation in climatic variables, such as temperature and rainfall, the approximate rate of growth of rootless molars, incisors, and tusks that are common in the large South American ungulates. Isotopes provide a means to study the advent and spread of C4 grasses in South America. Furthermore, isotopes from fossil teeth provide important information about the timing of uplift of the Bolivian Andes and the formation of the Altiplano.

LATE MIOCENE MAMMALIAN FAUNA INCLUDING LARGE HOMINOIDS FROM THE NAKALI FORMATION, RIFT VALLEY, KENYA

HIDEO, Nakaya, Kagoshima Univ., Kagoshima, Japan; YOSHIIRO, Sawada, Shimane Univ., Matsue, Japan; YUTAKA, Kunimitsu, Kyoto Univ., Kyoto, Japan; INUMAYA, Japan; MASATO, Nakatsukasa, Kyoto Univ., Kyoto, Japan; HARUO, Saegusa, Univ. of Hyogo, Sanda, Japan

The branchiing age of the human clade from the other hominoids was estimated to be around five million years ago by the calibration of DNA sequence. Hominid fossils are reported from some localities over six million years ago (Senut et al. 2001, Brunet et al. 2002) post 20th Century. The late middle to early late Miocene (between 13 and 7 Ma) is the important age for revealing the human origins. Samburupithecus kiptalami (Ishida & Pickford 1997) from the Namurungule Formation (Rift Valley, Kenya) is the only hominoid fossil associated with a rich vertebrate fauna from Sub-Saharan Africa in this geologic age. The Namurungule Fauna was correlative with the Fauna Set VI (10 to 8 Ma) of mammalian biostratigraphy of Sub-Saharan Africa by Pickford (1981) (Nakaya et al. 1984, Nakaya 1994, Pickford et al. 1984, Tsuikawa 2004). Geologic age of the Namurungule Formation was determined as 9.6 Ma by K-Ar dating and magnetostatigraphy (Sawada et al. 1998). However, S. kiptalami is represented only by a single left maxilla with the upper cheek tooth row. Phylegetic position of S. kiptalami is not yet established within the Hominidae. The Japanese expedition team has excavated the Namakali Formation (Rift Valley, Kenya) since 2002. This team has collected more than 700 vertebrate remains including hominoid fossils (Nakatsukasa & Kunimitsu 2005, Nakatsukasa et al. 2005). We have identified 27 taxa of the following orders and families from the Namurungule Formation, and also correlated with the Fauna Set VI (10 to 8 Ma). Large hominoid fossils from the Nakali Fauna are new material from the late Miocene in age.
phylogenetic relationships and biostatigraphy. Anatomically nonoverlapping specimens have frustrated attempts at species-level phylogeny, and whereas some species exhibit survival across the K-T boundary, others, ostensibly more primitive, are known only from temporarily restricted Paleogene localities.

We describe new crocodiliform fossils from three separate localities in Mali, representing sediments of Maastrichtian, Paleocene, and Eocene ages. At least four distinct crocodileiform species are identified, two of which are unequivocally dyrosaurids. The crocodileiform material collected at the Maastrichtian locality includes two partial dyrosaurid braincases, along with numerous disarticulated cranial elements, vertebral, limb bones, and osteoderms. The Paleocene locality produced a well-preserved posterior braincase of a medium-sized dyrosaurid, and the partial braincase of a much larger crocodiliform. Paired, articulated dentaries and splenials of a large dyrosaurid were discovered at the Eocene locality.

Morphological character data from these specimens are incorporated into existing phylogenetic analyses to test hypothesized relationships among dyrosaurid genera. The occipital region and osteoderms have recently been identified as two anatomical regions that may provide new data to refine crocodiliform phylogeny. Data from these regions are used to supplement more traditional morphological data that describe the postcranial skeleton, skull, and, especially, the mandible. These new fossils provide additional insights into the apparent incompatibility between genotype and stratigraphic data for dyrosaurids. A temporal range extension is indicated for at least one dyrosaurid taxon, based on its occurrence in Maastrichtian sediments.

### Poster Session I

**USING STABLE CARBON ISOTOPE, MICROWEAR, AND MESOWEAR ANALYSES TO DETERMINE THE PALEODEIETS OF NEOGENE Ungulates AND THE PRESENCE OF C4 OR C3 GRASSES IN NORTHERN AND CENTRAL FLORIDA**

**HOGANSON, John, North Dakota Geological Survey, Bismarck, ND**

In 1992, restoration of the Highgate Mastodon skeleton was completed at the North Dakota Heritage Center, Bismarck. This ended the fossils incredible journey that began when collected by Elwyn Robinson, historian at UND, to Russell Reid, State Historical Society of ND, purchased the skeleton for $10, shipping by rail cost $27.84. Grassick loaned the specimen to the U. of North Dakota in 1920, then sold it to them for $100. A 1947 letter from Elwyn Robinson, historian at UND, to Russell Reid, State Historical Society of ND, describes the specimen as a commercial exhibit. The specimen surfaced again in dead storage at the Bibb Broom Heritage Center, Bismarck. This ended the fossils incredible journey that began when collected by Elwyn Robinson, historian at UND, to Russell Reid, State Historical Society of ND, purchased the skeleton for $10, shipping by rail cost $27.84. Grassick loaned the specimen to the U. of North Dakota in 1920, then sold it to them for $100. A 1947 letter from Elwyn Robinson, historian at UND, to Russell Reid, State Historical Society of ND, describes the specimen as a commercial exhibit.
announced that a “a partial mastodon skeleton had been found in the attic of Macnie Hall” and would the Society want it. It was transferred to Bismarck in 1948 and fell into obscu-

rity until 1991.

The unmineralized bones of the Highgate Mastodon were in remarkably good condition when restoration began in 1991, perhaps because the bones had been “sized” with white glue when collected. The skeleton is 80 to 85% complete. A tusk, left femur, left ulna, tooth, and several foot bones were missing and were fabricated for the restoration. The missing tooth was discovered by Regcraft’s granddaughter in an attic in 2006. Dental analysis indicates that this adult male mastodon was 40–45 years old when it died. The bones show no indication of disease. Several broken ribs on its left side may indicate cause of death, perhaps as a result of combat. A pebble size piece of entombing sediment recov-
ered from a hole in the sternum indicates that the Highgate Mastodon inhabited a boreal for-
est dominated by spruce, probably between about 12,000 and 10,300 yrs BP.

CRANIAL AND POSTCRANIAL PERSPECTIVES ON THE AFFINITIES OF PACHYNOLOPHUS (MAMMALIA, PERISSODACTYLA)

HOLBROOK, Lake, Rowan Univ., Glassboro, NJ

Pachynolophus is a genus of perissodactyl known from the Eocene of Europe. Previous studies have allied this genus with a number of different perissodactyl groups, including the Equidae, Palaeotheriidae, and tapirmorphs. Most studies have addressed the question of the affinities of Pachynolophus with evidence from dental characters. Cranial material of

two different species of Pachynolophus, however, has been described, and the collection of the Faculty of Sciences of the Univ. of Lyon includes a number of isolated postcranial ele-

ments. So far, no attempt has been made to study the relationship of Pachynolophus to Palaeotheria. Skulls and postcranial material referred to Pachynolophus were examined in an effort to identify characters relevant to the phyle-

netic position of this genus. Overall, the morphology of Pachynolophus is similar to that of other primordial perissodactyds, and there are few derived features suggesting a relationship to a particular group. For instance, Pachynolophus lacks a preglenoid process characteristic of palaeotheriids, and its orbital foramina, as far as can be told, are not positioned in the derived manner characteristic of equids. There are, however, several interesting derived characters, including a few that suggest a relationship with palaeotheriids. Pachynolophus is similar to palaeotheriids in possessing deep pits for the cruciate ligaments, a distinct adductor tubercle on the distal femur, and a “J”-shaped sustentacular facet of the astragalus. In addition, the shape of the glenoid fossa of Pachynolophus is similar to that of cerato-

morphs, and, perhaps most surprisingly, the fovea capitis of the femur is centrally located, a derived feature of chalicotheres and lophiodontids. Because the postcranial remains are not associated but merely referred to Pachynolophus, any phylogenetic conclusions based on postcranial characters are necessarily tentative, but these characters otherwise suggest a close relationship between Pachynolophus and palaeotheriids.

Saturday 12:15

A NEW ARRANGEMENT OF THE PALATAL ELEMENTS IN TYRANNOSAURUS REX

HOLLAND, Michael, Museum of the Rockies, Bozeman, MT

Previous descriptions of tyrannosaur palates place the posterior end of the vomer medial to and between the anterior pterygoid flanges. This vomeropterygoid complex is then posi-
tioned medial to and between the ascending processes of the palatines. This arrangement left an open space between the two posterior plates of the vomer. The recent assembly of two Tyrannosaurus rex skulls suggest a different arrangement of these palatal elements. The skull of MOR 008 has an open skull, and the skull of MOR 1125 has a more closed skull. A series of photographs taken during the process enabled comparison of relevant elements from both skulls. Images of MOR 1125 provide additional sup-
porting evidence for the arrangement revealed by MOR 008. A computed tomography (CT) scan animation sequence of the vomeropterygoid complex of MOR 008 was used to assess the validity of the alternate arrangement without cutting the fossils. The resulting alternate palatal arrangement presented here places the anterior flanges of the pterygoids adjacent to and contacting each other at the midline of the skull. These closely appressed flanges may produce a more rigid functional connection between the anterior plates of the vomer, and penetrate wholly into the middle of the vomer. This revised arrangement may have implications for tyrannosaur phylogeny, ontogeny and functional morphology.

Saturday 1:30

CRITICAL APPRAISAL OF CRANIAL KINESIS IN DINOSAURS

HOLLIDAY, Casey, WITMER, Lawrence, Ohio Univ., Athens, OH

Cranial kinesis (e.g., streptostyly, pleurokinesis, prokinosis) has been postulated to be com-
mon among some dinosaurs (e.g., theropods, ornithopods) but absent in others (e.g., anky-
losaurs, sauropods). The presence of synovial cranial joints (e.g., otic and basilical joints) typ-
ically has been the sole indicator of kinesis, whereas the protractor musculature, which sup-
posedly powers these joints, has received little attention. Indeed, previous studies often are
unclear as to whether a powered system (as in extant birds and squamates) or a passive sys-
tem is envisioned. We reviewed the relevant musculoskeletal structures in extant diapsids and fossil taxa to assess the inference of cranial kinesis in dinosaurs. Synovial joints and protractor musculature are ubiquitous among dinosaurs including clearly akinetic taxa (ankylosaurs, ceratopsids). Most of the nonmousynaptic contacts postulated in dinosaurs are without extant analogs. Although these ubiquitous, plesiomorphic structures (e.g., key syn-

oval joints, protractor musculature) may be necessary for powered kinesis, they are not suf-
ficient for positive inferences of cranial kinesis, in that another critical requirement, the presence of kinematic linkages between bones that permit movement, is needed. Such per-

missive kinematic linkages are present in kinetic birds, snakes and many lizards, involving loss of bones, reduced palatal and temporal bars, and novel flexion zones. Any inference of powered (or even passive) cranial kinesis in dinosaurs must go beyond the mere presence of synovial cranial joints and address kinematic linkages, the vast majority of which appear non-permissive. Indeed, although many extant lizards bear all the “necessary and sufficient” morphological features suggestive of kinesis, they do not express in vivo cranial kinesis, which thus represents an important caveat for any fossil inferences. As an alternative hypothesis, we suggest that persistent synovial joints may represent growth sites that facil-
itate cranial growth and remodeling during ontogeny.
This study will present analyzes of the nitrogen isotope ratios of modern bison and grassland plants from 11 locations across the United States that will serve as a baseline comparison for determining the nitrogen isotope compositions of fossil bison. These samples were collected from locations in California, Kansas, Montana, Nebraska, North Dakota, Oklahoma, South Dakota, and Wyoming. Climatic conditions vary considerably between locations. Mean annual temperatures (MAT) range from 2.1 to 18.5°C. Mean annual precipitation (MAP) range from 390 to 1080 mm. The mean values of nitrogen isotope of collagen will be compared with climatic variations in MAT, MAP, and relative humidity. Bison isotopic values will also be compared with analyses of the nitrogen isotopes of dietary plants from the same location and with changes in grassland vegetation (i.e., C-3/C-4 ratios).

Poster Session II

COMMUNITY MEMBERSHIP OF MIDDLE Miocene PIKAS FROM NORTH-CENTRAL SPAIN
HORDKE, Kees, VAN DER MEULEN, Albert, Utrecht Univ., Utrecht, Netherlands

Pikas (Lagomorpha, Mammalia) are commonly found in European Neogene small-mammal assemblages and represent an important component of the primary consumers of that time. Previous research has mainly been focused on rodents. The pikas studied here come from the rich small-mammal succession in the Calatayud-Daroca Basin (North-Central Spain).

This well dated record consists of more than 100 localities, covering the time interval between 17 and 10 Ma. The pikas appear to be a quantitatively important group, as a separate signal with respect to the rodents and can, therefore, be considered as an important factor in paleoecological analysis. Recently, regularities in the assembly, composition, and disposition of the rodent community structure from this record have been demonstrated. The community membership changes of the evolutionary lineages of the pikas confirm the presence of two successive communities in the succession.

Poster Session II

A GLOBAL VIEW OF THE CRETACEOUS DINOSAURS FROM SOUTH KOREA
HUH, Min, Gwangju, South Korea

Recently, abundant dinosaur fossils including dinosaur footprints, eggs and nests, bones and teeth have been found from the Cretaceous non-marine deposits of South Korea. In Korea, over 20 dinosaur localities have been discovered from the Cretaceous in several basins. The track sites (dinosaur, pterosaur, bird) comprise the majority of fossil localities in Korea. These unique and distinctive dinosaur tracksites are known as one of the world's most important dinosaur track localities. Mostly dinosaur footprints consists of various typed-ornithopod, theropod and sauropod. The variety of morphotypes and sizes of the footprints and the calculated body sizes indicate that different dinosaurs with various gait inhabited in these areas during the Late Cretaceous. Abundant dinosaur eggs and clutches occur in seven dinosaur egg localities. Mostly the eggs are top-broken and filled with surrounding sediments, while some eggs at Boseong site show geoid-fill. Articulate subadult dinosaur bones assigned to a new hypsilophodontid dinosaur, turtle bones and turtle eggs were also found at Boseong. The pterosaur tracks are the most immense in the world. The longest pterosaur trackway yet known from any track sites suggests that pterosaurs were competent terrestrial locomotors. In the dinosaur localities of Korea, other fossils including turtles, crocodiles, mammals, insects and ostracods have been discovered.

The occurrences of Korean dinosaurs in diverse stratigraphic formations, sizes and morphotypes provide an opportunity to study the palaeoecologic and palaeoenvironmental conditions of the sites of the Late Cretaceous dinosaurs.

Friday 11:30

EXCEPTIONAL PRESERVATION OF VERTEBRATES FROM HAILE 7G, A NEW LATE PLIOCENE SITE FROM FLORIDA
HULBERT, Richard, BLOCH, Jonathan, POYER, Arthur, Florida Museum of Natural History, Gainesville, FL

Over 50 fossil vertebrate localities have been discovered in limestone quarries near the former town of Haile in western Alachua County, north-central Florida. The newest Haile site, designated Haile 7G, is a former sinkhole about 30 m in diameter filled with clay, sand, and water. The site was identified early in July 2005 when work yielded over 60 partial to nearly complete skeletons from only a small percentage of the total volume of the site, as well as hundreds of isolated bones and teeth representing 32 vertebrate taxa. The fossils show no evidence of pre-burial weathering, waterwear, or scavenging.

Haile 7G likely formed as an alluvial sinkhole that was surrounded by a relatively dense forest. About half the fauna lived in freshwater habitats, including fish (e.g., Amia, Ictiobus, Lepomis), amphibians (e.g., Rana, Siren), reptiles (e.g., Alligator, Chelydra, Trachemys, Chrysemyx, Natricina snakes), and birds (teal-sized Anas). To date, 16 mammalian taxa have been found at Haile 7G. Surprisingly, the most abundant mammal is Tapirus, represented by about 30 skeletons, many with skulls and mandibles. They range in age from very young juveniles to full adults. Next in abundance, with about 10 individuals each, are two ground sloths, Erethizon dorson and Megalonyx lepontostoma. Although rarer, the most completely known skeletons of both the porcupine Erethizon poyerti and the palm-pather Holomusca floridanus were also found. Common smaller mammals include leporids and the biologically significant Sigmodon curtisi. Carnivores are rare, but include the raccoon Procyon and the saber-toothed felid Xerotherium kodanokae. A late Blancan age, ca. 2 Ma, is assigned to the Haile 7Ga fauna based on mammalian biochron-

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ogy. Haile 7G has already produced more mammalian skeletons than any other Florida vertebrate fossil locality, and the largest populations of Tapirus and Eremotherium. Ongoing fieldwork will add to these totals and recovery of the first-known skeletons of other poorly known Blancan taxa are likely.

Poster Session I

YESTERDAYS CAMEL: A PALEOPROTEOMIC COMPARISON OF EXTINCT AND MODERN CAMELIDS

HUMPLA, James, Michigan State Univ., East Lansing, MI; ANDREWS, Phillip, Univ. of Michigan, Ann Arbor, MI; GANDHID, Hasand, OSTRUM, Peggy, Michigan State Univ., East Lansing, MI; VOORHIES, Michael, Univ. of Nebraska-Lincoln, Lincoln, NE

The extinct taxa Camelops hesternansis and Camelops hesternus have been classified as separate species based on minor cranial differences, e.g. the location of the postpalatine foramen. Some paleobiologists argue that the morphological differences that define the two species may instead represent variation within a single species, and that C. hesternus and C. hesternus are conspecific. We are generating molecular data to supplement the morphological data and hope to clarify these otherwise uncertain species definitions. Here, we examine the relationship between fossil and extant camelid species using amino acid sequence data from the bone protein osteocalcin, derived from the bone of a 21,190±110 year-old C. hesternus from Isleta Cave, NM. Sequences were obtained using Edman and MALDI-MS (MS/MS and Peptide Mass Fingerprinting (PMF)) techniques and were then compared to the sequences of modern dromedary camels (Camelus dromedarius), bactrian camels (Camelus bactrianus), and llamas (Llama glama). The monoisotopic mass for the molecular ion from C. bactrianus was 5608 m/z, identical to that of C. dromedarius and L. glama. The monoisotopic mass of the C. hesternus molecular ion is 5663 m/z, which may indicate an important taxonomic difference between the modern and extinct cameldids. We are currently investigating this possibility and plan to analyze fossil material from C. hesternus.

Poster Session II

PACKING AND TRANSPORTING VERTEBRATE FOSSILS OVERSEAS

HUNT, Andrew, LUCAS, Spencer, New Mexico Mus Nat Hist, Albuquerque, NM

There are three fundamental terms in ichnology relevant to ichnofacies: (1) ichnocoenosis, which is an assemblage of ichnofossils conceptually equivalent to an assemblage of body fossils; (2) ichnoecoens; which is a trace fossil assemblage produced by a biological community that can be characterized by morphological criteria; and (3) ichnofacies, which refers to recurrent ichnoecoens that represent a significant portion of Phanerozoic time. There are two distinct traditions that can be identified in ichnology which we term the ichnotaxonomic and the biotaxonomic. Invertebrate ichnologists mostly use an ichnotaxonomic approach to ichnology by describing and naming behavioral interactions between an organism and the substrate. In contrast, vertebrate ichnologists have principally applied a biotaxonomic approach by attempting to relate tracks and traces to the taxonomy of the producer (e.g., ichnotaxa as proxies of biota). Thus, there are two types of ichnoecoens, ichnotaxonomic (mostly ichnofacies) and ichnotaxonomic (mostly invertebrate ichnofacies). Nommarine invertebrate ichnologists now recognize five archetypal ichnogenera (Mermia, Skolithos, Scoyenia, Coprinisphaera, Psilonichnus) to which we have added the Octopodichnus ichnofacies. Nonmarine ichnologists have not yet proposed a coherent and consistent classification and nomenclature for tetrapod ichnofacies. We recognize five archetypal vertebrate ichnofacies for nonmarine environments: Chelichnus, Grallator, Brontopodus, Batrachichnus and Characichichnos ichnofacies.

Poster Session III

A NEW PARADIGM FOR TETRAPOD ICHNOFACIES

HUTTSON, Joel, Northern Illinois Univ., DeKalb, IL

Digital animation technology offers a powerful tool for recreating and analyzing functional morphology. Software can be used to articulate or reconstruct skeleton morphology in three dimensions, and then to portray motion graphically. Maya animation software is used to relate tracks and traces to the taxonomy of the producer (e.g., ichnotaxa as proxies of biota). Thus, there are two types of ichnoecoens, ichnotaxonomic (mostly invertebrate ichnofacies) and ichnotaxonomic (mostly tetrapod ichnofacies). Nonmarine invertebrate ichnologists now recognize five archetypal ichnogenera (Mermia, Skolithos, Scoyenia, Coprinisphaera, Psilonichnus) to which we have added the Octopodichnus ichnofacies. Nonmarine ichnologists have not yet proposed a coherent and consistent classification and nomenclature for tetrapod ichnofacies. We recognize five archetypal vertebrate ichnofacies for nonmarine environments: Chelichnus, Grallator, Brontopodus, Batrachichnus and Characichichnos ichnofacies.

Poster Session I

RELATIVE BRAIN SIZE OF SMALL THEROPOD DINOSAURS INDICATES PROBABLE OBLIGATE ENDOTHERMY

HURLBURT, Grant, Dallas, TX

The large relative brain sizes of small theropod Cretaceous dinosaurs (Troodon, Ornithomimus, and Bambiraptor) probably required them to be visceral endotherms, defined as endotherms whose high resting metabolic rate (BMR) depends on visceral organ metabolism. Their relative brain sizes were well within the relative brain size range of Recent endothermic amniotes (birds) and well above the range of Recent (nonavian) reptiles. This proposal rests on the hypothesis that the relatively large brains of Recent visceral endotherms require both a high and controlled BMR. In all known endo- and endothermic vertebrates, the central nervous system (CNS) uses 2-8% of basal metabolism, excepting 20% in Homos, and 11-13% in other primate taxa. Although some eumammals have large brains, the low metabolic rate of elasmobranch brains makes them metabolic equivalents of bony fish brains one-third their size, meaning their large relative brain size does not invalidate this hypothesis. Dinosaur brain mass was estimated from endocasts, using brain-endocast ratios of adult alligators. Dinosaur relative brain sizes were calculated as EQs, which were based on brain-body equations of reptiles (REQ) and birds (BEQs). Ranges of reptile log (log10) REQs and bird log BEQs were used because, unlike the corresponding EQs, they are normally distributed, validating use of Standard Deviations (SDs). Other than small theropods, dinosaur log EQs (-0.60 to 0.38); -3.0 to 2.0 SDs of the mean) were within both the actual range and two SDs of the mean of reptile log REQs (-0.41 to 0.39; -2.0 to 1.9 SDs of the mean). Small theropod log EQs of 0.17 to -0.09 (1.05 to 0.58 SDs below the mean) were well within the range of bird log BEQs (-0.40 to 0.50; -2.3 to +2.3 SDs of the mean), and within 1 SD of the bird log BEQ mean. The only eothermichic vertebrae over 3 SDs above the reptile log REQ mean is the elephant-nosed fish, Gnathophemus, log REQ 0.64), at 3.3 SDs above the reptile mean. It denotes 60% of total body metabolism to the brain, an amount unknown and unlikely in terrestrial amniotes. Log REQs (-0.45 to 0.48) of other bony fish are -2.3 to +2.5 SDs of the reptile mean.

Poster Session I

A COMPARATIVE STUDY OF FORELIMB RANGE OF MOTION IN REPORTED BIPEDAL AND QUADRUPEDAL BASAL ARCHOSAURS

HUTSON, Joel, Northern Illinois Univ., DeKalb, IL

Digital animation technology offers a powerful tool for recreating and analyzing functional morphology. Software can be used to articulate or reconstruct skeleton morphology in three dimensions, and then to portray motion graphically. Maya animation software is used to estimate the range of motion of the forelimb of the basal archosaur Postosuchus kirkpatricki with the goal of finding evidence for or against bipedalism. Basal archosaurs are an important example of tetrapods that had a diverse array of postures and gaits. Postural features are one of the primary characters used to differentiate among archosauromorphs, although researchers debate the presence and/or extent of bipedalism in several taxa, including Postosuchus. Previous hypotheses for bipedalism in extinct archosaurs have rested mainly on observations of fore and hindlimb disparity. Most studies on posture and gait have focused on analyses of the hindlimb and pelvis, not on the shoulder girdle and forelimb. Few attempts have been made, likely because of a lack of well-preserved forelimb material. However, as shown here, forelimb evidence can be important in interpreting posture in basal archosaurs. To consider the range of motion in Postosuchus within a phylogenetic context, its forelimb elements were compared with those of two quadrupedal archosaurs, the aetosaur Desmatosuchus haplocerus and the phytosaur Pseudoplatysma pristinus, and the exact phylogenetic bracket of the crocodylian Alligator mississippiensis and the bird Opisthocomus cristatus. All forelimb range elements of motion were measured and all material was digitized three dimensionally with a MicroScribe and Rhinoceros software. The completed elements were then imported into Maya to be articulated and to build up range of motion animations. Inferences as to the posture and degree of mobility of the forelimbs of Postosuchus were then made with these comparisons and animations. Results indicate that the forelimbs of Postosuchus were well-adapted for quadrupedalism, although facultative bipedalism can not be ruled out.

Saturday 2:15

OSTEOHISTOLOGY OF SPHENACODON (SYNAPSIDA: SPHENACONTIDAE) AND THE HIDDEN DIVERSITY OF GROWTH PATTERNS IN BASAL SYNAPSIDA

HUTTENLOCKER, Adam, California State Univ., San Bernardino, San Bernardino, CA; ANGIELCZYK, Kenneth, Univ. of Bristol, Bristol, United Kingdom; LEE, Andrew, Univ. of California, Berkeley, Berkeley, CA; HUTTENLOCKER, Adam, California State Univ., San Bernardino, San Bernardino, CA

Recent histological investigations of bone microstructure in nonmammalian therapsids have documented an abundance of fibrolamellar bone tissue in numerous genera. Although some instances of this tissue type have been reported in neural spines of Dimetrodon, fibrolamellar bone has never been described in the long bones of ‘polycoelous.’ Here we provide a preliminary description of bone microstructure in the closely related Sphenacodon and highlight its utility in elucidating the origins of therapsid-like growth patterns in the synapsid lineage.
Sphenacodon humeri and femora from the Lower Permian Anderson Quarry in New Mexico (Cutler Formation) were separated into five age classes and were serially sectioned for histological analysis. Generally, the cortical bone is well vascularized and the bone matrix is woven-fibered with some alternating sheets of lamellar bone, forming an overall fibrolamellar structure in conjunction with the primary osteons. Early growth stages in Sphenacodon are diagnosed by thick growth zones in the cortex lacking LAGs or annuli in the smallest individuals, densely packed radial primary osteons, and an irregular gradation between the cancellous medulla and the compact cortex. Later growth stages display several LAGs and annuli, fibrolamellar bone tissue with abundant radial canals and primary osteons; and an abrupt transition from the cortex to the medullary region with some secondary osteons forming along the endosteal surface. The basic organization of the bone tissue closely resembles that of some gorgonopsian theropods (e.g., Stylacopus), but the overall growth pattern reflects that which has been described for some therocephalians and basal cynodonts, with evidence for rapid sustained growth in juveniles, and cyclical but decreasing rates of periotic deposition in some of the largest (presumably older) individuals. The possibility of such growth stages in an early synapsid, which pre-dates those thesaurischian and ornithischian dinosaur taxa were first mapped onto independently generated reference phylogenies to determine their evolutionary trends. Within many monophyletic dinosaur clades, the combination of enamel types and enamel features within a tooth — the schmelzmuster — is the same in all the taxa due to their common ancestry, and their schmelzmusters are diagnostic of their respective clades. However, the enamel complexity of a taxon does not necessarily coincide with the position of the taxon on a phylogenetic tree; more derived taxa do not necessarily have more derived enamel and more primitive taxa do not necessarily have more primitive enamel. Therefore, there is no overall trend in enamel evolution within Dinosauria.

Second, features observed in dinosaur enamel microstructure were parsed into phylogenetic characters. These enamel characters were analyzed separately as well as added to datasets of skeletal characters for theropod and ornithischian dinosaurs. Tests for phylogenetic signal in enamel type were also performed. Phylogenetic analysis of enamel characters and tests for phylogenetic signal in enamel type confirm the pattern observed via character analysis, namely that there are enamel characters that diagnose different clades within Dinosauria, but that there is not an overall trend in enamel evolution within Dinosauria. Enamel characters alone are not enough to recover the traditional groups obtained via skeletal characters, and all of these few studies have included only mammalian taxa. Non-mammalian amniote (“reptile”) enamel remains tremendously understudied in comparison to mammals. Although, because of the preservation of the enamel, it is difficult to determine the original identity of the teeth.

Enamel characters of 54 saurischian and ornithischian dinosaur taxa were first mapped onto independently generated reference phylogenies to determine their evolutionary trends. Within many monophyletic dinosaur clades, the combination of enamel types and enamel features within a tooth — the schmelzmuster — is the same in all the taxa due to their common ancestry, and their schmelzmusters are diagnostic of their respective clades. However, the enamel complexity of a taxon does not necessarily coincide with the position of the taxon on a phylogenetic tree; more derived taxa do not necessarily have more derived enamel and more primitive taxa do not necessarily have more primitive enamel. Therefore, there is no overall trend in enamel evolution within Dinosauria.

Student Poster Session

THE EVOLUTION OF THE GROOMING CLAW IN CASTORIDAE

HYNES, Kristin, Carleton Univ., Ottawa, ON, Canada

Extant beavers (Castor) possess a grooming claw, which can function as a comb or a pincher. The grooming claw has been described as a secondary adaptation to the beaver’s semi-aquatic lifestyle. It is held in a semi-retracted position, on the second digit of the hind foot. This specialized posture is associated with skeletal modification of the distal and middle phalanges of this digit, allowing the presence of a specialized claw to be identified in fossil taxa. Dissections of Castor canadenis and Felix silvestris catus feet were performed to investigate how the grooming claw works (opens and closes) and to compare hind foot anatomy. The Castor and Felix silvestris catus phalangeal bones were also examined for comparison and to identify characters associated with the grooming claw as well as those associated with claw retraction. This project also tested the hypothesis that the grooming claw evolved secondarily to swimming in Castoridae by looking for evidence of the claw in a fossorial genus (Palaeocastor) of Castoridae. The phalanges of Palaeocastor fssorrn were examined for evidence of a grooming claw on their second digit. Results suggest that the opening and closing of the grooming claw may be primarily controlled by the tension of the webbing on the medial and lateral sides of the claw. While P. fssorrn had skeletal characteristics which are similar to those observed in Castor’s second phalange, these are likely associated with the retracted position of the claw and not necessarily characteristic of a pincher claw. Since it is unlikely that P. fssorrn had webbed feet, their grooming claw may not have been able to function as a pincher but perhaps served as a comb prototype which was later co-opted into the modern claw. It appears that the modern Castoridae grooming claw most likely evolved after the adoption of webbed feet in the semiaquatic clade, suggesting that a pincher-type grooming claw (but not the comb-type grooming claw) arose as a secondary adaptation to swimming.

Neoceti Symposium, Saturday 10:45

A NEW SQUALOZIPHIUS-LIKE ODONTOCETE CETACEAN FROM THE LATE TRIASSIC OF THE CHINLE FORMATION IN NEW MEXICO

ICHIHISHIMA, Hiroto, Fukui Dinosaur Museum, Katsuyama, Japan; SAWAMURA, Hiroshi, Ashoro Museum of Paleontology, Ashoro, Japan

The early Miocene Squalozihipus emlongi Muizon (Washington) is known from an incomplete skull, originally attributed to the living family Ziphiidae (beaked whales). Alternatively, some authors have suggested that Squalozihipus is related to the Eutrichodontidae. Both options raise questions about the identity of odontocete fossils, although the original specimen is probably too incomplete to judge which option is best. Here we record a new skull (AMP 19) of late Oligocene age, which is similar both in size and in morphology to Squalozihipus emlongi. The new skull, which lacks most of the rostrum and some ventral structures, is markedly similar to S. emlongi in overall topography and in: a well-developed posteroventral process of the squamosal; an elevated synvertex, comprising the fronto-nasal platform, the maxilla, and the postero-medial split of premaxilla; and a wide, dorsally-opened maxillary groove just anterior to the bony naris. The skull differs from S. emlongi in its more elevated synvertex and the laterally and anteriorly more inflated nasals, and thus probably represents a new species.

The relationships of Squalozihipus with other odontocete groups — Ziphiidae, Eutricho-
dentidae, or other — have been controversial. It is now known that ziphiid-like features have arisen in separate odontocete lineages as a result of convergence, exemplified by Australodelphis from the early Paleocene of Antarctica. Australodelphis shows surprising resemblances with ziphiid odontocetes, including an elevated synvertex, despite its clear allocation to the dolphin family Delphinidae. In the case of Australodelphis, tympanoperi-
etotics are potentially powerful tools to reveal relationships; for Squalozihipus, the lack of ear bones in AMP 19 and S. emlongi hampers comparisons. We have found it difficult to justi-
fy placing Squalozihipus with Eutrichodontidae or Ziphiidae, and expect that supposed early eutrichodontids such as Argycocetus must be reviewed before Squalozihipus rela-
tionships can be finalised. Revision of early eutrichodontids has implications for defini-
tion and recognition of early clades of Odontoceti.

Wednesday 10:15

A NEW UPPER TRIASSIC VERTEBRATE QUARRY FROM THE CHINLE FORMATION OF NORTHERN NEW MEXICO WITH A UNIQUE AND EXCEPTIONALLY DIVERSE TETRAPOD FAUNA

IRMIS, Randall, Univ. of California, Berkeley, Berkeley, CA; NESBITT, Sterling, American Museum of Natural History, New York, NY; DOWNS, Alex, Ghost Ranch Conference Center, Abiquiu, NM

Large, multi-taxa tetrapod assemblages are rare in the Upper Triassic Chinle Formation of southwestern North America. Only the Placerias Quarry in Arizona and the Snyder and Coelophysis quarries in northern New Mexico preserve a wide variety of taxa and a large number of specimens. Thus, any similar new locality will increase our understanding of Late Triassic tetrapod diversity patterns in North America. The Hayden Quarry, a recently discovered locality from the Petrified Forest Member of the Upper Triassic Chinle Formation in northern New Mexico, at Ghost Ranch, preserves an abundant tetrapod fauna comparable in diversity to these three previously known localities. Taxa known from the Hayden Quarry include metoposaurid temnospondyls, the diapsid Vancleavea, pseudopala-
donts, the aetosaur Tyrannosuchus, and the aetosaur Typeotyrannus, a tooth-bearing jaw fragment similar to Revueltosaurus calderoni, an unidentified ‘rauisuchian’, the basal dinosauriform Eucoelophysis, associated material of a new basal dinosaur with an ilium similar to Chindesaurus and Carseosaurus, and several individuals of a large coela-
phonid theropod.

Beyond its raw diversity of taxa, the Hayden Quarry is important because it represents the first confirmed co-occurrence of a basal dinosauriform, basal dinosaur, and basal thero-
pod, suggesting a greater range of contemporaneous early dinosaurian taxa from North America than previously realized. Put in context with other geographically proximate localities from the Chinle Formation of northern New Mexico (e.g., Snyder, Canjilon, and Coelophysis quarries), the Hayden Quarry provides a detailed view of changes in tetrapod assemblage diversity and composition through time in one geographic space. Such a refined study is currently not possible anywhere else in the Late Triassic of North America.

Poster Session I

NEW INFORMATION ON THE PECTRAL FISH IN PLACODERMI FROM THE LATE DEVONIAN CLEVELAND SHALE FAUNA (FRASIAN OF NORTHERN OHIO)

JACKSON, Gary, Cleveland Museum of Natural History, Cleveland, OH; CARR, Robert, Ohio Univ., Athens, OH

Placoderms have been characterized as either obligate benthic organisms or that they were limited to life just off the bottom. These interpretations are a consequence of our lack of understanding of the locomotor structures in these fishes. Preservation in most taxa is limited to perichondrally ossified pectoral girdle and basal fin elements. An exception to this pattern is the ray-like chondrichn, Gemaundina, with a pectoral fin consisting of a single proximal element with up to three rows of radials. Other than this rare example, little is known of the fin distal to the proximal basal.

Four placoderm specimens from the Cleveland Shale provide new information on the pectoral fin. A large Dunkleosteus terrilli specimen documents the first recognized occur-

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rence of radials among the arthrodires. A second specimen of *D. terrelli* possesses numer-
ous basals with a carbon film representing the distal fin (no ossified radials are seen in this
specimen suggesting radial ossification may represent an age-related phenomenon). Two
specimens of unidentified selengorid arthrodires also demonstrate the presence of organic
films. The importance of these specimens is the information they provide on estimates for
the aspect ratio of the pectoral fin. In comparison to the chondrichthyan *Cladoselache* (a
recognized active swimmer in the pelagic realm), the pectoral fin in arthrodires appears to have
a comparable aspect ratio (standardized for size and thus suggesting equivalent lift
capabilities). In the arthrodire *Heinrichsichthys*, the presence of potential muscle attachments
on the basal elements suggests the possibility of active fin retraction or alteration of fin cam-
ber further adding to controlled maneuverability.

A proposed explanation for the extinction of placoderms is thought to be through the
process of competitive displacement by the contemporaneous chondrichthyans and oste-
ichthyans. This has been related, in part, to relative differences in effective locomotion
(based on incomplete evidence among placoderms). The recognition of comparable loco-
motor structures in arthrodires and sharks of the Late Devonian necessitates our reevalua-
tion of placoderm extinction at the close of the Devonian.

Marine Reptiles Symposium, Wednesday 4:45

**SYSTEMATIC POSITION AND GEOLOGICAL CONTEXT OF ANGOLASASURUS (MOSASAURIDAE) AND A NEW SEA TURTLE FROM THE CREATACEOUS OF ANGOLA**

JACOBS, Louis, SMU, Dallas, TX; MORais, Maria, Geologia, Luanda, Angola; SCHULP, Anne, Naturhistorisches Museum Maastricht, Maastricht, Netherlands; MATEUS, Octávio, Museu da Lourinhã, Lourinhã, Portugal; POLCYN, Michael, SMU, Dallas, TX.

Results of recent fieldwork in Angola after a hiatus of nearly fifty years include discovery
of the skull of a new taxon of turtle, new and higher quality mosasaur material (including
the second skull of the mosasaur *Angolasaurus*), and a number of plesiosaur specimens. The
*Mosasauridae* material allows evaluation of alternative hypotheses of its placement
within and composition of Pliopleurocaenidae. The new turtle has a derived palate and
closed incisura columella similar to Aiptian *Sandownia* from the Isle of Wight and an
unnamed late Aiptan taxon from Texas. Turtles and plesiosaur have longer marine records
than do mosasaurs, but together their history must reflect the biogeographic evolution of the
Cretaceous South Atlantic and its Albian connection with the North Atlantic. The comple-
tion of the Atlantic Ocean allowed mixing of low latitude marine faunas through the tropi-
cal Atlantic, but it also completed the breakup of western Gondwana and contradicts
hypotheses of dinosaur dispersal between Africa and South America after 100 Ma.

Romer Prize Session, Thursday 9:30

**EVOLUTIONARY INSIGHT FROM CHARACTER ANALYSIS: TESTUDINATA AS A CASE STUDY**

JAMNICKZY, Heather, Univ. of Calgary, Calgary, AB, Canada

Treating phylogenetic characters as hypotheses has long been advocated. The process of
character analysis, however, whereby potential characters are evaluated using multiple
sources of data, prior to being inserted into phylogenetic analyses for congruence testing,
has received less attention. Herein I demonstrate the utility of an integrative approach to
crater analysis, both as a means of posing more robust phylogenetic characters, and as a
source of insight into the evolutionary trajectory of certain morphological traits.
Multiples lines of evidence, provided by soft-tissue and developmental studies of extant taxa,
provide new insight into homology relations among parts of organisms, and allow more
robust inferences of morphology in fossil taxa. I show that the use of such techniques, in
combination with an “overall pattern” approach to homology definition, reveals that the cra-
ters of the Atlantic Ocean allowed mixing of low latitude marine faunas through the tropi-
cal Atlantic, but it also completed the breakup of western Gondwana and contradicts
hypotheses of dinosaur dispersal between Africa and South America after 100 Ma.

Poster Session II

**EFFECTS OF HEAT ON AVIAN Dinosaur EGGshell FRAGMENTS**

JANSSSEN, Jennifer, Georgia Aquarium, Atlanta, GA; HAYWARD, James, Andrews
Univ., Berrien Springs, MI

The taphonomic effects of heat and/or fire on bones, conodonts, and plant tissues have
received significant attention among palontologists and geologists, but to our knowledge
an examination of the effects of high temperatures on amniote eggshell has not been made.
We compared the effects of heat on extant avian dinosaur eggshell, which, like non-avian
dinosaur eggshell, is constructed primarily of CaCO3 deposited within a protein matrix.
Ostrich and glaucous-winged gull eggshell fragments were heated to temperatures up to
850°C for various lengths of time. A series of dramatic color changes, similar to those
reported for conodonts, began to occur at about 200°C, especially in ostrich eggshell.
Reverse curling of eggshell was observed at temperatures above 600°C. Thermogravimetric analysis showed a negligible decrease in mass below 200°C, which was
attributable to water loss. Sharp decreases in mass occurred at about 710°C for both eggshell types. The remaining CaO residue represented 55% of the original mass. Heat
should not be overlooked as a factor contributing to the variability of fossil eggshell, includ-
ing color differences and reverse curling. Existence of these effects, in turn, may provide
important clues toward an understanding of environmental conditions and events preceding
or accompanying fossilization.

Poster Session III

**A PRELIMINARY ANALYSIS OF STOMACH CONTENTS FROM A NEW POLY-
COTYLID PLESIOSAUR**

JANZIC, Anita-Maria, Canadian Fossil Discovery Centre, Morden, MB, Canada

The Pembina Hills of the Manitoba Escarpment of Southwestern Manitoba has produced
many marine reptile specimens with the co-operation of mining companies. The mining
has ceased but the quarries remain and a new discovery of a polyctydylid plesiosaur was dis-
covered in 2004. The remains were located within the Pembina Member of the Pierre Shale
Formation (Campanian) deposits from the Western Interior Seaway. This new polyctydylid
and only two other plesiosaur specimens from the Pierre Shale Formation in Manitoba are
associated with stomach contents.

The stomach contents were conglomerated into a solid layer beneath the specimen resulting
in a gastric residue, spanning an area of 2.5 square metres. Preliminary dissocia-
tion of fragments from the residue yielded teeth and vertebral. These stomach contents
are not unusual for polyctydylid plesiosaur, however the dimensions and quantity are
This preliminary analysis indicates teeth lengths between 1.0mm and 5.0mm representing
only the tips or apex of the crown. Samples that have been analysed yielded over 100
teleost teeth.
lower jaw rami at symphysis and labial ridge sharp as in Erymnochelys and Podocnemis. Although, its systematics is actually under determination, all characteristics indicate its close relationship to Podocnemis. No other similar species of this genus. The fossil was found in the oldest neotropical rainforest known so far (the late Paleocene Corregio Flora) suggesting that relationships between freshwater South American turtles and rainforest go back a long period of time.

Saturday 1:45
GREAT BAY BIOGEOGRAPHY: A NEW PERSPECTIVE IN TIME JASS, Christopher, Austin, TX
A considerable amount of research has been dedicated to understanding late Pleistocene to Recent biogeographic patterns in the Great Basin of the western United States. Numerous studies support the hypothesis that the modern, disjunct distribution of several montane mammals within the Great Basin arose as a direct result of climatic change from the late Pleistocene to Recent. Presently, our understanding of this biogeographic model is chronologically restricted to that time frame.

An improved understanding of the chronology at Cathedral Cave, Nevada, provided an opportunity to test for similar patterns in the fossil record prior to the terminal Pleistocene. Climatic perturbations were common throughout the Pleistocene and as such it is possible that biogeographic patterns documented for the latest Pleistocene-Recent in the Great Basin also occurred prior to that time. Data from Cathedral Cave provide preliminary support for this hypothesis.

Faunal remains from Cathedral Cave provide evidence of: (1) extinct taxa that pre-date any late Pleistocene extinction, (2) possible unique extinction events with respect to the late Pleistocene, and (3) possible population-level response to changing climate. Four arvicoline rodent taxa (Allophaiomys plicacanalicu, Microtus meadii, Microtus paroperaribus and Phenacomys gryci) represent unique extinction events with respect to the late Pleistocene. The presence of Azlanolagus sp. may represent a unique extinction event in the Great Basin prior to the Family to extinction in the Pacific Northwest. Abundant data for Microtus versus Lemmiscus throughout the excavated sediment levels show an inverse relationship. Episodes of increasing abundance in Microtus correspond to decreasing abundance in Lemmiscus whereas increases in the abundance of Lemmiscus correspond to decreases in the abundance of Microtus. These changes in relative abundance may reflect changes in climate, given the habitat tolerances of these taxa today.

Vertebrate Development Symposium, Wednesday 12:15
MAMMALIAN DENTITION: FROM DEVELOPMENT AND GENES TO FOSSILS JERNVALL, Jukka, Institute of Biotechnology, U. Helsinki, Helsinki, Finland
To help identify species in the fossil record, the typical range of dental variation found in living taxa and populations has attracted continuing research interest. While developmental biology studies of mice are uncovering details about molecular signaling and morphogenesis, present day knowledge about development is often too crude to address questions about population level variation. New avenues to study detailed changes in morphology include ‘modulatory’ signaling molecules which seem to fine tune the overall effects of gene networks. Mice with dental phenotypes that lack functional copies of these modulatory molecules still have teeth but with altered cusp morphologies. One example of the effects of Modulatory signaling on tooth morphology is the ectodysplasin gene. Total inactivation of, or increase in, ectodysplasin production changes several dental characters without the loss of occlusion. The effects of ectodysplasin and other modulatory genes indicate that even large morphological changes in dental form could have simple genetic underpinnings. Furthermore, character state analysis of transgenic mice, quantitative alterations of molecular signaling during mouse tooth development, and mathematical modeling suggest that certain tooth shape variants are more likely to be present in populations than others. The developmentally decomposed morphological variation can be used to identify variation delineating fossil taxa and so test at what point mammalian ancestors can be interpreted to have evolved their modern mode of tooth development.

Student Poster Session
CT-SCAN-BASED ANALYSIS OF MORPHOLOGICAL FEATURES OF THE OTIC REGION IN MIocene LAMNID SHARKS JERVE, Anna, Michigan State Univ., East Lansing, MI
Fossil sharks, particularly from the Cenozoic, are primarily known from isolated teeth. Recent advances in the biomedical science of CT-scanning have increased our understanding of fossil sharks, particularly from the Cenozoic. JERVE, Anna, Michigan State Univ., East Lansing, MI
REGION IN MIocene LAMNID SHARKS
CT-SCAN-BASED ANALYSIS OF MORPHOLOGICAL FEATURES OF THE OTIC REGION IN MIocene LAMNID SHARKS
JERVE, Anna, Michigan State Univ., East Lansing, MI

Marine Reptiles Symposium, Wednesday 2:45
FIRST RECORD OF PLACODONTOIDEA (REPTILIA, SAUROPTERYGIA, PLA-
CORTONIA) FROM THE EASTERN TETHYS
Jiang, Da-yong, HAO, Wei-chung, SUN, Yuan-lin, Peking Univ., Beijing, China; MOTANI, Byousuke, SCHMITH, Lars, Univ. of California, Davis, CA
THE Order Placodontia comprises the unarmored placodontoids and the armored cyamodontids. Placodontoids are known only from the Middle Triassic whereas cyamodontids range from the Middle Upper Triassic. Traditionally, the group was known to be restricted to western Tethyan province, but more recently, two cyamodontoid placodonts have been reported from the Upper Triassic of Guizhou Province, China. Unarmored placodonts, however, have been thought to be endemic to Europe.

We report the first record of the unarmored placodont from outside Europe. The specimen was collected from the Pelsonian (middle Anisian) of the Middle Triassic in Panxian County, Guizhou Province, China. As we reported last year, abundant vertibrate fossils have been excavated from the horizon. The specimen is a complete skeleton that spans 205 cm. The skull, which is 18 cm long, is deep, carrying three procumbent and chisel-shaped premaxillary teeth and four flat to rounded maxillary teeth. There are one anterior procumbent tooth and four posterior flat teeth present in the dentary. The verticle oriented external nares results in a distinct step of the preorbital region. A single row of osteoderms caps the expanded dorsal tips of the high neural spines. These and other characters enable us to assign the specimen to the genus Placodus, which is monotypic. Our specimen exhibits some differences from the type species, P. gigas. For example, the ventral process of the nasal is absent, allowing the prefrontal to enter the posterior margin of the external nares. Also, the distinct postorbital process projecting into the orbit is lacking. It is possibly a second species of the genus for this reason. Our study shows that unarmored placodonts, against conventional wisdom, had a wide geographical distribution within the Tethyan realm in the Middle Triassic. It further reinforces the similarity between Middle Triassic marine reptile faunas of China and Europe that we discussed last year.

Poster Session III
THE EARLY BLANCAN CAMELIDS FROM SAN MIGUEL DE ALLENDE, GUA-
NAJUATO, CENTRAL MEXICO JIMENEZ-HIDALGO, Jukka, Institute of Biotechnology, U. Helsinki, Helsinki, Finland
The examination of cranial and limb material collected from several localities allowed us to significantly increase the knowledge of the camelid species present in the area. Previously, only Camelops sp. was tentatively recognized. The fossil material was recovered from sandy and silty Pleistocene deposits of the San Miguel de Allende Basin, Gualajauto, central Mexico. Identified taxa include Hemiauchenia blancoensis, a small species of Hemiauchenia, Blancocamelus meadii, Camelops sp. and Megatolopus sp.? The lamina H. blancoensis and B. meadii represent the first Mexican records of the species; also the record of B. meadii is the oldest in North America, since previously it was only identified in the late Blancan faunas of USA. The small species of Hemiauchenia is also present in the Hemphillian deposits of the studied area. The record of Megatolopus (?) sp. is the first one in the Blancan age of Mexico. The early Blancan camelid species richness observed in San Miguel is higher than the one from USA faunas of the same age, where three or four taxa are associated.

Previous studies on their probable feeding strategies indicate that H. blancoensis and the small species of Hemiauchenia were browser-like intermediate feeders or browsers, while Camelops was an intermediate feeder and B. meadii and Megatolopus (?) sp. were browsers. This suggests an important component of trees and shrubs besides of grasses in the studied area during the early Blancan. The records of these camelid species in San Miguel de Allende are at present the southernmost in North America.

Poster Session III
PHYLLOGENETIC POSITION OF SOUTHWESTERN NORTH AMERICAN TOR-
TOISES (TESTUDINIDAE) JONES, Cory, San Diego State Univ., San Diego, CA
Gopherus is part of a clade of tortoises restricted to North America. Gopherus is represented by four extant taxa, Gopherus agassizii (Desert tortoise), G. berlandieri (Texas tortois), G. flavomarginatus (Bolson tortoise), and G. polyphemus (Gopher tortoise). In the Tertiary, three other genera of tortoises inhabited North America. The earliest known, Hadrianus, is thought to have given rise to Gopherus and Stylemys=Hesperetustes. The earliest Gopherus, Gopherus laticeps, is known from the White River Formation in the central United States. Interestingly, from the understood Eocene and Oligocene sedi-
ments of Southern California, gopher tortoises have been reported and are thought to belong to G. laticeps or perhaps an undescribed species. These taxa have yet to be examined in detail and will provide much insight to the zoogeography and the evolution of Gopherus and North American tortoises as a whole. Preliminary results on the southern California fossil tortoises indicate that these fossils do indeed belong within Gopherus, but they appear to be morphologically distinct from the other Oligocene Gopherus, G. laticeps and the Eocene Hadrianus uintensis.

To this point most systematic analyses of North American tortoises have coded Hadrianus, Stylomys, and Hesperotherium only at the generic level rather than examining individual species. This project includes species within these three genera. This analysis aids in understanding the relationships between the early diverging Hadrianus and the later diverging taxa.

This study builds on previous work on North American tortoises especially with the addition of postcranial characters. This increases the number of characters that are coded for fossil specimens from which only postcranial elements are found. This study will result in greater phylogenetic resolution within the North American Gopherus clade.

Friday 1:30

A NEARLY COMPLETE SKELETON OF POPOSAURUS GRACILIS FROM THE LATE TRIASSIC OF UTAH

JOYCE, Walter, GAUTHIER, Jacques, Yale Univ., New Haven, CT

The Yale Peabody Museum has been conducting fieldwork in the Chinle Formation of southern Utah since 2002. In the course of four field seasons, a significant amount of vertebrate fossil material was recovered, that consists primarily of fragmentary basal archosaur and temnospondyl remains of limited diagnostic value. This situation contrasts with the find of a skeleton in 2003 along the western rim of Circle Cliffs in the newly established Grand Staircase-Escalante National Monument in Garfield County. That find appears to represent one of the most complete bipedal stem-crocodilian skeletons known world-wide. The specimen likely once consisted of a single, fully preserved individual that eroded headfirst down to the base of the neck. The rest of the specimen is largely preserved in full articulation with little post-mortem distortion. Comparison with the holotype of Poposaurus gracilis, which consists of a partial pelvis and femur from the Upper Triassic Popo Agie Formation of Wyoming, reveals only minor differences in size and degree of ossification at muscle attachment sites and the specimen is thus interpreted as a less mature individual of that species.

The postcranium reveals clear evidence that corroborates the hypothesis that Poposaurus gracilis possessed a bipedal stance and gait. Anatomical traits that favor this interpretation include a forelimb to hindlimb ratio of 1:2.2, a hind limb to presacral column ratio of approximately 1:1, the presence of a long tail (approximately 65 percent of the total vertebral column length) that placed the center of gravity at the hip joint, restriction of lateral movement in the thoracic vertebrae, a narrow pelvic girdle, a modest lesser trochanter and prominently overlapping supracartilaginous, and the presence of a prominent ante-rior iliac spine. Although the pes exhibits four well-developed digits, Poposaurus gracilis walked digitigrade on the median three, and may have left only tridactyl imprints. Overall, the postcranial skeleton of Poposaurus gracilis resembles that of the contemporaneous Coelophysus bauri in gestalt, although the body is estimated to somewhat larger.

Wednesday 8:45

RODENT INCISORS AS BIONIC MODELS

KALTHOFF, Daniela, KONINGSWALD, Wighart, Univ. of Bonn, Bonn, Germany

Rodent incisors are (almost) all purpose tools. They are used for gnawing, chopping, slicing, digging, cutting down trees, or as tweezers and many other applications. This wide suitability is guaranteed by three factors: firstly, the combination of a hard tissue (enamel) with a softer tissue (dentin) provides a self-sharpening construction; secondly, the stability of the thin cutting edge is maintained by a crack preventing microstructure of the enamel; and thirdly, heavy abrasion is allowed and compensated by continuous growth. This mechanical principle of self-sharpening incisors evolved in several mammalian lineages independently. The self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, the self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, the self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, cutting, digging, cutting down trees, or as tweezers and many other applications. This wide suitability is guaranteed by three factors: firstly, the combination of a hard tissue (enamel) with a softer tissue (dentin) provides a self-sharpening construction; secondly, the stability of the thin cutting edge is maintained by a crack preventing microstructure of the enamel; and thirdly, heavy abrasion is allowed and compensated by continuous growth. This mechanical principle of self-sharpening incisors evolved in several mammalian lineages independently. The self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, the self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, cutting, digging, cutting down trees, or as tweezers and many other applications. This wide suitability is guaranteed by three factors: firstly, the combination of a hard tissue (enamel) with a softer tissue (dentin) provides a self-sharpening construction; secondly, the stability of the thin cutting edge is maintained by a crack preventing microstructure of the enamel; and thirdly, heavy abrasion is allowed and compensated by continuous growth. This mechanical principle of self-sharpening incisors evolved in several mammalian lineages independently. The self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, the self-sharpening abilities are fascinating for bionic engineers. Industrial knives, calipers, cutting, digging, cutting down trees, or as tweezers and many other applications. This wide suitability is guaranteed by three factors: firstly, the combination of a hard tissue (enamel) with a softer tissue (dentin) provides a self-sharpening construction; secondly, the stability of the thin cutting edge is maintained by a crack preventing microstructure of the enamel; and thirdly, heavy abrasion is allowed and compensated by continuous growth. This mechanical principle of self-sharpening incisors evolved in several mammalian lineages independently.

Thursday 1:30

ANALYSIS OF CRANIAL DISPARITY IN THE THEROCEPHALIA USING GEOMETRIC MORPHOMETRICS

KAMMERER, Christian, Univ. of Chicago, Chicago, IL

Therocephalians represent one of the major subclades of Permo-Triassic therapsids. Therocephalians are known from the earliest therapsid-bearing strata of the Late Permian South African Karoo Basin and persist until the Middle Triassic. The group attained a high level of morphological diversity compared to eococel clades, and included herbivorous and probably venomous forms. Here I present the results of an investigation into patterns of the therocephalian disparity over time. I undertook a geometric morphometric analysis of therocephalian specimens using 10 lateral and 8 dorsal cranial landmarks taken from digitized images. Shape-based variance in the data was summarized using relative warps. Specimens were binned into eight Karoo biozones, with differences in extent of morphospace occupation between the bins quantified using variance and range metrics.

Therocephalians remain highly conservative in cranial morphology through the first three biozones, followed by expansion into new morphospace but loss of old in the Tropidostoma Zone. The major burst of therocephalian morphospace expansion does not occur until the end-Permian Dicyonodon Zone. Therocephalians parallel cynodonts and anomodonts in their evolution towards broad-headed forms with large temporal openings over the course of clade history. These features have been associated with the independent evolution of herbivory in therapsid groups. However, some of the stratigraphically earliest members of the therocephalians in question display the “herbivore skull” morphology but retain carnivore dentition, so this cranial form may have been exaptive within the clade.

Therocephalians suffer a major contraction in morphospace occupation across the Permo-Triassic boundary, and continue to lose morphological diversity through the Early Triassic (Lystrosaurus Zone). Although therocephalians go on to diversify taxonomically in the Triassic, they do not regain lost morphospace. Triassic cynodonts, on the other hand, expand into areas of morphospace occupied by therocephalians in the Permian.

Saturday 2:30

BRAIN SIZE, ACTIVITY PATTERN, AND VISUAL ACUITY IN HOMUNCULUS PATAGONICUS, AN EARLY MIocene STEM PLAYTHRYRINE: THE MOSaic EVOLUTION OF BRAIN SIZE AND VISUAL ACUITY IN ANTHROPOIDEA

KAY, Richard, Duke Univ., Durham, NC; LINCOLN, Abraham, Washington, DC; COLBERT, Matthew, Univ. of Texas, Austin, Austin, TX; MALINZAK, Michael, Duke Univ., Durham, NC; KIRK, E., Univ. of Texas, Austin, Austin, TX

A nearly complete and undistorted skull of Homunculus patagonicus, an early Miocene stem platytherine collected in 2004, was scanned by high-resolution CT. The skull provides the oldest record of orbit size, optic canal size, and endocranial volume (ECV) in a platytherine, allowing reconstruction of adaptive parameters of the visual system and a broader consideration of anthropoid brain size and visual system evolution.

The relative orbital aperture size of Homunculus suggests diurnal habits and is smaller than expected for a nocturnal monkey. The optic canal, and by inference the optic nerve, is anthropoid-like and larger than in strepsirrhines. This feature is related to the amount of visual information transmitted from the retina to the brain. It suggests that Homunculus had highly refined visual acuity, a hallmark of living anthropoids not found in strepsirrhines. The African Oligocene stem anthropoid Simonsia and the stem catarrhine Aegyptopithecus also resemble living anthropoids in having a high level of visual acuity. Simonsia has a large optic canal. The canal is not preserved in Aegyptopithecus but the rostrally positioned lunate sulcus on its endocast, suggests that visual areas in the occipital lobe were relatively large as in living anthropoids. The more caudal position of the lunate sulcus in strepsirrhines reflects reduced cortical visual processing.

In spite of the increased visual inputs and a proportionately enlarged visual cortex, it is clear that relative ECV was small and strepsirrhine-like in stem anthropoids (Simonsia) and stem catarrhines (Aegyptopithecus). The relative ECV of Homunculus likewise is small-
er than in any living platyrrhine or catarhine and falls near the mean for living strepsir-
rhines. These findings suggest that the very high encephalization of living anthropoids evolved independently in platyrrhines and catarhines and not in conjunction with the ancient initiation of increased visual acuity. Once initiated, additional selection for increased visual processing to meet socioecological demands led to further increases in rel-
ate brain size among anthropoids.

**Poster Session II**

**SOFT TISSUE SURROGATES FROM AN SEM SURVEY OF FOSSIL MATERIAL FROM THE LANCE AND HELL CREEK FORMATIONS**

KAYE, Thomas, Prospect Heights, IL; SALOWICZ, Zbigniew, Jagiellonian Univ., Krakow, Poland; GAUGLER, Gary, Microtechnics Inc., Granite Bay, CA; STITANOVIC, Bozidar, APL Bioporation Technologies, Highland Park, IL

Prompted by recent excitement in the scientific community surrounding the discovery of soft tissues in Tyrranosaurus rex bone, a survey was undertaken in an attempt to discover these tissues in situ. A variety of Lance and Hell Creek specimens including triceratops, hadrosaur, ankylosaur, and pachyceous were small bones examined under the scanning electron microscope (SEM) and energy dispersive spectroscopy (EDS). Many likely structures were identified and found in surprisingly common numbers. Micron-sized spheres containing iron and oxygen were identified as an oxidized sub-group of common sulfur-iron framboids. Filamentous mats and non-bone coatings were imaged in the open vascular canals showing evidence of microbial movement though a viscous film. Characteristic micron size pores on both the canal walls and the framboide surfaces, suggest

presence of desiccated biofilms. Quartz crystals with attached framboids suggested a prolonged time line for framboid and biofilm development. Further analysis after digestion in acid, showed that these structures resembled presumed dinosaur soft tissues but this study suggested that they were in fact microbiologic and mineral in origin with a mor-

phology that could allow for multiple interpretations. Additional surveys of ammonoids from the Cretaceous and the Late Cretaceous near the Hell Creek group also contained these same structures indicating that morphology alone is not a reliable identification method for soft tissues. Consequently, this survey suggests, that a biologic testing regiment is required to determine affinities and ages of biomolecules.

**Wednesday 1:30**

**AN ASSESSMENT OF HEARING FUNCTION IN A NONMAMMALIAN EUCYN- ODONT**

KEMP, Tom, Oxford Univ., Oxford, United Kingdom

Allin’s theory that the postentery bone and quadrates of cynodonts were not only the homologues of the mammalian ectotympanic and accessory ear ossicles, but also func-
tioned in essentially the same way in sound reception is assessed in the light of an excep-
tionally well-preserved and completely prepared specimen of Chiniquodon (=Probolosco-
don). The sound reception function was compromised by the design requirements for a per-
sistent, though reduced mechanical function of stress transmission during jaw muscle func-
tion, and in particular during jaw-opening. However there were also adaptations specifical-
ly to improve the sound-conduction function, notably in nature of the attachment of the postentery rod to the dentary and skull. There was an acoustic transformer ratio of about 30, which is within the range of modern mammals. But the estimated masses of the bones, and a subjective assessment of the compliance leads to the conclusion that only low fre-

quency sound up to 1-2kHz could be detected. No reptile-like postquadratum tympanum was present, no evidence a functional expectation of an air-filled tympanum-

Monday 8:45

**RECONSTRUCTING NIGERSAURUS TAUQUETI**

KEILLOR, Tyler, Brookfield, IL

The reconstruction of the bizarre African sauropod, Nigeraurus tauqueti, required a meld-
ing of old and new materials and techniques. Careful preparation freed the fossils from a sandstone matrix. The impossibly delicate, disarticulated skull bones could not be molded; but were CT scanned and prototyped. The scan data yielded reversed bones, as well, where only one side was preserved. The prototyped bones were fitted together, and missing bones were sculpted with plasticine clay to fill the gaps. The reconstructed skull model was molded with silicone; skulls were cast with polyurethane resin. Over a cast of the skeletal elements, a flesh reconstruction was sculpted. Care was taken to follow the bony landmarks for clues to soft tissue, and diverse extant taxa were observed for comparison and inspiration. Skin impressions and scrotal rings from other species of sauropods were the reference for scales and eye size; while details like the skin color, and bits of green plant material mixed with saliva were speculative artistic decisions. A truly unique and unusual dinosaur like Nigeraurus could not have been reconstructed for public exhibition without the full spec-

trum of materials and techniques available to skilled preparators today.
UNDER THE FEET OF GIANTS: AN INVESTIGATION OF THE SMALL VERTEBRATES AT THE MYGATT-MOORE QUARRY, MORRISON FORMATION, WESTERN COLORADO

KING, Lorin, Dinosaur Depot Museum, Cañon City, CO; FOSTER, John, Museum of Western Colorado, Grand Junction, CO

For over 25 years, the Mygatt-Moore Quarry has been producing abundant remains of large dinosaurs represented mainly by *Apatosaurus* and *Ailurosaurus* with some camarasaurid, diplodocid, and ceratosaurid material. The ephebmeral shallow lacustrine paleoenvironmental setting is generally devoid of smaller vertebrates. However, the quarry has produced some identifiable, albeit fragmented, small vertebrate remains. The rare, smaller non-dinosaurian vertebrates include the first pterosaur and turtle material ever found at the quarry, a plesiosodont, a small primitive crocodylomorph, and a goniopholid crocodyliform. These remains are represented mainly by limb bones, vertebrae, and teeth. The one goniopholid tooth known from the quarry is in stark contrast to the more than 300 shed teeth of theropods. Several fish (*Morringlepis*, cf. *Leptolepis* and *“Huletta”*) are known from the quarry, but these remains are found in a different lithology approximately 2m stratigraphically above the dinosaur bone bed. The Mygatt-Moore Quarry is similar to the Colorado-Lloyd Quarry and several sites at the eastern end of Como Bluff in the paucity of avian vertebrae such as turtles, crocodylians and the high ratio of shed theropod teeth to those of crocodylians. Other sites such as Quarry 9, the Small Quarry, and Ninemile Hill have abundant fish, turtles, and crocodylians and differ substantially from the Mygatt-Moore, Colorado-Lloyd, and Como Bluff sites. Although the scarcity of fish, turtle, and crocodile material in the bone bed at Mygatt-Moore suggests that standing water was infrequent, the abundant plant material in the bone bed mudstone indicates an often wet substrate and likely a higher local water table.

Friday 8:30
REASSESSING THE PALEOECOLOGY OF THE PLOECENE SITE OF LAETOLI, NORTHERN TANZANIA, UTILIZING ISOTOPIC ANALYSIS OF FOSSIL HERBIVORE SKELETONS

KINGSTON, John, Emory Univ., Atlanta, GA; HARRISON, Terry, New York Univ., New York, NY

Interpretations of paleoenvironments at the Pliocene locality of Laetolil have figured prominently in discussions of human evolution, primarily because early hominins recovered from Laetolil are generally inferred to be associated with grassland, savanna or open woodland habitats. These reconstructions effectively extend the range of habitat preferences for Pliocene hominins and contrast with interpretations of predominantly woodland and forested ecosystems at other early hominin sites. Here we reevaluate the paleoecology at Laetolil using isotopic analyses of the enamel of twenty-one extinct mammalian herbivore species from the Laetolil Beds (~4.3-3.5 Ma) and Upper Ndolanya Beds (~2.7-2.6 Ma) to develop a consensus reconstruction of available forage and inference habitat types within the succession. Dietary patterns of the various herbivore genera represented in the Laetolil and Upper Ndolanya Beds indicate ecletic, mixed C3/C4 diets for all herbivore families other than the obligate browsing giraffids. The almost complete absence of specialized grazing guilds and the heavy reliance on browse by most fossil herbivores does not support earlier interpretations of a predominantly grassland-savanna biome. Evidence of a variable C4 grazing component in most lineages, however, does indicate that grasses were ubiquitous, consistent with habitats dominated by closed woodlands with a substratum of C4 grasses or open woodland interspersed with grassy patches. Relative to other Pliocene African fossil localities where enameled has been extensively analyzed, Laetolil isotopic values generally indicate similar dietary patterns for specific taxonomic groups, although there is a consistent bias towards a greater C3 browsing component among Laetolil herbivores. Compared to modern African herbivore isotopic profiles, the Laetolil cumulative dietary spectrum is heavily weighted towards mixed C3/C4 foraging patterns with limited evidence for specialized grazing or browsing strategies that characterize modern descendants. These data suggest that modern African ecologies may not provide appropriate analogs, specifically in the foraging behavior of the herbivore community, but perhaps also in the overall physiognomy and composition of the vegetation.

Poster Session II
APPLICATION OF GEOGRAPHIC INFORMATION SYSTEMS (GIS) TO MODEL THE KOOBI FORA

KIRERA, Francis, Univ. of Arkansas, Fayetteville, AR

This study examines the application of GIS technology in combination with faunal ecomorphological analysis to model the paleoenvironment of the Plio-Pleistocene Kooib Fora Hominin sites. Several researchers have used ecomorphology to reconstruct aspects of early Hominin paleoenvironments in East Africa. Such studies have been based on the notion that morphological adaptations evinced by herbivorous mammals reflect specific aspects of environment. The current study adds to our knowledge of the paleoenvironmental dynamics of Kooib Fora, by bringing data into a platform that can be clearly visualized using a Geographic Information Systems (GIS) model.

We present some of the technical aspects of incorporating GIS into the analysis of the spatial and temporal dynamics of adaptations inferred from fossil bone morphology. Fossil elements of bovid are transformed into the GIS model using geo-referenced data points collected with the aid of GPS survey in the field and on-table digitizing of previously marked locations on maps.

This study is divided into two parts; First, traditional multivariate analyses are used to gather ecomorphological data on fossil elements (based on relationships between environment and ecomorphology of extant fauna) Second, these data are incorporated into a GIS environment for spatial modeling and geostatistics. Results from this study clearly indicate both general shifts and the variability of Kooib Fora paleoenvironment with open environments dominating the entire epoch intermittent with closed and intermediate habitats.

Friday 11:45
A NEW GENUS OF ORNATE LONG-HORNED CENTROSAURINE CERATOPSIAN FROM THE MIDDLE CAMPAIGN (CRETACEOUS) WAHWEAP FORMATION, GRAND STAIRCASE-ESCALANTE NATIONAL MONUMENT, SOUTHERN UTAH

KIRKLAND, James, DEBLIEUX, Donald, Utah Geological Survey, Salt Lake City, UT

An isolated, well-preserved skull (~1 m long less parietal spines) of a ceratopsid dinosaur from the “middle mudstone member” of the middle Campanian Wahweap Formation may be the oldest, and is the first diagnosable, centrosaurine recovered south of Montana. It shares with more derived centrosaurines the stepped squamosal and a nasal-premaxillary process along the caudal border of the nares. The preorbital skull is deep and shorter than other known centrosaurines. Rostral to a low, subconical nasal horn is a smaller “epinasal” suggesting the presence of a second smaller nasal horn. Long, erect postorbital horns extend over the nasal horns. Large, vertically oriented, blade-like epijugal extend laterally from skull. The erect frill is subequal in length to the skull, and is widest at the laterally directed squamosals, tapering to half its width at the base of a pair of caudal parietal spines separated by a medial notch. The parietal fenestrae are caudo-rostrally elongate. The parietal preserves weak undulations, but no distinct ornamentation. The squamosals each bear four epijugal. Laterally, the parietal bears five triangular epijugalcs with the lateral near its base at the squamosal. The epijugalcs are progressively smaller caudally such that, at the base of the elongate caudal parietal spine, the epijugalcs is less than one square centimeter in size. The narrow caudal parietal margin is dominated by a pair of robust spines as long as the entire frill, which extend caudally and then gradually sweep laterally beyond the widest portion of frill. The long postorbital horns and small nasal horn are primitive character states as indicated by the ceratopsid sister taxon *Zuniceratops*. Autapomorphies include a separate nasal horn and rostral “epinasal,” short muzzle, large blade-like epijugalcs, and a caudally-tapering frill with long sweeping spines.

Saturday 9:45
AN UNUSUAL BONE HISTOLOGY AND GROWTH PATTERN IN *AMPELOSAUROSAURUS ATACIS*, A TITANOSAUR SARCOPHAGUS FROM SOUTH FRANCE

KLEIN, Nicolle, SANDER, Martin, Institute of Paleontology, Bonn, Germany; LELOUEUFF, Jean, Musée des Dinosaures, Esperanza, France

Several humeri and femora of the titanosaur sarcophagus *Ampelesaurus atacis* from the Maestrichtian of South France were sampled by core drilling and cross sectioning for paleohistological study. The material was collected within the scope of a large project about sauropods from the Aptian-Albian, where the comparison with other sampled sauropods (*Neosauropoda* including several Diplodocoidea and Macronaria) or any other dinosaur currently studied by bone histology, shows that *Ampelesaurus atacis* is clearly different/unique in its bone histology. Whereas all studied sauropods and even closer relatives like *Alamosaurus* and *Phuwiangsaurus* show the laminar fibro-lamellar bone typical for most dinosaurs, *Ampelesaurus atacis* indeed retains the laminar vascular organization, but completely lacks the fibrous bone tissue component, even in early ontogenetic stages. The dominant bone tissue here is the parallel-fibred bone and lamellar bone. However, contrary to e.g. reptiles which also grew with parallel-fibred bone and lamellar bone, *A. atacis* growth was not cyclically interrupted by LAGs or other growth marks, except in the outer cortex of some ontogenetically old specimens. Furthermore, *A. atacis* long bones are characterized by remodelling (secondary osteons) starting very early in ontogeny. Current phylogenetic hypothesis place *Ampelesaurus* as a derived titanosaur. Thus, its unique bone histology shows that growth rate and delayed maturity relative to other sauropod dinosaurs. Such a delayed maturity is sometimes seen in insular forms such as the extant moa (*Dinornis*) of New Zealand, although the bone histology of moa is different from *Ampelesaurus*. This is consistent with the Maestrichtian paleogeography of southwestern Europe, which indicates that *A. atacis* inhabited large islands.

Student Poster Session
NEW SKELETAL REMAINS OF PALAEOSPINACID SHARKS—KEY-TAXA FOR UNDERSTANDING THE INTERRELATIONSHIPS OF SYNECHODONTIFORMES (NEOSELACHII)

KLUG, Stefanie, Berlin, Germany

Palaeospinacids sharks ranging from the Late Triassic to the Eocene are the most diverse family (~30 species) of Synechodontiformes, which are supposed to be a monophyletic group of basal galeomorphs (Neoselachii). Most palaeospinacids are represented by isolat-
ed teeth, placoid scales, and fin spines. Currently, there is a major controversy concerning the value of diagnostic characters for distinguishing palaeocalposinidae genera, because of very similar dental morphologies and the scarcity of articulated skeletal material, which is only known from the Lower Jurassic of Lyme Regis (England) and Holzmaden (southern Germany), from the Upper Jurassic of southern Germany, and the Late Cretaceous of England.

So far, two genera are considered valid within this family: Paraathracodus being represented by one partial and Synchodus by several skeletal remains. All specimens from the Lower Jurassic bear two fin spines, whereas all other material known up to date lacks most posterior parts.

A re-examination of all articulated selachians from the Upper Jurassic Lithographic Limestones of southern Germany yielded several complete palaeocalposinidae individuals displaying abundant dental, cranial, and postcranial characters. One new species of Paraathracodus is represented by very well-preserved adult and juvenile individuals. In addition, skeletal remains of two different species of Synchodus including one new taxon are reported here. This new material proves to include key-taxa for solving taxonomic problems and reconstructing the phylogeny and biogeography of synchonditiform sharks.

Important characters are the number of dorsal fins, the distribution of fin spines, and the position of paired and unpaired fins. Based on this material, it is possible to define apomorphy of dental characters for distinguishing Paraathracodus and Synchodus, and additionally, to transfer all Early Jurassic palaeocalposinids possessing dorsal fin spines to a new genus.

Poster Session II

DOES PROCOMPSONGATHUS HAVE A HEAD? SYSTEMATICS OF AN ENIGMATIC TRIASSIC TAXON

KNOll, Fabien, SCHoCH, Rainer, Staatliches Museum für Naturkunde, Stuttgart, Germany

Procompsonogathus triassicus is a taxon from the Stubensandstein of Paffenhofen, near Heilbronn (Baden-Württemberg, Germany), which has been the subject of persistent controversies. In order to provide clarification of the status of SMNS material ascribed to this enigmatic archosaur (SMNS 12591, 12591a, 12352, and 12352a), additional preparing as well as high-resolution X-ray CT analyses have been conducted. From a global morphological point of view, the type material, SMNS 12591, shows strong similarities with Coelophysis. A supertree analysis suggests that Dilophosaurus, Lillensternus, Coelophysis, and Siggasaurus may be successively closer sister-taxa to Procompsonogathus. SMNS 12591a shows a mosaic of characters difficult to decipher in terms of phylogenetic affinities, but it is tentatively suggested that it is from an early and very plesiomorphic tetanuran based on the presence of an assumed maxillary fenestra. SMNS 12352 likely pertains to a crocodylomorph in part due to the separation between the nasal and the antorbital fossa. SMNS 12352 has been attributed to Saltopusuchus connectens but there are some differences between SMNS 12352 and 12596 (regarding the outline of the antorbital fenestra and the depth of the maxilla at the level of the rostral part of the antorbital fenestra) that cast serious doubt on this identification. Finally, SMNS 12352a shows a definitive primitive *Bauplan* in being pentadactyl with no obvious differential developmental of the digit II. Yet, a long and powerful three-fingered hand arose in the earliest theropods whereas the hand of "thecodonts" is generally crocodile-like. Therefore, though it cannot be definitely asserted that SMNS 12352a is a valid crocodylomorph, we suggest a new name for this specimen. The carnivorous guild that dwelled southern Germany prior to the Triassic boundary events was remarkably diverse and strengthens the hypothesis according to which fundamental evolution within the clade Theropoda was under way before the Triassic boundary events.

Saturday 11:00

ORNITHOMIMIDS (THEROPODA: DINOSAURIA) FROM THE LATE CRETAEOUS OF ALBERTA, CANADA

KOBAyASHI, YoshitsuSu, Hokkaido Univ., Sapporo, Japan; MAKOVICKY, Peter, Field Museum of Natural History, Chicago, IL; CURRIE, Philip, Univ. of Alberta, Edmonton, AB

Ornithomimid dinosaurs are common in Upper Cretaceous sediments of North America, but most are fragmentary and crushed. In the 1990's, beautifully preserved skeletons of two ornithomimid genera (Struthiomimus albertensis (TMP 90.26.1) from the Horseshoe Canyon Formation and Ornithomimus edmontonicus (TMP 95.110.1) from the Dinosaur Park Formation) were discovered in Alberta, providing a better understanding of North American ornithomimids.

Comparisons of these two skeletons with other North American ornithomimid specimens clarify differences between *Struthiomimus* and *Ornithomimus*. These differences are mainly seen in the structures of skull (e.g., skull size relative to femur length, shapes of anterior ramus of the postorbital, dorsal ramus of the quadratojugal, and parap拉ridic para- men), arm (e.g., robustness of humerus and relative length of metacarpals and manual unguals), and posterior caudal vertebrae. The unique features of *Struthiomimus* are a small skull relative to femur length and long manual unguals. *Ornithomimus* is diagnosed by an accessory process of the anterior ramus of the postorbital, bifurcated dorsal ramus of the quadratojugal, deep embayment along the posterior border of the quadratojugal for the parap拉ridic foramen, and ridge and groove articulation between pre- and postzygapophysees of the posterior caudal vertebrae. *Dromiciumcinus*, another ornithomimid genus from North America, was originally diagnosed by proportions of selected elements, but some previous studies suggested that those ratios are not statistically supported and that *Dromiciumcinus* is a junior synonym to *Ornithomimus*. A partial skull of *Dromiciumcinus brevifrons* (CMN 12228) shows

**Ornithomimus** characters (shapes of anterior ramus of the postorbital, dorsal ramus of the quadratojugal and parap拉ridic foramen), confirming that *Dromiciumcinus* is synonymous with *Ornithomimus*. Wednesday 10:15

ENAMEL MICROSTRUCTURE IN CORYPHODON AND THE POSSIBLE CORRELATION OF BODY SIZE AND SCHMELMZUSTER

KOENIGSWALD, Wighart, Univ. of Bonn, Bonn, Germany; ROSE, Kenneth, Johns Hopkins Univ., Baltimore, MD; GINGERICH, Philip, Univ. of Michigan, Ann Arbor, MI

Most small mammals (e.g., rodents, bats, shrews, and primates) have only radial enamel. In this body size group, Glires are a remarkable exception, having a modified schmelzmuster in their ever-growing incisors. During the Paleocene and Eocene, most placental lineages independently evolved transversely oriented Hunter Schreger-bands (HSB) as body size increased: e.g., Primates [Pliopithecus, Periostadylus [Hyracotherium], Artiodactyla [Dioicodes], and Notoungulata [Colbertia], Primm dentaluss of the HSB protects the enamel from cracking. In the lower Eocene the pantodont Coryphodon is by far the largest herbivore, surpassing contemporary Hyracotherium and Dioicodes by more than two orders of magnitude. The dentition of Coryphodon differs from that of the small herbivores in two ways: (1) the molars have better developed high cutting edges; and (2) the enamel microstructure is modified in a very specific way. There is intensive decussation of prisms, but no transverse HSB. It is striking that extant African rhinos and elephants have modified enamel too, showing the 3D-enamel and a vertical arrangement of HSB. This is in contrast to the smaller herbivorous zebras and antelopes. Similar modifications in enamel microstructure have been observed in the giant South American ungulates Pyrotherium and Astrotherium, and in the North American brontotheres, chalicotheres, and Uintatherium. Most herbivores of smaller body size have transverse HSB. Certainly body size and enamel microstructure are only weakly correlated, but three size classes may be differentiated. (1) small mammals with radial enamel, (2) mid-sized mammals with transverse HSB, and (3) giants with strongly modified prism decus- sation. This seems to apply generally to placental mammals, whereas marsupials developed HSB only occasionally.

Friday 9:00

RECONSIDERATION OF TECTONICS-REGIONAL CLIMATE FORCING OF MIOCENE FAUNAL DIVERSITIES IN THE WESTERN UNITED STATES

KOHN, Matthew, Univ. of South Carolina, Columbia, SC; FREMD, Theodore, National Park Service, Kimberly, OR

Reconsideration of the temporal patterns in mammal alpha diversities confirms a correlation we suggested earlier with respect to regional tectonics and climate change. In this study we: 1) consider faunal diversity patterns in four provinces: Great Plains, Pacific Northwest, Mojave, and Rockies, 2) screen for taphonomic and area biases to better characterize alpha diversities, 3) include ungulates, carnivores and rodents to investigate different correlations with climate parameters, and 4) consider global climate and tectonic drivers of regional climate.

Ungulate diversity increases much more abruptly at ~17.5 Ma than previously recognized (<1 Myr, and possibly not resolvable chronologically), diversity then gradually decreases to ~15.5 Ma, then increases to ~15 Ma and remains high until the present. At 17.5 Ma, abrupt, widespread extensional tectonism increased topographic diversity and best explains near-coincident increases in ungulate and carnivore diversities. The other trends mainly reflect global influences on regional climate. Atmospheric and ocean circulation patterns shifted to quasi-modern conditions, initiating ~15 Ma with narrowing of Tehsak, and strengthening at 11 and 8 Ma with growth of the Tibetan Plateau. These changes yielded a new, progressively intensifying climate regime in western North America—drier conditions overall, greater precipitation seasonality, and warmer winters along the west coast. Correlations between modern faunal diversities and climate show that these changes should yield increased diversities in large mammals (ungulates) and carnivores, but decreased diversities of small mammals (taphonomy, area, and climate), and 3) include ungulates, carnivores and rodents to investigate different correlations with climate parameters, and 4) consider global climate and tectonic drivers of regional climate.

The Missouri paleontological societies, with the Missouri Geological Survey, who provided access to the Public Papers and Reports of the Kansas Geological Survey. The research described herein was supported by the National Science Foundation through the Paleontological Research Office. The Missouri Geological Survey. The research described herein was supported by the National Science Foundation through the Paleontological Research Office. The Missouri Geological Survey. The research described herein was supported by the National Science Foundation through the Paleontological Research Office. The Missouri Geological Survey. The research described herein was supported by the National Science Foundation through the Paleontological Research Office. The Missouri Geological Survey. The research described herein was supported by the National Science Foundation through the Paleontological Research Office. The Missouri Geological Survey.
Poster Session III
DIVERSITY AND BIOGEOGRAPHIC PATTERNS OF LATE JURASSIC NEOSELACHIANS (CHONDRICTHYES, ELASMIMORPHA)
KRÜWET, Juergen, KULG, Stefanie, Palaeontologie, Berlin, Germany
The regional diversity and biogeographic patterns of Late Jurassic neoselachians at genus level in Europe were analysed. The fossil record of neoselachians, as expressed by the simple completeness metric (SCM), is quite good in the Late Jurassic with a peak in the Kimmeridgian. We also calculated origination, extinction, diversification, and turnover rates. The observed diversity fluctuations are related to normal background originations (Oxfordian, Kimmeridgian) and background extinctions (Tithonian). The decline in diversity at the end of the Jurassic is not related to an extinction event but is the expression of missing sediments; the latest Jurassic to Berrissian was a time of major regressions. During the Late Jurassic, an obvious reduction of biogeographic diversification is apparent from the Oxfordian to Tithonian. The more or less uniform faunal compositions, especially in the Kimmeridgian, are related to uniform palaeoclimatic conditions, which were warm and humid, sea level high stands, and absence of important physical barriers in central and northern Europe. The opening of the Bay of Biscay rift had a great influence on the ocean currents and acted as a physical barrier reducing the possibilities of faunal exchanges.

The degree of endemism is highest in the Oxfordian and decreases continuously towards the Tithonian. Our analyses indicate that the distribution of Late Jurassic neoselachians is the result of vicariance and subsequent endemisms but also of dispersal events. Consequently, parsimony analyses of endemism, which assume vicariance being the predominant process for organization distributions fails to provide an accurate sketch of faunal and area relationships.

The results indicate that (1) neoselachians in the Late Jurassic are still underexplored and their true diversity is far from being completely known and (2) neoselachian occurrences are usually reported on rather large spatial and temporal scales. The limited data sets and inaccurate faunal descriptions continue to form a serious problem in analysing past diversity and biogeographic patterns of sharks.

Poster Session II
A VARIATION ON THE Padded PLASTER JACKET FOR HOUSING VERTE- BRATE FOSSILs
KROEHLER, Peter, Smithsonian Institution, Washington, DC
The Smithsonian Institution’s vertebrate paleontology lab has been constructing housing for its large fragile vertebrate fossils using a method described by Jabo, et al. for a number of years. This method has worked well and hundreds, if not thousands, of jackets have been constructed in this manner. This paper will show other now acceptable method of construction using polyethylene felt as the padding liners instead of the polyethylene foam previously described. The new method eliminates a few of the time consuming gluing and clay rolling steps. Samples of the new lining material will be shown at the poster and a limited number of samples will be available. Suppliers names will be provided (though not endorsed) by the author.

Student Poster Session
ORNITHOPODS OF THE WAYAN FORMATION (ALBian) OF EAST IDAHO: A RE-EVALUATION OF THE DINOSAURIN FAUNA
KRUMENACKER, L.J., Idaho Museum of Natural History, Pocatello, ID
The dinosuar fauna of the middle Albian Wayan Formation of east Idaho appears to be somewhat different from other Albian faunas of North America. As is typical for the Cretaceous, this fauna is ornithopod dominated; but by smaller ornithopods (possibly representing a taxa, rather than larger ones.

Despite previous reports, there is no postcranial evidence for a Tenontosaurus-like iguanodont in the Wayan fauna. The associated skeleton previously reported as such belongs to another ornithopod. The only evidence for a Tenontosaurus-like animal comes from a single worn tooth recovered in the 1980’s.

The vast majority of ornithopod fossils come from small, long tailed, gracie animals similar to Hypsilophodon, Orodromes, and Zephryosaurus. Remains common occur as very fragmentary appendicular skeletal elements associated with partially articulated or associated vertebrae. Elongate caudal vertebrae have ventral grooves, lateral ridges, and distinct hexagonal articulations. Caudals are commonly associated with or encased in hypaxial and epaxial tendons. Previous reports suggested the presence of abundant dromaeosaurids in the Wayan, but it now appears more probable that the reputed dromaeosaur material belongs to these small ornithopods.

An enigmatic collection of associated caudal vertebrae may represent a second ornithopod type. These vertebrae come from an animal somewhat larger than the more common smaller ornithopod type. Caudals have circular articulations with tail, thin nueral spines. Distinct lateral grooves are present on the mid-caudals. Osified tendons entirely encase the vertebrae and nueral spines. This animal is the largest probable ornithopod for which there is postcrania evidence from the Wayan.

KRAUSS, David, CUNY, New York, NY; RESHANOV, Alexandra, Borough of Manhattan Community College, New York, NY
A persistent question in dinosaur paleobiology is that of the age structure of dinosaur populations. Rare finds of dinosaur herds provide some insight to this issue. Here we present a statistical method that can provide more insight across a wider spectrum of area and species. It is well established that hadrosaur shed their teeth as they are worn down and that shed teeth are frequently encountered in appropriate sediments. By analyzing the size distribution of teeth found in sediment samples it is possible to gain information about the age structure of hadrosaur populations. Analysis of hadrosaur tooth-bearing bones in museum collections established that larger individuals have larger teeth and shed them at a larger size (p<0001 for regression against body length). The regression is empirical, but was not established in the literature. By measuring teeth still in place and gaps in tooth rows from shed teeth we established that this relationship exists both within and across hadrosaur species. The size distribution of hadrosaur teeth collected from sediment samples was significantly different from that of hadrosaur jaws of any specific size range in museum collections. These data indicate that the shed teeth in the sediments reflected the population as a whole. Size fractionation does not appear to be a problem as all sizes were collected within the same sites and collection methods were designed to accommodate all size categories of shed tooth. Our results suggest a preponderance of mid-size to large individuals and relatively few very large and small individuals. Such an age distribution suggests a stable population with a low replacement rate typical of k-selected species. A possible confounding factor is that larger animals have more teeth and thus should shed teeth more frequently. This pattern would produce a preservation bias towards older individuals and so the population may be younger than our results indicate. Nonetheless we feel that this analysis provides important insights into the population dynamics of hadrosaurid dinosaurs and may be applicable across a wider taxonomic range.

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THE PHYLOGENY OF LIVING AND FOSSIL SPHENISCIFORMES (PENGUINS)

KSEPKA, Daniel, Division of Paleontology, American Museum of Natural History, New York, NY; BERTELLI, Sara, Natural History Museum of Los Angeles County, Los Angeles, CA; NORBERTO, Gianni, Dept. of Mammalogy, New York, NY; CLARKE, Julia, Dept. of Marine, Earth and Atmospheric Sciences, Raleigh, NC

The Sphenisciformes have an exceptional fossil record by avian standards. Fossil penguins offer insight into the transition from aerial to underwater flight, gigantism in birds and the interplay between avian distribution and Gondwanan break-up. We compiled a matrix of 210 morphological characters as well as sequence fragments from 5 genes (12S, 16S, COI, cytochrome b, RAG-1) and sampled 20 fossil and 17 living ingroup taxa to reconstruct the evolutionary relationships of penguins. Despite large percentages of missing data in several fossil taxa, combined analysis using POY 3.11 yielded a largely resolved strict consensus cladogram.

Our results place Waimanu as the most basal penguin genus. Three small fossil penguins and two clades including the giant fossil penguins *Aptenodytes* and *Pygoscelides* occupy other basal branches of the penguin tree. The interrelationships of these taxa indicate major shifts in body size occurred during early penguin evolution. Further up in the tree, an alternating pectinate arrangement of fossil taxa from the South American and Australian quadrants of the Southern Hemisphere reveals dispersal between these areas was common throughout the Tertiary. Nearly all included fossil taxa fall outside of the crown clade Spheniscidae, suggesting the modern penguin fauna is the result of a successful radiation of derived forms rather than an assemblage of survivors from numerous lineages. Many derived cranial features correlated with diet in living penguins are restricted to the Spheniscidae. *Aptenodytes* is the basal extant genus in the combined result, but *Endyptula*-*Spheniscus* form the basal divergence within Spheniscidae when only morphological character is considered. This is largely the effect of different rooting of the extant penguin subtree supported by molecular vs. morphological data. Our results do not support an expansion of crown penguins out of a deteriorating Antarctica, but instead suggest that penguins currently breeding on Continental Antarctica have re-colonized the area.

Poster Session II

REEXAMINATION OF ADASARUS MONGOLIENSIS (DINOSAURIA: THEROPODA) FROM THE UPPER CRETACEOUS NEMEGT FORMATION OF MONGOLIA

KUBOTA, Katsuhito, Graduate School of Life and Environmental Sciences, Univ. of Tsukuba, Tsukuba, Ibaraki, Japan; RINCHEN, Barsbold, Geological Institute, Mongolian Academy of Science, Ulaan Baatar, Mongolia

*Adasaurus mongoliensis* from the Upper Cretaceous Nemegt Formation of Bugin Tsav, southwestern Mongolia, was described based mainly on pelvic and pedal elements in 1983 and was originally diagnosed by highly reduction of pedal ungual II-3. *Adasaurus mongoliensis* has been referred as a member of dromaeosaurids, but its phylogenetic position within Dromaeosauridae remains unresolved. In this study, it holotype (MPD 100/20, a posterior portion of skull and postcranial skeleton, missing dorsal ribs, forelimbs, and some pedal phalanges) and referred specimens (MPD 100/21, two caudal vertebrae and right foot) are reexamined and compared with other dromaeosaurids.

Preliminary phylogenetic analysis in our study indicates that *Adasaurus mongoliensis* shows affinities with another Mongolian dromaeosaurid, *Velociraptor mongoliensis*, in having fused scalapulocostal and distal tarso-fus with metatarsals. Differences between *Adasaurus mongoliensis* and *Velociraptor mongoliensis* are expanded maxillary process of jugal, paroccipital process with straight dorsal edge, and pleurocoels on only anterior sacrals. *Adasaurus mongoliensis* can be distinguished from other dromaeosaurids in having a low dorsal ridge on median frontals (continuous with sagittal crest on parietals), large surangular foramen, and notched anterior margin of preacetabular process as well as reduced ungual of pedal digit II. Our study suggests that a ventral surface of procoxal-ventral heel on the penultimate phalanx has no asymmetrical ridges like other dromaeosaurids and troodontids (*Deinonychosaurs*), supporting that the use of pedal ungual II-3 is different from that of other deinonychosaurs theropods.

Vertebrate Development Symposium, Wednesday 8:15

DEVELOPMENTAL FACTORS BEHIND THE EVOLUTIONARY NOVELTIES OF VERTEBRATES

KURATANI, Shigeru, Center for Developmental Biology, RIKEN, Kobe, Japan

Genes involved in specification and patterning of global structures such as pharyngeal arches and neuromeric compartments in the vertebrate pharyngula tend to be upregulated in conserved spatiotemporal patterns. Homologous genes are often associated with morphological novelty such as homologous cell populations and primordia as typically seen in the Hox code. Emergence of evolutionary innovations, on the other hand, can be viewed as changes introduced into the developmental program, resulting in acquisition of new developmental patterns that never existed in ancestors. It does not necessarily mean, however, that generation of novel genes is a prerequisite for the novel structures. Instead, homologous sets of regulatory genes can be recruited to different sites of developmental stages. Thus homologous genes and morphological patterns are primarily uncoupled. Evolutionary novelty is often obtained by heterotopic and heterochronic shift of gene regulations or tissue interactions that lead to loss of morphological novelties. I will use the acquisition of the jaw in gnathostomes and shells in turtles as examples of evolutionary novelties in vertebrates, and will show how these phenomena can be explained as result of shift of tissue interactions and folding of tissues.

Romer Prize Session, Thursday 9:45

QUANTIFICATION OF THE EXTENT OF DIAGENESIS IN BIOGENIC APPATITE OF CENOZOIC SHARK CENTRA

LABS HOCHSTEIN, Joann, Florida Museum of Natural History, Gainesville, FL

Diagenesis of bone during fossilization is pervasive, however, the extent of this process varies with depositional environment. This study quantifies diagenesis of shark vertebrae through analysis of a suite of morphological characters. Although shark skeletons are initially cartilaginous, the soft cartilage of the vertebral centra is replaced with carbonate hydroxyapatite during the growth of the individual. Nine vertebral centra are analyzed from the Lampaodulea ranging in age from the Cretaceous to Recent using Fourier Transform Infrared Spectroscopy (FT-IR) and Inductively Coupled Plasma Mass Spectrometry (ICPMS). The variables CI, carbonate content, rare earth element (REE) concentrations, (La/Yb)N vs. (La/Sm), La/Yb, and Ce anomalies, elucidate the diagenetic and depositional environments of the seven fossil vertebral centra. The two extant centra demonstrate the initial, unltered end-member conditions for these variables. Two fossil vertebral centra (C. megalodon and T. hastalis) demonstrate a strong terrestrial influence during diagenesis (distinctive flattening of shale-normalized REE patterns) that masked the seawater signal. Three centra (C. auriculatus, C. angustidens, and C. mantelli) have indications of some terrestrial influx evident by some flattening of the REE patterns relative to seawater. The terrestrial influence in these five shark centra (C. megalodon, T. hastalis, C. auriculatus, C. angustidens and C. mantelli) are interpreted to represent a primarily nearshore habitat for these species. In contrast, the two O. obliquus centra have REE patterns that represent the original seawater signal and have no indications of terrigenous input. These results indicate that fossil shark vertebral centra have the potential to understand diagenesis and reconstruct paleoecological environments.

Wednesday 1:45

AN EMERGING FOSSIL BIOTA FROM THE EARLY CRETACEOUS OF NORTH-WESTERN CHINA

LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA; LI, Da-Qing, Third Geology and Mineral Resources Exploration Academy of Gansu Province, Lanzhou, China; YOU, Hai-Lu, JI, Qiang, Chinese Academy of Geological Sciences, Beijing, China; HARRIS, Jerald, Dixie State College, St. George, UT

In 2004 and 2005, cooperative Chinese-American field efforts recovered abundant and often beautifully preserved plant, invertebrate, and vertebrate fossils from lacustrine deposits of the Lower Cretaceous Xiaogou Formation exposed near the town of Changma in Gansu Province, northwestern China. Although the precise age of the Xiaogou Formation is presently unresolved, it is probably slightly younger than the early Aptian Jiufotang Formation of northeastern China, as it contains several forms characteristic of the Jehol Biota (e.g., the insect *Ephemeropsis trisetata*) but lacks others (e.g., the fish *Lycoptera*). Moreover, the Xiaogou Formation overlies the Chiupinu Formation, which yields *Lycoptera* as well as other representative Jehol Biota taxa.

Megafloral remains recently recovered from the Xiagou Formation have not yet been studied in detail, but most appear to pertain to ferns and conifers. Invertebrate fossils include ostracods, conchostracans, and a diversity of insects. Bird specimens prepared to date include several enantiornithine partial skeletons and over 30 fragmentary to nearly complete ornithomorpha. The overwhelming majority of the latter are referable to the basal ornithuran *Genus yumenensis*, and collectively represent all parts of its skeleton except for the skull, yielding significant new insight into the anatomy of this taxon.

Analyses of many of these new fossils from the Xiagou Formation are still in their initial stages. However, as the Changma assemblage becomes better characterized, it will enable comparisons with the celebrated, nearly coeval Jehol Biota, and greatly improve our understanding of Early Cretaceous paleoecosystems in central Asia.

Friday 1:45

A RELATIVE OF THE BELUGA AND NARWHAL (ODONTOCETI, MONODONTIDAE) FROM THE EARLY PLIOCENE OF THE NORTH SEA

LAMBERT, Olivier, Institut royal des Sciences naturelles de Belgique, Brussels, Belgium; GIASE, Pierre, Antwerp, Belgium

The odontocete family Monodontidae includes two modern species: the beluga *Delphinapterus leucas* and the narwhal *Monodon monoceros*; both species are geographically limited to the cold Arctic Ocean and adjoining seas. The fossil record of the family is poor: one species *Denebola brachycephala* from the latest Miocene of Mexico, *Monodon* ear bones from the early Pliocene of Peru, and an undescribed skull and ear bones referred to *Delphinapterus* sp. from the early Pliocene of the east coast of USA.

A fragmentary skull with atlas and axis discovered in the early Pliocene (5.0-4.4 Ma) of Antwerp (North of Belgium, near the omega margin of the North Sea Basin) clearly belongs to a Monodontidae, based a.o. on the dorsal exposition of the maxilla along the bony naris, the anterior position of the suprarosphial process of the frontal and the related longitudinally elongated temporal fossa. The skull, with a size somewhat smaller than the adult beluga,
bears predation/scavenging marks likely inflicted to the animal by a large shark.

From an ecological point of view, this new record indicates a much wider latitudinal dis-
tribution for the early Paleolotitherium (from the tropical South America, now in the cool-temperate North Sea) than for the Arctic to sub-Arctic modern beluga and narwhal.
The shift to the North Sea was achieved before or during the first steps of the strengthening of the Gulf Stream related to the progressive closure of the Isthmus of Panama (from ca. 4.7 Ma).

More generally, the oldest reliable records of crown-Delphinoidae (Delphinidae + Monodontidae + Phocoenidae) date from the late to latest Miocene in the east Pacific Ocean, while crown-Delphinidae are first discovered in the North Atlantic realm during the Early Pliocene. This chronological gap suggests an origin of the group in the Pacific Ocean and a subsequent migration across the Panama Seaway, a hypothesis that should be tested with a more detailed late Miocene odontocete record in the North Atlantic.

Poster Session III

BOOTSTRAP RESAMPLING AND THE STATUS OF THE FOSSIL PENGUINS

PALAEOSPHINCUS GRACILIS, P. PATAGONICUS AND P. WIMANI

LAMM, Kristin, KSEPKA, Daniel, American Museum of Natural History, New York, New York

The fossil penguins Palaeosphenicus gracilis, P. patagonicus and P. wimani are known from the Miocene of Patagonia. Relative size alone distinguishes these three taxa from one another—P. gracilis is the smallest, P. patagonicus is intermediate and P. wimani is the largest. This diagnostic criterion assumes that the size variation between any two of these fossil species exceeds the range of size variation within any extant penguin species.

However, this assumption has not been adequately explored using quantitative methods. We assess the probability of sampling a set of n individuals from a given extant penguin species whose size variation is greater than that in a sample of n individuals from these fossil taxa. If the fossil record represents a random and independent sample, then these random samples approximate potential “fossil samples” for the extant penguins. The humerus, radius, ulna and the tibiotarsus are used to examine size variation, and the geometric mean is taken as the size variable for each skeletal element. For each element, 1000 samples of n geometric means are randomly selected with replacement from each of the extant penguin species considered. Coefficients of variation (CVs) and max/min ratios are calculated for each sample. For each element and each extant species, we assess the probability of obtain-
ing a CV or max/min ratio equal to or greater than that of each pair of fossil species. If the size variation between the extinct species does not significantly exceed that within the test subject group (p<0.05), then variation in size alone is not a sufficient criterion for assigning these specimens to different species.

Vertebrate Development Symposium, Wednesday 11:15

DEVELOPMENTAL MECHANISMS IMPLICATED IN THE EVOLUTION OF THEROPOD-AVIAN TAIL REDUCTION

LARSSON, Hans, EBN-AL-NASSIR, Arshed, MORISON, Stephen, BURE, Lionel, McGill Univ., Montreal, QB, Canada

The evolution of the short tail skeleton of birds was achieved during the evolution of their dinosaurian ancestors and throughout basal birds. Tails were reduced from over fifty vertebrae to only five to eight free vertebrae in modern birds. Modern bird embryos were examined to illuminate the early patterning of the tail skeleton. Mesenchymal condensations that later give rise to bones in the tail were found in developing chickens and alligators. These condensations indicate that a large number of vertebrae are present initially but only a few later chondrify and even less ossify. Some of the developmental mechanisms responsible for vertebrate tail development were examined in developing chickens and alligators and compared to those acting in known model species. A model of the evolution of develop-
mental mechanisms that may be responsible for theropod tail reduction is presented based on the fossil record of theropods and the development of modern birds.

Poster Session II

REVIEW OF THE BRAZILIAN ICHTHYODECITFORMES

LEAL, Maria Eduarda, ALVARADO-ORTEGA, Jesus, BRITO, Paulo, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil

In Brazil the Order Ichthyodectiformes is well represented in Lower Cretaceous sediments and they start to be described since 1841. Today, at least three genera belonging to the sub-
order Ichtchtyodectidoi are recognized in the country: Saurochelus, Cladocychus, and Chiromystus. The validity of a fourth genus, Icaparica, is now under study. Once Chiromystus and Icaparica were located as synonymy of Cladocychus; however, recent phylogenetic analysis shows that the latter is a basal form of the most derived Ichthyodectiformes including Saurochelus, among others. Chiromystus and probably Icaparica, characterized by a low amount of vertebrae (40-50), are located among the most primitive ichthyodectoids. The review Cladocychus is Brazilian ichthyodectiform and it has been described from many localities by diverse authors. The review of this record of Cladocychus into the collection of the DNPM allows recognizing the presence of a new species (and probably new genus) related to Chiromystus. This new species differs from Chiromystus because it has about 60 vertebrae but both shares the position of the pelvic fin in the middle of the body, a primitive feature does not present in Cladocychus.

Friday 11:30

EVOLUTION OF RAPID LIMB GROWTH AND VASCULAR CANAL ORGANIZATION IN CERATOPSIAN DINOSAURS

LEE, Andrew, Univ. California, Berkeley, Berkeley, CA

Ceratopсид dinosaurs are common in the Late Cretaceous deposits of Asia and North America, yet relatively little is known about their skeletal growth dynamics. To assess how rapidly ceratopсид dinosaurs achieved skeletal maturity as well as to understand the relative impor-
tance of phylogeny, ontogeny, and mechanics on bone microstructure, a histological analy-
sis of the limb bones of Psittacosaurus, Protoceratops, and Centrosaurus was performed. Skeletal maturity required 8 to 13 years in Psittacosaurus, about 7 years in Protoceratops, and 6 years in Centrosaurus. In those ceratopsians, the presence of cyclical annuli suggests that limb bone growth did not abruptly stop but slowed towards the end of each growth cycle. Vascular canal organization also provides evidence of rapid growth. Radial vascular canals, which are found in some rapidly growing aniotic bones, are common in the limbs of yearling Psittacosaurus and Protoceratops but are replaced by reticular or longitudinal canals during subsequent years of growth. In Centrosaurus, radial canals dominate the beginning of each growth cycle, and that pattern continues through the third year of growth after which canals are generally longitudinal. Repeated deposition of radial vascular canals correlates with accelerated limb growth in ceratopsians and suggests the relative importance of ontogeny over mechanics in vascular canal organization.

Poster Session II

NEW PTEROSAUR TRACKS FROM THE HASANDONG FORMATION (LOWER CRETACEOUS) OF HADONG COUNTY, SOUTH KOREA

LEE, Yuong-Nam, LEE, Hang-Jae, Korea Institute of Geoscience and Mineral Resources, Daejeon, South Korea

New pterosaur tracks were discovered in the Hasandong Formation (Aptian) at an aban-
doned quarry of Hadong County in 2004. A total of 50 pterosaur footprints are preserved as natural impressions on a big black slab (70 x 50 cm). Footprints consist of isolated 25 manus and 25 pes prints, indicating the quadrupedal locomotion. The average manus length and width are 25.6 mm and 12.3 mm, respectively. The manus prints are asymmetric, with three digit imprints. The first digit imprint is anterolaterally oriented and is the shortest. The sec-
ond and third digit imprints are posterolaterally oriented. The average pes length and width are 25.7 mm and 12.8 mm, respectively. The pes prints are triangular, elongate and fully plantigrade. They are tetradactyl with anterior claw marks. The first digit impression (average 8.9 mm) is shorter than digits II-IV, subequal in length. The metatarsals are long and elongate which are always longer than digits. It is difficult to trace complete trackways due to lack of consecutive manus-pes footprints. Nevertheless, in a complete manus-pes set, the pes print is anterior to the manus print and the latter is located further from the mid-line than the former. Hadong pterosaur tracks are distinguished from Haenamichnus uhangrien-
sis reported in the Uhangri Formation (Upper Cretaceous) of Haenam County, Korea in terms of the size and morphology.

Student Poster Session

DETERMINING CURSORIALITY OF MID-TERTIARY MAMMALS THROUGH DISTAL/PROXIMAL LIMB BONE RATIOS

LEVINE, Eric, Univ. of Oregon, Eugene, OR

The ratio between proximal long bones (humerus or femur) and distal long bones (ulna or tibia) is a measure of running ability (cursoriality). In increasingly open and grassy habitats of the mid-Tertiary, cursoriality has been considered an adaptation to running escape from increasingly fleet-footed predators, and increasing locomotor efficiency at distance. Limb long bones of fossils and some living mammals were measured in the collections of the Condor Collection of the Univ. of Oregon, Univ. of California Museum of Paleontology in Berkeley and John Day Fossil Beds National Monument at the Condon Center. These data were supplemented with an array of published data for living and fossil mammals, where living mammal data were used as a scale for determining cursorial capacity in fossil taxa. Measurements of mid-Tertiary fossil sabertooths (Nimravidae), oreodonts (Oreodontidae), and horses (Equidae) show that predators showed less elongation in the dis-
tal portion of the forelimb than prey, regardless of size. Hindlimbs display markedly less distal long bone lengthening than forelimbs in both predator and prey. This difference between hindlimb and forelimb ratios gave some mammals much greater running stride than others, and may be due to biomechanical advantage of keeping the back straight while running, which is reflected also in adaptations of vertebrae of modern running mammals.

Marine Reptiles Symposium, Wednesday 4:00

AN UNUSUAL ARCHOSAUR FROM THE MARINE TRIASSIC OF CHINA

LL Chou, Institute of Vertebrate paleontology and Paleoanthropology, Chinese Academy of Sciences, Beijing, China; WU, Xiao-chun, Canadian Musuem of Nature, Ottawa, ON, Canada; WANG, Liting, Guizhou Geological Survey, Guiyang, China; SATO, Tamaki, National Science Museum, Tokyo, Japan; CHENG, Yen-nien, National Museum of Natural Science, Taichung, Taiwan, ROC

Archosaurus (=Archosauriformes in some publications) originated in the Late Permian and later gave rise to dinosaurs (and probably birds), pterosaurs, and crocodylomorphs (including extant crocodylians). Its early members, traditionally called “thecodonts”, flourished world-
wide during the Triassic, and have been long considered terrestrial. Archosaurian remains have been reported from Triassic marine strata before but most are believed to be the
remains of terrestrial animals washed out to sea. Sikaninius and a few of European phytosaur (such as Mystriosuchus) from the marine Upper Triassic are considered to be specialized toward marine life. Here we report a new Triassic archosaurian which, together with fishes, nothosaurs, protorosaurs and ichthyosaurs, has been collected recently from the Middle Triassic marine limestone in west Guizhou, China. The new archosaurian is well represented by articulated skeletons with skulls. The new archosaurian shows a number of aquatic specializations, of which the most striking is the extreme lateral compression of the long tail. Others that may also reflect aquatic adaptations include plate-like scapula and coracoid, elongate neck with extremely long and slender ribs, and reduction of osteoderms. These indicate that the new form was more aquatic than any of other known taxa among the Triassic archosaurians. In contrast, its pelvic girdle and hindlimb of the new archosaurian have no aquatic modifications. Anatomical features, taphonomy and local geological data suggest that the new form may have lived in a coastal-island environment. This style, convergent with some Jurassic marine crocodyliforms that lived at least 40 million years later and the saltwater species of extinct Crocodylus, contradicts with the prevailing view that Triassic archosaurians were restricted to non-marine ecosystems. Its mosaic anatomy represents a previously unknown ecomorph within primitive archosaurians.

Poster Session II

AN OVERVIEW OF VERTEBRATE PALEONTOLOGY IN NORTHERN CALIFORNIA: KNOWN LOCALITIES, TAXA, AND FUTURE POTENTIAL

LIGGETT, Gregory, Northern California Natural History Museum, Chico, CA

Northern California contains relatively few fossiliferous outcrops. Those that exist are interspersed among the remote and rugged igneous and metamorphic landscape that rings the Sacramento Valley. Northern California is arbitrarily defined here as the northern-most 28 counties of the state, the roughly 55,000 square miles north of Sacramento, approximately equal to the state of New York. Most of the organized collecting activity in northern California has taken place during the late 19th and the first half of the 20th centuries. In more recent decades only a handful of collectors have scoured the region for vertebrate fossils.

Despite its intermittent history of collecting, the region has produced many significant vertebrate paleontology localities covering a wide geologic time span: Triassic, Jurassic, Cretaceous, Eocene, Miocene, and Pliocene aged localities are known. Some notable holotypes from the region include the enigmatic Thalattosaurus alexandrei and the ichthyosaur Shastasaurus pacificus from the Triassic; the Jurassic ichthyosaur Ichthyosaurus franciscus; and the Quaternary bear Arctodus simus.

A compilation of the vertebrate sites of northern California was produced as a preliminary step in developing a deeper understanding and characterization of the vertebrate paleontology resources of the region. Vertebrate fossil localities were compiled primarily using the University of California Museum of Paleontology Web site and a detailed literature review. A Geographic Information System (GIS) database focusing on northern California was initiated. The locality data layer helps to clarify the spatial relationships between localities, and will be used in conjunction with additional data layers to create a paleontology potential map to target areas for future exploration.

Student Poster Session

FOSSIL SPEAK: CONTROVERSIAL CONCEPTS OF DEEP TIME AND CHANGE THROUGH TIME PRESENTED TO STUDENTS THOUGH THE STRONG EVIDENCE OF THE FOSSIL RECORD

LINDSAY, Thomas, Portland State Univ., Portland, OR

“Life of the Past” is a survey of life as evidenced by the fossil and rock record. It is used for upper division and graduate students to meet a general science with a lab requirement for non-BS geology majors. The major themes of the class are the evidence for the advent and evolution of life, transitional species, conceptualization of deep time, the correlation of climatic, volcanic and other conditions at times of major extinctions, and the geological concepts which support the occurrence and distribution of the fossil record. According to NSF, 44% of people surveyed on biological evolution and the “big bang” accepted these concepts. This class has the opportunity to present strong evidence in the rock and fossil record of these scientific concepts to students. I have conducted two of three proposed treatments to examine student conceptualization of the themes listed above to evaluate which factors are most conducive to student learning. Treatment one is a condensed summer class with 16 participants in 2005 and an unknown number of students in 2006, in which the lecture and lab times are reduced, and in their stead, students participate in two on-site fossil locations found in Oregon. The second treatment is a full lecture and lab with 56 students from both winter and spring terms of 2005/2006, but the course does not include fieldtrips. Dodick and Orion developed the GeoTAT assessment, which has correlated geologic skill and cognitive skill in a series of questions. The GeoTAT questions were linked to the pedagogy that addressed that particular question. Students took a pre-assessment the first week of class, and a post-assessment on the last day of class. Paired Student-t test was used to evaluate the pre- and post-assessments by student. The results were then compared to the geologic skill, cognitive skill and the pedagogy that addressed those concepts to elucidate what combination of pedagogical approaches gained significant results. This approach also revealed concepts that were most difficult for student comprehension, as revealed by non-significant results.

Poster Session III

THE LATE EOCENE MAMMALIAN FAUNA OF THE FLORISSANT FORMATION, CENTRAL COLORADO, INCLUDING THE DISCOVERY OF A NEW INSECTIVORAN

LLOYD, Karen, EBIBLE, Jaelynn, Univ. of Colorado at Boulder, Boulder, CO

Renewed collecting of fossil vertebrates in the Upper Eocene Florissant Formation in Florissant Fossil Beds National Monument, central Colorado, has nearly tripled the number of mammalian taxa from this rock unit. Here we report the coyonid rodent Paradajidea triflophus, the lagomorph Palaeoelagus, and the rare ariodactyl Pseudoprotocricet longi-naris. The Florissant mammalian fauna corroborates the Chadronian (latest Eocene) age determined by others, with many occurrences representing southwestern geographic range extensions. We also report the discovery of an insectivoran that appears most similar to Miocene-aged Mystipeterus (Uropsalinae; Talpidae; shrew-moles). The miniscule (approximately 377 mm long) incomplete right dentary with m1-m3 shares the following characters with Mystipeterus: posterior mental foramen positioned under m1; crista obliqua long and extends lingually, intersecting the posterior wall of the protolophid below the metastopid; labial cingulids interrupted by hypocionid; and a prominent posterior accessory cuspid (hypoconid) directly posterior to the entocionid. The Florissant insectivoran seems a plausible ancestor to Miocene Mystipeterus (also known from Colorado), and extends the known temporal range of New World moles back several million years.

Student Poster Session

LUMB BONE SCALING IN DINOSAURS

LINTON, Deborah, The Natural History Museum, London, United Kingdom

Previous work by Carrano compared scaling in the long bones of dinosaurs with those of mammals, to look for describe and explain scaling patterns relating to body size and posture. No attempt was made in that paper to separate the major divisions within the Dinosaurs, which could cloud the possible causes of any observed differences with mammalian scaling.

In order to establish whether the posture has a different effect on limb bone scaling with in Dinosaurs, Redel’s Major Axis regression analysis was performed a dataset consisting of this same data and supplemental measurements obtained separately. Length was regressed against diameter for humeri and femora for the Theropoda, Sauropoda, and three postural groups within the Ornithischia.

Forelimbs tended to scale more negatively for bipedal forms than quadrupedal: lengths increase at a faster rate compared to diameter in bipeds and semi-bipeds than in quadrupeds. This is in accordance with Carrano’s observation of the same, but the tendency is more pronounced in theropods than ornithischians.

In the hindlimb, however, the greatest distinction was between the taxonomic groups: saurischian hindlimbs scale more negatively than ornithischian of any posture, implying that there is some sort of taxonomic constraint having a greater effect on the rate of hind limb scaling than posture alone.

Friday 8:30

A NEW DINOSAUR SUPERTREE AND THE UTILITY OF LARGE TREES IN MACROEVOLUTION

LLOYD, Graeme, Univ. of Bristol, Bristol, United Kingdom; DAVIS, Katic, Univ. of Glasgow, Glasgow, United Kingdom; BENTON, Michael, Univ. of Bristol, Bristol, United Kingdom; PISANI, Davide, National Univ. of Ireland, Co. Kildaire, Ireland

Evolution occurs along the branches (not across the tips) of a phylogenetic tree, but that tree must be as comprehensive as possible in order to provide an adequate framework to answer macroevolutionary questions. Here a ‘supertree’ approach (which combines the information contained in source trees that have overlapping taxon sets) is applied to the Dinosaurs.

Supertree methodology has gained more sophistication since its inception and new methods applied here included filtering criteria (which removed redundant source trees), node-based higher taxon substitution and multiple supertree construction algorithms (e.g. MRPP, triplet/quartet fit). In total 147 source trees (after filtering) were used, spanning over half (377) of all valid non-avian dinosaur species. Due to the size of the dataset analyses were performed on a supercomputer array.

Lack of resolution in the resulting supertrees was attributed in part to problematic taxa, which provided insufficient information concerning their placement. Remaining uncertainty was due to conflict between source trees and was concentrated amongst maniraptoran theropods, a historically problematic group. An objective criterion (stratigraphic fit) was used to select a fully resolved tree for subsequent analyses. These included palaeobiogeographic, body size, diversification rate and ghost range analyses. Overall the various dinosaur clades show divergent trends of dispersal ability, body size change and speciation rate, but are all similarly constrained by the fossil record.

An alternative approach to constructing large phylogenies is the ‘supermatrix’ method, where source matrices rather than their resulting trees are combined. Here such an approach was applied to maniraptoran in an attempt to better resolve their interrelationships. Additionally the use of morphological characters enabled analysis of character acquisition along the branch leading to birds. Here a ‘ground-up’ rather than a ‘trees-down’ model is more parsimonious.
A NEW MAP AND ANALYSIS OF AMERICAS MOST FAMOUS HOMINID FOOTPRINT SITE: ACAHUALLINCA, NICARAGUA

LOCKLEY, Martin, Univ. of Colorado at Denver, Denver, CO; GARCIA-VASQUEZ, Ramiro, Museo Nacional, Managua, Managua, Nicaragua; ESPINOZA, Edgar, Departamento de Investigaciones Antropológicas, Managua, Nicaragua; LUCAS, Spencer, New Mexico Museum of Natural History and Science, Albuquerque, NM
6000-year-old hominid (H. sapiens) tracks from the Acahuallinca Footprint Museum, Nicaragua, known since 1874, have never been mapped or described in detail. We report the results of mapping about 500 tracks attributed to at least 15 humans, two ungulates (a ‘caco’ and a bird). The tracks occur in volcanic ash containing plant remains, on two exposures of the same surface separated by an area still buried for future study. More than 1000 tracks are estimated for the whole area. The human trackways are all parallel, ranging in size (track length) from 18.5 to 22.0 cm, suggesting individuals between 1.32 and 1.57m tall (estimated foot length/height =14%). It is possible to identify some individuals on the basis of track depth and differential toe impression configurations. Most literature on the site promotes anecdotal ideas about trackmaker identity and behavior. For example, there is debate about whether the humans were fleeing as a group from an eruption and ashfall. Human trackway step and depth indicates normal walking at different times. Trackways run to the NW perpendicular to small ‘channels’ that erode some tracks. Reports of tapir and otter tracks have not been confirmed, but the museum preserves a pair of bovine tracks from another nearby site (El Recreo) that is no longer accessible.

With the exception of one track from Chile dated at about 12,500 years, the well-preserved human tracks from Nicaragua are as old as any reliably dated from elsewhere in the Americas: e.g., Californian and Argentinian footprints dated to about 6-7,000 BP.

Early human tracks are also reported from several Mexican sites, but dates are problematic.

Othnielia spec. (Cretaceous, Argentina), and P. planorbis (Jurassic, France and Germany), the monospecific Araripelapidoidea (Cretaceous, Brazil), Paralepidotus (Triassic, Italy), and Pliodetes (Cretaceous, Niger), the recently described Lepidotes tendaguransensis (Jurassic, Tanzania), L. buddhabutrensis (Jurassic-Cretaceous, Thailand), and L. microrhis and L. tanyrhis (Cretaceous, Spain), the recently revised Nessemnothus (Cretaceous, Argentina), and Semionotus elegans and S. kanabensis (Triassic-Jurassic).

The analyses also show that several characters that have been traditionally considered in semionotid taxonomy (e.g., number and arrangement of subribal plates, the presence of a dorsal ridge of scales). On the other hand, the systematic value of other characters has been underestimated (characteristics of the circumbiboral ring, the shape of the parietals (=frontals), etc.). Despite the differences depending on the choice of outgroup, several recurring patterns are found. Whereas Lepidotes is polyphyletic in all topologies found, the genus Semionotus always results as monophyletic. For example, L. tendaguransensis and L. buddhabutrensis do not appear referable to Lepidotes. Thus, a thorough taxonomic revision of Lepidotes is needed and should be based on a phylogenetic analysis.

A SYSTEMATIC REVISION OF THE “AGRICHOERIDAE” (CETARTIOIOCTA: OREODONTIA)

LUDTKE, Joshua, San Diego State Univ., San Diego, CA
Oreodonta, despite being a common group of extinct North American ungulates, has a high-contentious placement within Cetartiodactyla. Most workers agree that it is an early diverging group, but disagreement exists as to whether oreodonts are more closely related to Tylopoda, Ruminantia, or Suina. The earliest appearing branch of Oreodonta is the clade Agriochoeridae, which is defined by the retention of several ancestral character states, such as rostral postcanine dental characters and a lack of femoral fossa. The clade is represented by the ubiquitous middle and late Eocene genus Protoreodon, the less common Diplobunops from the same time period, and the unusual, clawed Eocene-Oligocene genus Agriochoerus. “Protoreodon”, “Agriochoerus”, and “Agriochoeridae” are, as currently defined, paraphyletic, with the genera consisting of various ill-defined species and the clade containing basal oreodonts, true agriochoerid oreodonts, and basal members of the merycoidodont oreodonts. These overgeneralized definitions add nothing to the studies of the position of oreodonts within Cetartiodactyla and the phylogenetic relationships within Oreodonta.

Reorganization of the species and supra-species level systematics of the “Agriochoeridae” is necessary to allow the proper placement of Oreodonta in cetartiodactylan systematics. This investigation uses measurements and observations of dental, cranial, and postcranial morphology to diagnose and describe “agriochoerid” oreodonts at the species level. At least twenty species in this clade can be distinguished, mostly by a combination of dental size and the cusp development of the upper and lower fourth premolar. These characters are used to place the “agriochoerid” species into a phyleogenetic taxonomy. Using this approach, the existence of the three described genera, Protoreodon, Diplobunops, and Agriochoerus, as monophyletic taxa is supported, along with the existence of unnamed genera currently lumped into Protoreodon and Agriochoerus. This information will be used to further refine the placement of “Agriochoeridae” and Oreodonta within Cetartiodactyla.

Poster Session I

AN ARTICULATED PARTIAL POSTCRANIAL SKELETON OF A SMALL ORTHONOTID (C.F. OTINIELIA) DINOSAUR (MORRISON FORMATION: ALCOWA, WYOMING)

LOVELACE, David, Big Horn Basin Foundation, Thermopolis, WY
UW24823, a small articulated orthonotid skeleton was discovered in 1991 by a summer high school field-science outing at Alcowa Lake in Natrona County, Wyoming. The skeleton was partially prepared and displayed at the Tate Museum, with recent completion of preparation carried out at the Univ. of Wyoming in 2005. The skeleton is lacking a skull but exhibits a well-preserved forearm, manus, pelvis, both hindlegs sans pes, 3-dimensionally preserved rib cage, and serveral novel structures preserved along the costal midline.

UW24823 was found in a medium-coarse-grained sandstone channel in the upper Morrison Formation. The high-energy fluvial environment provided a rapid mode of burial, allowing 3-dimensionial preservation of the body cavity. The dorsal neural spines were facing the recent erosional surface and are only present as casts of the centra and transverse processes.

Thin structures adjacent to the rib cage were initially interpreted to be skin impressions; upon further preparation these structures appear to be bone or partially ossified cartilaginous elements. The structures, found along the midline of the ribcage, are tentatively identified as uncinate processes. Each structure originates from one rib and overlaps the following posterior rib resulting in a more ridged ribcage. Stiffening of the ribcage may have played a role in locomotion or respiration. Similar structures have been observed in the ornithopod Hypsilophodon.

The rib cage clearly demonstrates posterior deflection of the anterior and mid ribs grading into a more vertical alignment of the posterior most ribs. The forearm and manus are well preserved and fully articulated from phalanges to distal humerus. Compared to other Othnielia specimens UW24823 shows few skeletal differences. UW24823 has a less pronounced brevis shell, and the skeleton is 35-40% larger than other reported specimens of this genus.

Wednesday 10:30

FASTER VELOCIRAPTOR AND THE POSITION OF THE TRIASSIC-JURASSIC BOUNDARY

LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM; TANNER, Lawrence, Le Moyne College, Syracuse, NY

The working definition of the Triassic-Jurassic boundary (TJB) has long been taken as the LO (lowest occurrence) of the ammonite Psiloceras (usually P. planorbis). But, there is no direct way to relate the LO of P. planorbis to the fossil vertebrate record across the TJB. In the nonmarine Newark Supergroup of eastern North America, the TJB has been placed just below the oldest basalts of the Central Atlantic Magmatic Province (CAMP) based on palynostratigraphy, and most vertebrate palaeontologists have long relied on this placement of the TJB. This boundary, however, is demonstrably older than the TJB defined in marine strata.

The palynological turnover cited as the TJB in the Newark most resembles a late Norian change in the European sections and does not correspond to any palynological event at the marine-defined TJB. Vertebrate footprint evidence (LO of Eubrontes) used to support the palynostratigraphically defined placement of the TJB in the Newark Supergroup is undermined by occurrences of Eubrontes in the Triassic of Europe and Australia and of bones of potential Eubrontes trackmakers in Triassic strata. Radioisotopic ages indicate the marine TJB is no older than 200 Ma but the palynostratigraphically-defined TJB in the Newark Supergroup is older than 201 Ma, based on isotopic dates of the oldest CAMP basalts. Magnetostratigraphic correlation to European marine sections also suggests that the palynostratigraphically-defined TJB in the Newark Supergroup is older than the marine TJB. Thus, all data indicate that the TJB in the Newark Supergroup is above the lowest CAMP basalt, probably in the extrusive zone or just above it. Therefore, the position of the TJB in nonmarine strata is actually higher than generally thought, and does not obviously correspond exactly to any bioevent in the fossil record of vertebrates.
a team from the Univ. of Utah working in Grand Staircase-Escalante National Monument, southern Utah, has recorded 11 vertebrate localities preserving soft-tissue structures. Three of these sites are associated with dinosaur specimens: 1) a small ornithopod; 2) a 60% complete hadrosaur skeleton; and 3) a hadrosaur skull. Recovery and subsequent preparation of these specimens has resulted in a number of insights relating to the handling of fossilized vertebrate soft tissues both in the field and the laboratory. Dealing with soft tissue remains in the field and in the preparation lab is often problematic, since these remains—like vertebrate hard tissues—vary greatly in quality and preservational durability. One of the first obstacles is deciding what to preserve in situ, what to remove and retain from the specimen, and what to replace in order to carry out collection or preparation. As a general rule of thumb, it is best to delay this decision as much as possible until the specimen is in the lab, where preparation can occur in a more controlled setting. During field collection, wrapping smaller specimens in paper or cloth is usually sufficient for transport, but those specimens that are too large to pack out, or are associated with vertebrate fossils, should be encased within a protective plaster jacket. In some cases a consolidant may need to be applied, but use of adhesives should be minimal. Once back in the lab, abundant photographs should be taken before removal or destruction of any soft-tissue remains. Where possible, soft-tissue should also be molded with latex or silicon in order to preserve maximal information and enable placement of soft and hard tissues relative to each other at a later date.

Thursday 10:45
THIRNACODUS ST. JOHN AND WIRTHEN, AN ELASMOBRANCH FROM THE SERPUKHOVIAN HEATH FM. OF MONTANA
Isolated teeth of several species in the genus Thrinacodus have been described from the Famennian through Chesterian of Europe and North America. The type species is T. nanus St. John and Wirthen 1875, from the Kimeridgian of Kinderhook, Iowa, and the genus has been assigned to the cladombranchian Family Pholidosauridae. One complete and two partial specimens have emerged from the Upper Chesterian Bear Gulch Limestone, Heath Formation of Montana. The dentitions of the Montana Thrinacodus specimens are homodont, and differ significantly from previously described species in the genus. The dentition is homodont, consisting of tricuspid teeth on long, narrow, thick lingual bases. The cusps are subequal in length, elliptical in frontal section, strongly costate, widely divergently curving in anterior view, and posteriorly recurved. Bases of successional teeth are tightly overlapped and tooth families are closely packed together on the jaws. These observations together with data on gut contents present evidence of this dentition as a formidable piscivorous mill. The dentition is unusual in its elongated axial teeth, in the general proportions of the dentition, and in the incisive and canine teeth; the dentition is unique. A long, sturdy ethmoid, and lower jaws that project posterior to the occiput, articulate with the exoccipitals, and the posterior semicircular canal extending into the temporal emargination exhibited by both taxa. G. sonsali and G. sonsali are placed in the genus Thrinacodus based on the presence of a medially expanding triturating surface and deep temporal emargination exhibited by both taxa. G. sonsali differs from other baenids in having a large prefrontal with a medially expanded dorsal lappet that encloses the frontal from the orbital margin and forms a relatively large portion of the skull roof. G. sonsali shares two unique apomorphies with Stygolechus and Paladobatua. The triturating surface of the overall shape and robust nature of the skull of S. gilberti most closely resembles that of Stygolechus estesi. S. gilberti differs from S. estesi in having frontals that laterally enter the narial openings, small jugals that are restricted from the orbital margin, and the presence of a well-developed midline contact between the pterygoids.

A high-resolution phylogenetic analysis of the Baenidae supports the general phylogenetic framework of Gaffney and Meylan. The analysis supports the placement of both new taxa in the Euabenia. The analysis regards G. sonsali as the sister taxon to both S. estesi and S. gilberti. The placement of the two new taxa within Euabenia increases the group to eight taxa, with all but two of the taxa found in the Hell Creek formation. The addition of these taxa to the Euabenia indicates that this group was more diverse during the late Cretaceous than previously thought.

Wednesday 4:00
REFINED AGE OF THE LATE NEOGENE TERROR BIRD (TITANIS) FROM FLORIDA AND TEXAS USING RARE EARTH ELEMENTS
MacFADDEN, Bruce, LABS-HOCHSTEIN, Joann, HULBERT, Richard, Univ. of Gainesville, FL; BASKIN, Jon, Texas A & M Univ., Kingsville, TX
The giant flightless bird Titanis walleri (‘Phurusracoidae’) is known from three localities in Florida and one in Texas. At two FL sites (Port Charlotte and Inglis) the age of Titanis is constrained by associated late Blancan mammals. The age of Titanis at the other two sites, however, is problematical because this taxon co-occurs with temporally mixed faunas. Thus, prior to the current study, T. walleri from the Santa Fe River, FL (type locality) was either as old as late Blancan (~2.4 to 2.0 Ma) or as young as latest Rancholabrean (RBL, ~15 ka). Likewise, Titanis from a gravel pit along the Nueces River, TX was either as old as late Hemphillian (~5 Ma) or as young as latest RLB (~15 ka). This study uses Rare Earth Elements (“REEs”) to refine the age of Titanis from the two problematic sites. REEs occur in low abundances in living vertebrate skeletons, but are rapidly taken up during early diagenesis. Therefore, REEs in fossil bones and teeth are characteristically “locked in” as such. REEs preserve a distinctive signature of local geochemistry and environmental conditions for a short period of geological time. The REEs of Titanis (N = 6) from the Santa Fe River, FL were compared to two biochronologically unambiguous groups (Blancan [N = 17] versus RLB [N = 12]) of fossil mammals from the same locality. Similarly, the REEs of Titanis (N = 1, only specimen known) from the Nueces River, TX were compared to two groups (Hemphillian [N = 9] versus RLB [N = 10]) of fossil mammals from the same locality. The REE signatures of Titanis from FL are indistinguishable from those of the Blancan mammals of FL. Likewise, the REE signature of Titanis from TX is indistinguishable from those of the Hemphillian mammals of TX.

Given these REE constraints, the refined age of Titanis is late Hemphillian in Texas (~5 Ma) and late Blancan (~2.4 to 2.0 Ma) in Florida. No evidence currently exists for latest RLB Titanis in North America. As such, Titanis was an early immigrant during the Great American Interchange. Analyses of REEs preserved in vertebrate fossils have the potential to elucidate a broad range of age-related questions in Deep Time.

Poster Session II
REDESCRIPTION OF IEMANJA PALMAE (ACTINOPTERYGI: Pycnodontiformes) FROM THE ALBIAN OF THE SANTANA FORMATION, NORTHEAST BRAZIL
MACHADO, Lúcio Paulo, BRITO, Paulo, Universidade do Estado do Rio de Janeiro, Rio de Janeiro, Brazil
Pycodonts are a neopterygian fish clade considered to be sister group to tetrapods. Specimens of Iemanja palmae from the Santana Formation are among the best preserved pycodont specimens in the world, however much of its anatomy remains to be described. All anatomical knowledge on I. palmae is based on three specimens, one of them acid-prepared. Recent discovery and acid-preparation of new specimens of I. palmae revealed new anatomical features and allowed a better appreciation of its phylogenetic position. A series of previously heretofore undescribed characters were discovered in the new specimens, such as contour scales showing large spines, a ventral lateral line (previously reported only in Abramostyx timlachioni from the Late Cretaceous of Lebanon, among pycodonts), and the correct estimation of the body shape as discoid. Even more interesting is the discovery of preserved endocranial elements, very rare in pycodont specimens, such as prootics, exoccipitals, and a very large “supraoptic”. Some cranial features of I. palmae are unknown in other pycodonts, as for example the way in which the efferent pseudo-branched arteries of the lateral line system branch at the parapophysis, the “supraoptic” articulating with the exoccipitals, and the posterior semicircular canal extending into the occipital region. The revision of a series of characters indicate a more basal position for Iemanja palmae among the family Pycnodontidae.

Poster Session II
TWO NEW EUBAENINE (BAENIDEA: TESTUDINES) TURTLE TAXA FROM THE LATEST CRETACEOUS OF NORTH DAKOTA
LYSON, Tyler, Yale Univ., New Haven, CT; SCHACHNER, Emma, Univ. of Pennsylvania, Philadelphia, PA; HANKS, Harold, Marmarth Research Foundation, Marmarth, ND; TREMAIN, Emily, Kansas Univ., Lawrence, KS
Two new genera and species of nautiloid turtle are described based on well-preserved skull material found in the Hell Creek Formation (latest Maastrichtian) of North Dakota. Gameraebana sonson-lai, gen. et sp. nov., and Stygiocolys Gilberti, sp. nov., are placed in the Euabenia of the Baenidae based on the presence of a medially expanding triturating surface and deep temporal emargination exhibited by both taxa. G. sonson-lai differs from other baenids in having a large prefrontal with a medially expanded dorsal lappet that encloses the frontal from the orbital margin and forms a relatively large portion of the skull roof. G. sonson-lai shares two unique apomorphies with Stygolechus and Paladobatua. The triturating surface is unique. A long, sturdy ethmoid, and lower jaws that project posterior to the occiput, articulate with the exoccipitals, and the posterior semicircular canal extending into the temporal emargination exhibited by both taxa. G. sonson-lai and G. sonson-lai are placed in the genus Euabenia. The analysis regards G. sonson-lai as the sister taxon to both S. estesi and S. gilberti. The placement of the two new taxa within Euabenia increases the group to eight taxa, with all but two of the taxa found in the Hell Creek formation. The addition of these taxa to the Euabenia indicates that this group was more diverse during the late Cretaceous than previously thought.

Poster Session II
92A
Virtual Marsupials: An Application of Digital Reconstruction to the Cranial Anatomy of Extant and Fossil Marsupials

MAGA, Murat, The Univ. of Texas, Austin, TX
AUJM 2002-25 is an enigmatic marsupial from the Paleogene of Central Turkey, which consists of both cranial and postcranial elements. Although the postcranial skeleton of the fossil is strikingly complete, the cranial skeleton suffered heavy weathering. Maxillae, basioccipital, supraoccipital, squamosals, jugal and questionable petrosals are among the recovered fragments. The mandible is complete, but no significant portion of the cranium is articulated. AUJM 2002-25 shares with other metatherians a robust inflected angle of the palate, a well-defined posterior border of the vomers, a dorsoventrally thin basioccipital, and a depressed occipital condyle. AUJM 2002-25 lacks the anterior paroccipital processes that are characteristic of Eucosmia, Euparkeria, and Procaprus. AUJM 2002-25 is an early Miocene marsupial with many derived features of the postcranial skeleton. It is similar to other early Miocene marsupials in its postcranial anatomy and in the preservation of the postcranial skeleton. AUJM 2002-25 may be a representative of an early Miocene marsupial that lived in Central Turkey during the Eocene-Oligocene transition. AUJM 2002-25 provides new information on the evolution of early Miocene marsupials in Central Turkey and on the radiation of marsupials in the early Miocene.
Here, I applied visualization techniques to digitally prepare, and then investigate the cranial anatomy of this mammal fossil by comparing it to other extant and fossil taxa. Cranial fragments of a UM 2002-25 along with complete skulls of Didelphis and a North American *Peratherium* were micro-CT scanned. Individual bones that constitute the Didelphis skull were segmented using a commercial software, VG Studio Max. The same method was applied to the fossil specimens to the extent that the boundaries between bones could be identified. Then, by means of scaling, the isolated elements were compared visually to each other for any alometric differences due to size. Finally, the removal of the matrix within the maxilla of UM 2002-25 suggested preservation of a nasal fragment and some of the turbinals within the maxilla. For example, presence of a well developed flange along the lower edge of the dentary, a trait diagnostic for some species, is correlated with ontogeny and a fully developed flange only occurs in older, subadult individuals. Individual variation in the expression of this character during ontogeny is also observed for the Yixian Fm. species. Conversely, characters such as skull and orbit shape and denticle counts appear to show relatively little ontogenetic variation, which does not transcend character state boundaries. Novel understanding of character evolution gained through this study has important implications for the validity of some species of *Pistacocaurus* and also for the phylogeny of the group. This study demonstrates the potential of life history studies for understanding evolutionary patterns and processes in extinct clades.

Poster Session II

**A FOSSIL LORICARIIDAE (SILURIFORMES: LORICARIOIDEA) FROM THE TAUBATÉ BASIN, EASTERN BRAZIL**

MALABARBA, Maria, MCT-PUCRS, Porto Alegre, Brazil; LUNDBERG, John. The Academy of Natural Sciences, Philadelphia, PA

The Taubaté basin is a rift basin situated in eastern São Paulo (Brazil), in the area of the present Paraíba do Sul River. Its origin has been associated to continental break-up and opening of the Atlantic Ocean. The clay layers and greenish shales of the Tremembé Formation, the lacustrine unit of this basin, have been dated as late Oligocene-early Miocene. Siluriformes are commonly represented in the basin by articulated skeletons of the pimelodid *Steindachneridion*. However, loricariids are rare and some isolated body plates and finspines are the only findings recorded so far. In this paper, a new species of *Loricariid* from the Taubaté Basin, based on a sole specimen represented by a neurocranial ventral impression is described. It can be phylogenetically defined as a *Loricariidae* based on three derived characters: dorsal margin of the metapterygoid contacting the lateral ethmoid; a mesethmoid disk; and a pterotic fused with supracleithrum. Also, the Baudelot's loricariid forms a distinct wall, as occurs in most loricariids. Some characters assignable to *Loricariid* subfamilies or genera were preserved. Among the loricarian characters are: a wide and low parapneophthalmid, the shape of pterotic-supracleithrum and the size and position of the mesethmoid disk. The lateral ethmoid presents a longitudinal, low ridge and a posterior condyle for contacting the metapterygoid. The presence of this ridge is generalized in loricariids, but it is rounded and low in *Hipoptomus*, some loricariids, and most hypoptopomatines. On the other hand, this condyle is symmorphomorphic for *Hypoptomus* plus *Ancistrinae*. Still, it shows a pointed distal margin of transverse process with *Hypostomum* and a wide and low parapneophthalmid with *Rhinelepis*. A triangular and expanded lateral ethmoid is symmorphomorphic for some hypoptopomatines. The fossil still shares some characters with subgroups within *Loricariinae* such as a trapezoidal pterotic with the *Loricariini*. The derived characters recognized in this fossil, form a puzzled pattern that makes it hard its assignment to a subfamily, but allow us to distinguish it from the other known loricariid, assigning it to a new species.

**DIGITAL DINOSAUR BIOGEOGRAPHY: DISTRIBUTIONS AND 3-D PALEOBIOGEOGRAPHIC MAPPING OF CRETACEOUS ECOSYSTEMS**

MAIDMENT, Susannah, Univ. of Cambridge, Cambridge, United Kingdom

The paleobiogeography of the dinosaurs is of interest to researchers due to their diversity and wide geographic occurrence during the break up of Pangea. The congruence of Mesozoic tectonics and dinosaurian evolution offers a unique opportunity to test paleobiogeographic hypotheses. Thus, the paleobiogeography of dinosaurs was modeled with a series of ArcGIS maps as part of the PALEOMAP Project. Dinosaur distribution maps for the Late Cretaceous were produced in a time slice series as rectilinear projections (2-D), which provide a broad, global view. However, 2-D projections distort the polar regions. To resolve this, a series of 3-D ArcGlobe maps were produced to model dinosaur distributions without creating regional distortion. Cretaceous paleobiogeographic maps were developed to plot the distributions of ornithopods (hadrosaurs), ceratopsians (chamosaurines), sauropods (titanosaurs) and theropods (coelurosaurians) during the Late Cretaceous. Dinosaur distributions were then used to postulate paleobiogeographic patterns on 3-D paleobiogeographic globes. From the new Cretaceous maps, diversity and distributions of faunas were analyzed for patterns of distribution trends such as response to paleoclimatic variation with time/latitude and potential resource partitioning. Small scale faunal variances within North American faunas were used to subdivide Laramidia and Appalachia into quadrants; NW Laramidia, SW Laramidia, NE Appalachia and SE Appalachia. Cretaceous paleobiogeography is discussed with emphasis on rates of seafloor spreading, timing of land bridge formation and fluctuating eustatic cycles. The Beringian land bridge is considered as a biogeographic dispersal route between Eurasia and North America while the continued separation of Africa from South America and the advance of the Western Interior Seaway and Alpine Tethys are considered as significant impact on the understanding of saurischian locomotory evolution. Only recently did a functional analysis of the *Plateosaurus* elbow show that the hand could not take an active part in locomotion. This still leaves many of the arguments for quadrupedality unaddressed, especially the often voiced claim that *Plateosaurus* was heavy-feet, and could not stand balanced on the hind limbs.

By creating digital 3D models from laser and CT scans of a mounted skeleton at the Institute for Geosciences, Tuebingen, and individual bones, we show that this claim is based on significantly flawed reconstructions of the body shape of *Plateosaurus*. Erroneous placement of the scapulocoracoids, misshaping of the anterior body due to misalignment of the ribs, and misrepresentations of the tail lead to a shift of the center of gravity anteriorly in most mounts, reconstruction drawings and plastic models.

Kinenmatical computer analysis of our improved model in MSC.visualNastran 4D shows that *Plateosaurus* was well-balanced on the hind feet alone, and would be seriously unbalanced during locomotion when forced into a quadrapedal position. The additional claim (*Plateosaurus* cannot stand with the femur held subhorizontally enough to balance the skull) can also be shown false by the digital model, where only negligible forces are needed to keep the animal in the balanced posture.

We also modeled a scaled-down *Plateosaurus*, adapted to the size and proportions of known *Massospondylus* babies to investigate center of gravity position through ontogeny. We find that evolutionary development of saurischian locomotion is hardly understood. It appears that ontogenetic shift from quadrupedal to bipedal locomotion may be ancestral for saurischians, possibly making the permanent quadrupedal of sauropods a neotenous feature.
The underlying assumption of many track interpretations is that they represent surface features. Therefore, dimensional parameters (foot length (FL), stride length, etc.) on which speed calculations are based are interpreted as records of FL (sediment/foot interface). Laboratory track simulations coupled with observations of fossil tracks, casts serious doubts on the use of track length in such calculations of speed. Dinosaur tracks are often used to calculate FL of a trace-maker. FL in turn is used to estimate a trace-maker’s body height (h), when calculating the speed at which an animal was travelling, using a non-dimensional parameter, the Froude number, allowing comparison between animals of varying size using physical similarity theory. The resulting equation was written so that speed (u) is estimated from known values (h) (stride-length) and h (estimated by multiplying FL by 4).

\[ u = 0.255 \sqrt[3]{\frac{0.5}{g} h^{1.17}} \]

Since the first application of this formula it was clear that if h were overestimated, u would be underestimated. Creating large discrepancies in speed from fossil trackway data is not difficult; for example, a track length of 0.10 m gives a hip height (h) of 0.4 m. However, if the 0.10 m track was a transmitted feature and the true foot length measured 0.07 m, h should have been calculated as 0.28 m, meaning speed (u) from the larger track would be underestimated in excess of 25%. Such error can easily arise from how a track is measured or by being an incomplete transmitted, under or over-track feature. The recovery of subsurface track layers from laboratory simulations provides a useful method to reconstruct the 3D subsurface track geometry and morphology for comparison with ‘true’ surface track features. Information gained from the laboratory track simulations confirms that many fossil tracks collected and described are transmitted features and do not represent ‘true’ surface tracks. This has significant implications for the interpretation, taxonomy and wider application of all fossil vertebrate tracks.

THE PERFORMANCE OF STRATOCLASTICS UNDER GEOGRAPHICALLY VARIABLE PRESERVATION
MARCOT, Jonathan, FOX, David, Univ. of Minnesota, Minneapolis, MN; FISHER, Daniel, Univ. of Michigan, Ann Arbor, MI
Use of stratigraphic data in phylogenetic analysis remains contentious. Central to this debate is stratoclastics, in which optimal trees minimize both homoplasy and implied gaps in the fossil record. The implicit assumption in stratoclastics that probabilities of preservation of taxa are roughly equal within single time intervals has been criticized because violations might cause stratoclastics to yield incorrect phylogenetic estimates, and because preservation potential is known to vary among taxa and over both time and space. We explore one particular violation of equal preservation across taxa: variable preservation among geographic areas. This has been cited as a serious concern for stratoclastics and is one case in which stratigraphic data could consistently conflict with character data. Conflict arises if ancestral taxa existed in regions with poor preservation, and their descendants dispersed to other areas with better preservation, which could lead to descendant lineages being served earlier than their ancestors with some frequency. Other models of preservation can lead to such instances, but geographically variable sampling is one in which this might be the case systematically. In principle, geographically variable preservation should not affect conventional cladistics.

We addressed this by simulating clades and corresponding character and stratigraphic data. We simulated two geographic areas, one with low and one with high preservation probability. Simulations began in the area of low probability. At cladogeographic events, new species had a fixed probability of dispersing to the opposite region. We then analyzed each resultant data set with both cladistics and stratocladistics and measured the accuracy of both using the maximum correspondence between the resulting sets of trees and the true tree. The numbers of analyses in which one method outperformed the other were statistically indistinguishable; stratocladistics was at least as accurate as cladistics, even under these theoretically adverse conditions. These results indicate that stratocladistics is not systematically misled by geographically variable preservation under conditions explored thus far.
and other forms. Other structures are more difficult to identify and more derived specimen is from the SKULL, UCMP 77270 and modern avian and some fossil Theropod dinosaurs by means of geometric morphometric patterns of endocranial shape variation and integration at a macroevolutionary scale across phylogenetic integration and modularity at a phenotypic level. We have explored the major developmental biology research is making giant steps into unveiling the mechanisms under- sueted methodologies for the study of the organization and evolution of the phenotype, Shape analysis via Landmark-based Geometric Morphometrics is currently one of the best Autónoma de Madrid, Madrid, Spain MARUGÁN-LOBÓN, Jesús, Madrid, Spain; BUSCALIONI, Angela D., Universidad RIC MORPHOMETRICS AND MODULARITY OF THE ARCHOSAURIAN CRANIUM USING GEOMET-This charismatic theropod specimen has been stressed over time by a latex-lined jacket that abraded the transparently thin and topographically complex parts of the skull’s crest as the jacket cover was removed and replaced during study. Because access to this spectacular fossil is often sought, redesign of the clasmeshell that will permanently house the speci-men will be a crucial step in assuring the specimen’s future preservation. The use of a custom-fitted sandbox has allowed placement of sculpted acrylic elements at key areas of structural stress. These supports have allowed further preparation of the ventr-al surface of the brain case, which was previously unknown, un-photographed and unstud-ied to the specimen’s fragility, it could not have been turned upside down before. To reduce unskilled handling in the future, as far as possible with visual clues, an archival graphic device that warns in the international signs and symbols code, “DO NOT TOUCH”, was developed and placed on key areas of weakness. Protection of other speci-mens in our collection with similar problems of fragility, combined with near universally comprehensible of warning labels, is also now addressed. Wednesday 10:45 NEW MULTIPLE LATE JURASSIC DINOSAUR ICHNOCOENOCES OF SWITZERLAND: EVIDENCE FOR ENDURING DINOSAUR COMMUNITIES ON THE NORTHERN TETHYS PLATFORM MARTY, Daniel, PARATTE, Géraldine, Office de la culture, Porrentruy 2, Switzerland; MEYER, Christian, Naturhistorisches Museum Basel, 4001, Switzerland; BILLON- BRUYAT, Jean-Paul, AYER, Jacques, Office de la culture, Porrentruy 2, Switzerland Since 2002 dinosaur tracks are systematically excavated in Late Jurassic (Kimmeridgian) carbonate platform sediments (Canton Jura, Switzerland). This platform formed part of the Northern Tethys passive margin in Late Jurassic times. To date, over 55 essentially narrow-gauge trackways of sauropods, and over 90 trackways of bipedal, tridactyl dinosaurs chiefly attributed to theropods, have been excavated and documented on multiple (>15) track-bear-sing surfaces. This provides insight into track formation and taphonomy, in particular the dis-tinction of true tracks from under- and overtracks, a key point for consistent ichnokon-imal and paleoecological interpretations. Multiple ichnocones (associations of true tracks on a single surface) include (1) trackways of tiny (FL (footprint length)-25 cm) and large (FL>100 cm) sauropods with trackways of small (10<FL<25 cm) theropods; (2) trackways of tiny and medium-sized (25-FL<40 cm) sauropods with trackways of minute (FL<10 cm), small and medium-sized (25-FL<30 cm) theropods; (3) trackways of tiny and medi-um-sized sauropods with trackways of medium-sized and large (FL up to 50 cm) theropods. These ichnocones exhibit diverse trackway orientation patterns and trackways with changes in gait and gait of both sauropods and theropods. Even if these ichnocones only partially reflect the former terrestrial vertebrate ecosystem of the platform, they indi-cate a recurrent presence of diverse dinosaur communities, at least during periods with pro-longed inter- to supratidal conditions. The repeated associations of trackways of similar pat-terns and track morphology of very small and medium or large sauropods give a hint for dif-ferent age classes within a single species. Moreover, this suggests that—contrary to recent publications—stature and resulting trackway gauge of sauropods is not necessarily related to ontogeny. This might be corroborated by more ichnocones obtained by ongoing exca-vations. Finally, the paleogeographic situation implies that the platform was frequently con-nected to continental landmasses. This probably prevented a development of insular, dwarfed faunas, as has been postulated for similar carbonate platform settings. Friday 9:30 THE CRETACEOUS OF ANGOLA MATEUS, Octávio, Lourinhã, Portugal; MORAIS, Maria, Universidade Agostinho Neto, Luanda, Angola; SCHULP, Anne, Naturhistorisches Museum Maastricht, Maastricht, Netherlands; JACOBS, Louis, POLCYN, Michael, Southern Methodist Univ., Dallas, TX The terrestrial faunas of Angola have long been known to be richly fossiliferous, but until recently no continuous vertebrate paleontology and collecting has been undertaken since the pioneering work of Miguel Telles Antunes in the early 1960's. In May 2005, two of us (O.M. and L.I.J.) performed a short field reconnaissance in the Angolan provinces of Namibe and Bengo, from where rich Cretaceous faunas, including mosasaurs, fishes, tur-tles, plesiosaurs and other marine taxa have been known, bringing to light the first dinosaur from Angola, a Late Turonian non-titanosaurian sauropod. The stratigraphic sequence extends from the Early Cretaceous (Barremian, 128 Ma) through the Neogene, making this the longest continuous fossiliferous section known in Africa. In addition to dinosaurs, this section records (1) the formation of the eastern mar-gin of the South Atlantic Ocean; (2) a nearly continuous and biostratiographically significant sequence of sharks and bony fishes that record changes in oceanic currents; (3) the opening of the Atlantic Ocean and the disruption of a land connection between South America and Africa; (4) the biogeographic invasion of the South Atlantic by marine amniotes, including turtles, plesiosaurs, and mosasaurs; (5) interbedded nearshore marine and igneous rocks; (6) a superbly exposed Cretaceous-Paleogene Boundary section; (7) Paleogene squamates and turtles; and (8) Neogene cetaceans and a rhinoceros. © 2006 by the Society of Vertebrate Paleontology
Besides the rich fish fauna, the known Cretaceous tetrapod fauna comprises turtles (including a recently collected undescribed genus of cryptodiran), mosasaur squamates Globidens sp., at least two Prognathodon-like taxa, Angolasaurus bocagei, Plioptolepiscus sp. and Tylotosaurus tetembeus, pleisosaurs aff. Cimoliasauridae, and a non-titanosaur sauropod dinosaur.

Friday 9:30

COMPARISON OF NEONEGNE RECORDS OF ENVIRONMENTAL CHANGE IN THE GREAT PLAINS, U.S.A., BASED ON PALEOSOL CARBONATES AND PALEODIETS OF EQUIDAE

MATSON, Samuel, FOX, David, MARCOT, Jonathan, Univ. of Minnesota, Minneapolis, MN; JANIS, Christine, Brown Univ., Providence, RI

Neogene records of environmental change in the Great Plains, U.S.A., derived from paleosols and paleodietary studies of fossil Equidae exhibit surprising contrasts. The stable carbon isotope composition (δ13C) of paleosol carbonates suggests C4 grass comprised 20% of plant biomass throughout the Miocene, increased to about 40% of biomass by the early Pliocene, and reached modern abundance by the early Pleistocene. Equids evolved high-crowned (hypodont) teeth, an adaptation for open habitats and/or grazing by ca. 18 Ma, and δ13C values of equid tooth enamel indicate C3-dominated diets during the Miocene until 6.6 Ma, at which point several species began to consume C4 vegetation while others maintained C3-dominated diets. To understand these contrasts better, we examined equid paleodiet in the context of a genus level phylogeny. Hypsodonty increased in parallel in several lineages and high δ13C values characteristic of C4 consumption arose independently within several derived genera nested within the tribes Equini and Hipparionini. Evolution of hypsodonty and consumption of C4 biomass does not appear to have promoted taxonomic diversification. Average magnitudes of evolutionary changes across the phyloge- ny towards increased hypsodonty and δ13C values were greater than those towards decrease, consistent with directed trends, but the patterns were not sufficiently distinct to reject null hypotheses of passive trends. A weak negative correlation between δ13C values and stratigraphic range in equid genera suggests C4 consumers may have had higher extinction rates. A possible explanation for the low variability in Miocene paleosol δ13C values is that habitats dominated by C4 grasses were patchily distributed across the landscape and migrated laterally on timescales rapid relative to carbonate formation; shorter-lived, C4-consuming genera may have been specialists that utilized C4-dominated patches and habi- tat change was sufficiently rapid to promote greater extinction. Parallel analyses of clades with similar diversity histories in the region, such as Camelidae, could help elucidate the basis of the contrasts between paleosols and equids.

Poster Session II

ISOTOPIC AND GEOCHEMICAL ANALYSES OF FOSSIL FISH REMAINS FROM THE UPPER DEVONIAN ESCUMINAC FORMATION (MIGUASHA, QUEBEC): IMPLICATIONS FOR PALEOVENOMONAL INTERPRETATION

MATTON, Olivier, STEVENSON, Ross, CLOUTIER, Richard, Université du Québec à Rimouski, Rimouski, QB, Canada

Devonian Old Red Sandstone fish assemblages have been classically considered to be fresh-water in origin. This includes the Escuminac assemblage, renown for the abundance and quality of preservation of fossil vertebrates as well as for the phylogenetic and evolutionary importance of its biota. However, the paleoenvironmental context of the Escuminac Formation is still a matter of debate, ranging from lacustrine to marine, with a recent conclusion that the Escuminac Formation is marine. In order to examine the development of these assemblages, we undertook a study on the isotopic and geochemical variability of different fish species (acanthodian Bothriolepis canadensis, osteolepiform Homalacanthus concinnus, acanthopterygian Chondrichthys canadensis, placoderm Bothriolepis canadensis, dipnoan Scamena macuta, osteolepiform Eusthenopteron foordi) from the base to the top of the Escuminac Formation. The isotopic analyses were performed by Thermal Ionisation mass spectrometry (TIMS) and compared with δ13C and δ18O values of fossil fish material. Apatite-bearing anatomical structures (e.g., teeth, bony plates, scales) of different fish species (acanthodian Homalacanthus canadensis, acanthopterygian Chondrichthys canadensis, placoderm Bothriolepis canadensis, dipnoan Scamena macuta) were studied for stable isotope enrichment. The third UCMP pareiasaur skull may constitute a new taxon within the genus Bradysaurus. The three UCMP pareiasaur skulls belong to the most basal pareiasaur genus Bradysaurus. The most basal taxon of this genus, Bradysaurus seeleyi, possesses a unique, therefore the generic name Bradysaurus can be considered a metataxon. Two of the three UCMP pareiasaur skulls are assigned to the other existing taxon within the genus, Bradysaurus baini. B. baini possesses three autapomorphies that separate it from B. seeleyi: a large round lump on the maxilla immediately behind the external naris, a swollen distal portion of the paroccipital process and teeth of the upper jaw directed ventromedially.

The third UCMP pareiasaur skull may constitute a new taxon within the genus Bradysaurus due to three potential autapomorphies, though further comparative work is required to confirm or deny the existence of a new species. The three autapomorphies are: a large boss flanking the anterior portion of both nasals, supratemporal bosses that rise above the skull roof to form a saddle between them, and a posteriorly facing shelf posterior to the ridge that is formed between the supratemporal bosses. This potentially new taxon also possesses all three autapomorphies of B. baini, which would make those charac- ters synapomorphic for both taxa. This would establish these two taxa firmly as sister groups, which results in B. baini as yet another taxon within the genus Bradysaurus that possesses no autapomorphies and could therefore be considered a metataxon.

Poster Session III

THE ANATOMY OF THE EMU WING: AN EXAMPLE OF PRIMARY DIGITAL REDUCTION IN ARCHOSAURIA

MAXWELL, Erin, MICHEL, Adam, LARSSON, Hans, HEPPLESTON, Audrey, McGill Univ., Montreal, QB, Canada

The Emu (Dromaius novaehollandiae) is a palaecognathous bird native to Australia that has undergone extreme wing reduction, both in relative size and in the number of ossified ele- ments. It usually ossifies only a single digit corresponding to the digitum major in other birds, and has no free carpal elements. This digital reduction is thought to have taken place over a very short evolutionary timescale, and is indicative of the loss of flight in the Emu from the rest of the ratites. In order to examine the development changes accompanying such an extreme adult morphology, we studied the mesenchymal skeletal tissue of a series of early stage Embryo embryos. We also cleared and stained sets of later stage embryos for the presence of bone and cartilage. Our results indicate that the Emu is the only known example of primary digit reduction in birds. In other words, unlike the state in Ostrich (Struthio) in which five digits chondrify, or the chicken in which five digits condense and four chondrify, only three to four digits condense and three chon- drify in the Emu. Furthermore, while the number of elements ossifying in flying birds as well as in the Ostrich is constant, the Emu ossifies either one or two digits. There is a wide range of variation in terms of shape, number and position of the elements that remain car- tilaginous in late stage embryos. This variability is also seen at the level of wing muscula- ture in adult Emus. This variation in digit number and shape is similar to that observed in the Kiwi, a New Zealand procellariiform that has independently converged on a reduced wing morphology. Emus differ from other birds in that they ossify the distal phalans of their sin- gle digit first. This is most similar to the pattern seen in the pes of other birds (including the Emu); the manus normally ossifies in a proximal-distal direction. Digital reduction has taken place multiple times in birds, and in the theropod lineage more generally. This research sheds light on some morphological and developmental changes that result in a sin- gle-digit phenotype in an adult tetrapod.

Poster Session III

ADULT SKELETAL REMAINS OF IANTHASAURUS, THE OLDEST KNOWN EDAPHOSAUR (SYNAPSIDA: EUPELYCOSAURIA) FROM THE UPPER PENN- SYLVANIAN OF KANSAS

MAZIERSKI, David, REINZ, Robert, Univ. of Toronto at Mississauga, Mississauga, ON, Canada

Infills of an abandoned channel near Garnett, Kansas preserve the most abundant and diverse assemblage of amniotes known from the Carboniferous. Most of the vertebrate remains recovered from the locality are those of terrestrial tetrapods. The most commonly found skeletal remains belong to the diapsid reptile Petrolacosaurus and the sphenacodontid Hylaeosaurus. However, other synapsids, represented either by single speci- men or relatively few individuals include an undescribed ophiacodontid, an undescribed sphenacodontid, the rare and enigmatic Xyropsodius, and the sphenacodontian Ianthodon. The sixth synapsid is the edaphosaur Ianthasaurus hardeyestorm, known from two frag- metary skeletons and a few isolated vertebrae, all belonging to juvenile individuals. Recently recovered parts of a skeleton of Ianthasaurus represent an adult individual. Its adult condition is indicated by its large size, 30% larger than all previously known speci- mens, and the fusion of the neuro-central suture. Ianthasaurus is the oldest known member of Edaphosauridae, and significantly smaller than any of the better known members of this clade. The new specimen provides important new, phylogenetically informative cranial and vertebral features. The maxilla is long, wide for at least 32 teeth; both the marginal and palatal teeth are slightly bulbous near their apex, resembling those in the oldest known herbivorous amniote Edaphosaurus. The anterior part of the preygued is shorter than in the carnivorous sphenacodontids, and similar in relative length to that in Edaphosaurus. The tall neural spines have up to eight pairs of lateral tubercles, nearly twice as many as on the vertebrae in the comparable region of the column of the juveniles. These adult skeletal features indicate that Ianthasaurus may be more closely related to the large Edaphosaurus than pre-
vously considered. However, despite the presence of the modified dentition, the teeth on the transverse flange of the pterygoid are unlike those in Edaphosaurus in being nearly twice as large as those on the rest of the palate, indicating that Ianthasaurus may have had an omnivorous diet.

Poster Session I
REASSIGNING GLOSSOTHERIUM CHAPADMALENSE AND INCREASED SPECIES DIVERSITY IN PARAMYLODON (MAMMALIA: XENARTHRA)
MCFEELY, Robert, Northern Illinois Univ., DeKalb, IL
Speciess diversity of the mylodontid sloth Paramyloodon is low, with only one species, P. harlani, currently recognized from the Irvingtonian and Rancholabrean of North American. Recent investigations of cranial characters and morphology have validated the continued separation of Paramyloodon from the South American genus Glossotherium, and have created an opportunity to address the species diversity of the northern genus. A possible second species is known from Blancan deposits but has remained in relative limbo as “Glossotherium” chapadmalense; due in part to a small number of available specimens for comparative studies. Using new generic characters generated for Glossotherium and Paramyloodon, crania belonging to “G.” chapadmalense were studied to establish its true placement within one of the two genera. Examination shows “G.” chapadmalense to have a greater affinity with Paramyloodon, as has been suggested by some authors. Characters uniting the two include: a well-defined parasagittal crest, relating to a larger fossa for the M. temporalis; palatine bones extended more posteriorly behind M4; a low angle of tooth-row divergence; skull width across the lacrimals nearly equal to those across the post-orbitals; and the size and position of the basilar tubercles. These results expand our assessment of Paramyloodon, repositioning it as a distinct genus which migrated into North American during the Blancan and then evolved into the larger Irvingtonian-Rancholabrean form.

Poster Session III
DEPOSITIONAL ENVIRONMENT AND TAPHONOMY OF A THERIZINOSAURID (DINOSAURIA) FROM THE TROPIC SHALE (CENOMANIAN-TURONIAN), KANE COUNTY, UTAH
McCORMICK, Kaitlin, Northern Arizona Univ., Flagstaff, AZ; HORTON, Travis, JOHNSON, Ben, Univ. of Puget Sound, Tacoma, WA; GILLETTE, David, Museum of Northern Arizona, Flagstaff, AZ
Fieldwork in the Tropic Shale (Cenomanian-Turonian) in southern Utah has resulted in the recovery of several vertebrate fossils, including a therizinosaurid, a terrestrial dinosaur. How a one to two ton terrestrial dinosaur was preserved relatively intact 100 kilometers from the paleoshoreline seems contradictory with the numerous predators in the Cretaceous Western Interior Seaway. The depositional environment of the therizinosaur site and other plesiosaur sites was investigated to determine if there are similarities in setting. Preliminary clay mineralogy and foraminiferal biostratigraphy results indicate a normal, offshore marine environment. X-ray analysis of the clay mineralogy demonstrates no significant variation in clay mineral percent. Planktonic foraminifera present indicate shallow water up to 100 m deep and the benthonic foraminifera present indicate normal marine salinities. δ18O values determined for calcite cements at the therizinosaur fossil site range from ~5.5% to -6.2% (PD) from a 1.5 mm thick section surrounding the bone layer. These values fall in between calculated Cretaceous meteoric water δ18O values (~10‰) and normal marine δ18O values. Petrographic analysis of the bone layer shows that extensive carbonate diagenesis has not occurred; calcite δ18O values at least partially record primary paleoenvironmental conditions. The presence of aragonitic shell material, as identified by X-ray diffraction, further supports this interpretation. In contrast to the clay mineralogy and foraminiferal biostratigraphy results, the stable isotope data suggest the therizinosaur was deposited in a mixed water setting such as an estuary. The therizinosaur probably died along the shoreline and swept out to sea, the carcass bloated and floated until the gases escaped and sank into the muddy bottom of the seaway. The therizinosaur sites was investigated to determine if there are similarities in setting.

Tuesday 2:00
A BIOMECHANICAL MODEL OF SMILODON FATALIS BASED ON FINITE ELEMENT ANALYSIS
McHENRY, Colin, Univ. of New South Wales, Sydney, Australia; CUNNINGHAM, Eleanor, Newcastle Mater Hospital, Waratah, Australia; WROE, Stephen, Univ. of New South Wales, Sydney, Australia; PENDHARKAR, Atul, CLAUSEN, Philip, Univ. of Newcastle, Callaghan, Australia
How do we reconstruct behaviour in extinct species? Since behaviours result in forces and loads that act upon an animal’s skeleton, biomechanical analyses can summarise the range of forces that a given skeleton could have resisted. This information can be used to assess the range of behaviours that a species was capable of.

This approach is particularly useful when dealing with extinct taxa that have no clear living analogue. The saber-toothed cat Smilodon fatalis is one such taxon and the behaviour of these iconic predators remains the source of perennial debate. Hypotheses of their killing technique vary with respect to: (1) the placement of the killing bite—was it directed at the throat or “belly”—and (2) whether the bite itself was adapted from that applied by more generalized cats (the canine-shear model), or was it a fundamentally different, largely neck driven stabbing bite.

Finite element analysis (FEA) is a numerical engineering approach that can simulate mechanical behaviour in complex structures, and the use of FEA in biomechanics is growing as technological advances allow biologists to explore the mechanics of even complex biological structures, such as carnivoran skulls. We have constructed finite element models of the skull and mandible in Smilodon fatalis and the African lion Panthera leo. Models were generated upon CT data, and included the behaviour of the jaw adductor muscles and the temporal-mandibular joints. A range of load cases, based upon published descriptions of behaviour in African lions and hypothesized behaviours in sabretooths, were applied to each model and the mechanical performance of each model was quantified. The differences and similarities in mechanical performance of each model allow the biomechanical performance of the S. fatalis skull and mandibles to be discussed with reference to the biomechanics of the lion. Our results have important implications for the interpretation of behaviour in this extinct predator.

Poster Session I
AGING PANTHERA ATROX FROM RANCHO LA BREA
MEACHEN, Julie, UCLA, Los Angeles, CA; BINDER, Wendy, Loyola Marymount Univ., Los Angeles, CA
The Rancho La Brea tar seeps are well known for their unusual preservation of more carnivores than herbivores. This may reflect repeated episodes of entrapment of carnivores feeding on a mixed herbivore. Possibly, the tar seeps attracted a vulnerable segment of large carnivore populations, such as the very old, injured, or young and naïve. Here, we use a radiographic aging technique to assess the age distribution of American lions (Panthera atrox) preserved at Rancho La Brea. African lions, Panthera leo, have been aged using a combination of cranial and dental features and pulp cavity diameter of the canine teeth. The diameter of the pulp cavity shrinks as the animal lays down dentin with age. P. atrox is closely related to the African lion, but cranial and dental features that could be used to age them may have different growth rates attributable to size difference in the two species. Previous work used tooth wear to age individuals, but this can be confounded by diet. The closure of the dental pulp cavity may be a more reliable method to age P. atrox and is unlikely to be affected by functional differences. Here, we estimate the relative age of individual P. atrox at Rancho La Brea by comparison with a sample of African lion skulls from museum collections.

Ages of wild African lions were estimated using a combination of craniodental features and radiographs of the dentaries. Cranial and dental age estimates were correlated with the extent of canine pulp cavity closure. Radiographs of all P. atrox dentaries in the Rancho La Brea collection were taken and the lower canine pulp cavity diameter measured. The pulp cavity dimensions were compared with those of the African lions to estimate their age at death. The ages of individual lions at Rancho La Brea were found to span a fairly wide range. Most individuals were young adult to middle-aged at death, and there was no evidence of predominance of old individuals.

Poster Session II
LATE QUATERNARY PYGOPUS AND DELMA (PYGOPODIDAE) AND RAMPHELOTHYLOPSIS (TYPHLOPIDAE: SQUAMATA) FROM WESTERN AND SOUTH AUSTRALIA CAVE DEPOSITS
MEAD, Jim, HOLLENHEAD, Marc, SWIFT, Sandra, Northern Arizona Univ., Flagstaff, AZ
New species of living squamates of Australia are still being described even though there is a profusion of published articles concerning the modern fauna. In vivid contrast, the fossil lizard fauna is still poorly known. The pattern of evolution and the geographic distribution of squamates dating from the Oligocene to Plio-Pleistocene are better known than those of the Holocene and Pleistocene. The deposits at Riversleigh, Queensland, have produced most of the earliest squamates from the continent, along with the oldest and only pygopod (Pygopodus hortulanus; Pygopodidae) and vertebrate assigned to Ramphelethylopsis (Typhlopidae). Cave deposits in Western Australia, excavated during the 1950s-1990s for late Quaternary mammalian and archaeological contents have produced 100s of squamate fossils. Skeletal remains of Pygopus and Delma recovered from Hastings Cave (Jurien coast) and Webbs and Wombat caves (great Nullarbor Plain) of Western and South Australia provide the first Quaternary record of these pygopod genera. Hastings Cave and the well-known Madura Cave (greater Nullarbor Plains) have also produced vertebrates of Ramphelethylopsis. Our overall project includes an ongoing description of cranial morphology of modern squamates along with their distribution and evolution in WA during the Neogene.

Poster Session I
KINEMATIC ANALYSIS OF STRIKE BEHAVIOR IN CROCODILIANS: IMPLICATIONS FOR THE EVOLUTION OF CRANIAL MORPHOLOGY AND ECOLOGY
MEERS, Mason, Univ. of Tampa, Tampa, FL; McHENRY, Colin, Univ. of Newcastle, Callaghan, Australia
The functional morphology of crocodylian crania has been the subject of much debate in the recent past, particularly with regard to flattening of the rostrum and its mechanical and
hydodynamic tradeoffs. Recent work, for example, has shown that the platyrostral morphology is well adapted to resist torsional loads likely experienced by many taxa during feeding. It follows then that the specific morphology of the rostrum may be constrained by other factors, including hydodynamic properties of the rostrum. Crocodylians typically strike prey items by means of a rapid, lateral sweeping motion of the head, resulting in prey capture near the middle to distal portion of the rostrum. The effectiveness of this kinematic pattern is profoundly affected by the morphology of the structure being accelerated through the water. In order to examine the possible effects of hydodynamic constraints on crocodylian morphology, we examine the kinematics of feeding crocodylians. Specifically, strike behavior is quantified in the American alligator (Alligator mississippiensis), with pilot data also collected for the American crocodile (Crocodylus acutus), using high speed videography. The results of the kinematic analyses are discussed in the context of extant and extinct crocodylian cranial morphology, which varies relatively widely from short, broad snouts to extraordinarily longirostrine taxa. It is apparent from our analyses that rostral morphology largely reflects hydodynamic constraints imposed by prey choice and availability. The evolution of crocodylian rostral form is then discussed in phylogenetic and functional contexts.

Poster Session II

CONGRUENT AFTER ALL—A NEW LOOK AT THE CHEEK AND PALATE OF PLACODUS GIGAS

MERCK, John, Univ. of Maryland, College Park, College Park, MD
Examination of the cranial material of the familiar placodont Placodus gigas indicates a revision of its temporal and basicranial osteology. Phylogenetic analyses of the last decade agree on the position of Placodontia as the sister taxon of Eosauropterygia within Sauropterygia, and on its general phylogenetic structure. The evolution of some diagnostic cranial characters within Placodontia has been less clear, however. Although often treated as the “classic” placodont, Placodus as currently described, displays atypical configurations of the squamosal/quadratojugal relationship and the basiocciput for Placodus, raising questions about their evolution and polarity within Sauropterygia. In other placodonts for which it is known the quadratojugal is broad and tall, closely approaching the supratemporal fenestra, whereas in Placodus, it is seen as confined to the lower third of the cheek plate. In those cyamodontoids in which it can be assessed, the basipterygoid processes are broad and closely applied to the pterygoids and palatines anteriorly, whereas in Placodus they are typically shown as cylindrical and visible in posterior view. This view of Placodus is based largely on the complete skull BP13 in Bayreuth. Reexamination of this and other material, notably BSP 1968175 in Munich, suggest that in both respects, Placodus follows the pattern seen in other placodonts, with a broad, tall quadratojugal and anteriorly directed basipterygoid articulation. While not altering placodont phylogeny per se, this revision influences our understanding of the polarity of these features’ evolution in Eosauropterygia and has implications for the homology of temporal elements in ichthyosaurs.

Wednesday 2:15

A PHYLOGENY AND TIMESCALE FOR MARSUPIAL EVOLUTION

MEREDITH, Robert, Univ. of California Riverside, Riverside, CA; WESTERMAN, Michael, La Trobe Univ., Victoria, Australia; CASE, Judd, St. Marys College of California, Moraga, CA; SPRINGER, Mark, Univ. of California Riverside, Riverside, CA
Even though marsupials are taxonomically less diverse than the placental mammals they exhibit a morphological and ecological diversity that is comparable as a result of their long and often isolated evolutionary history. However, much of their fossil record is missing. This problem is most evident for the Australasian groups. The approximately 300 living species of marsupials are grouped into three American (Didelphimorphia, Microbiotheria, and Paucituberculata) and four Australasian (Dasyuromorphia, Diprotodontia, Notoryctemorpha, and Peramelemorpha) orders. Higher-level interrelationships have been investigated using a wide range of methods that have often yielded contradictory results. Much of the controversy has focused on the placement of Dromiciops (Microbiotheria). Studies either support a sister-taxon relationship to a monophyletic Australasian clade or a nested position within the Australasian radiation. Familial relationships within the Diprotodontia have also proved difficult to resolve. Here, we examine higher-level marsupial relationships using a nuclear multigene molecular data set representing all living orders and employ a relaxed molecular clock to present a timescale for marsupial evolution. Using the molecular divergence dates and the known fossil record we estimate the completeness of the marsupial fossil record. Preliminary results support a paraphyletic Ameridelphia with Didelphimorphia sister to all other marsupials. Within Austridelphia, Dromiciops is the sister-taxon to a monophyletic Australasian clade. Within the Australasian clade, Diprotodontia is the sister taxon to Notoryctemorpha, Dasyuromorphia, and Peramelemorpha clade. Within the Diprotodontia, the wombat koala clade is the sister taxon to a paraphyletic possum clade (Phalangeriformes) with kangaroos nested inside. Estimated dates of divergence suggest a Late Cretaceous date for all interordinal divergences. All intrordinal divergences were based largely on the complete skull BP13 in Bayreuth. Reexamination of this revision influences our understanding of the polarity of these features’ evolution in Eosauropterygia and has implications for the homology of temporal elements in ichthyosaurs.

Poster Session II

REVISION OF MIOCENE MACKAREL SHARKS (CHONDRICHTHYES, LAMNIFORMES), WITH SPECIAL REFERENCE TO “ISURUS” ESCHERI FROM NORTHERN GERMANY

MEWIS, Heike, KLUG, Stefanie, Museum of Natural History, Palaeoentology, Humboldt-Universität Berlin, Berlin, Germany
Generally, Cenozoic lamniform sharks are represented by isolated teeth and vertebrae. Articulated skeletal remains are conversely very scarce. In 1989, a partially articulated skeleton of a specimen referable to “Isurus” escheri including 42 slightly disarticulated teeth and 49 vertebrae was recovered from Miocene clays during an excavation of whales in Groß Pampus (northern Germany). This specimen proves to be important for reconstructing the relationship of fossil lamniform sharks because it provides morpho-meristic data of the vertebral column and allows us to reconstruct the deminution of this taxon. It is the first and, until now, only time that more than few isolated teeth of this species have been found. Here, we are presenting results of our study of this specimen and other lamniform sharks such as Carcharodon carcharias, “Carcharodon” megalodon, “Isurus” hastalis, and “Isurus” escheri using dental and skeletal characters to create a modified phylogenetic hypothesis for Cenozoic lamniform sharks and to gain a better understanding of the evolution of the modern White Shark. There are two hypotheses on this topic: either “C.” megalodon or Isurus (e.g., “I.” hastalis) was the predecessor. Isurus is generally abandoned now after reintroducing the name Cosmopolitodus. There is genetic and now also fossil evidence that the mako and great white lineages must be separated. But even if Cosmopolitodus is accepted to be valid, the taxonomic identity of species such as “I.” planus and “I.” escheri remains ambiguous. In addition, the processes responsible for the evolution of “big” lamniforms in the Miocene are analysed and compared with that of teleosts and whales to gain a better understanding of the mechanisms underlying the size increase in these sharks.

Poster Session III

INSECTIVORES OF CHADRONIAN AGE FROM THE CYPRUS HILLS FORMATION, SASKATCHEWAN

MEYER, Taran, Univ. of Saskatchewan, Saskatoon, SK, Canada; BRYANT, Harold, Royal Saskatchewan Museum, Regina, SK, Canada
The Cypress Hills Formation of Saskatchewan preserves sediments of Uistant (middle Eocene) to Hemingfordian (middle Miocene) age, but the best-represented period is the Chadronian North American Land Mammal Age. The best-known site, with the highest known biodiversity, is the middle Chadronian Calf Creek Locality, from which over 70 mammal and 25 non-mammal species are known. The Calf Creek material was recovered from two sub-localities: the Hunter Quarry, which produced relatively complete skeletal elements of larger bodied taxa including bronchotheres, and the screening sub-locality, which is located opposite the quarry on the other side of a small coulee. The majority of these taxa have been described in the literature, but the portion of the fauna which includes the “insectivores,” members of the orders Leptictida, Apatotheria, and Lipotyphla, have not been formally described.

The current research undertaken to identify and describe the insectivores of the Calf Creek Locality, together with the insectivores from the nearby Chadronian-aged Horse Locality. The latter served two purposes: (1) to begin the formal description of material from the Horse Locality, and (2) to compare the two faunas to identify possible differences between the two. The insectivore faunas of the two sites were found to be very similar, with the same genera and species occurring at both localities. Although the non-insectivore taxa suggest that the Horse Locality dates from either later in the middle Chadronian or the Late Chadronian, in the groups studied here an evolutionary change between the Calf Creek and the Horse localities could not be detected. Taxa described at these sites include:

Poster Session I

IS THE CLADE CETERUMNANTIA RELEVANT? REVIEW OF MORPHOLOGICAL CHARACTERS IN EARLY SELENODONTIA AND ARCHAEOCETES

MÉTAIS, Grégoire, BEARD, Chris, Carnegie Museum of Natural History, Pittsburgh, PA
New fossil discoveries of postcranial material of early whales show they share what had been thought to be a key synapomorphy of artiodactyls, the double-trochleated astragalus. This character is consistent with molecular data that strongly support a close relationship between whales (Cetacea) and artiodactyls, with numerous studies nesting Cetacea deeply within a paraphyletic Artiodactyla. Recent molecular analyses identified three successive basal clades within artiodactyls: Tylopoda, Suina, and Cetrumniota containing Ruminantia and Cetanodontia (hippos and cetaceans). Moreover, estimates of divergence time between between Ruminantia and Cetanodontia indicate about 60 Ma, thus implying several long ghost lineages yet to be discovered in the early history of the Tylopoda and Suina, both of which first appeared in the middle Eocene. The phylogenies of cetartiodactyls based on morphological data tend to support the existence of a clade Seconodontia including Tylopoda and Ruminantia. Here we review the relevance of the clade Ceteruminantia in the light of morphological data and the fossil record of both Seconodontia and archaeocetes. It appears that these discrepancies between morphological and molecular data sets are probably biased by the inconsistency of the current fossil record of artiodactyls in Asia, and the resulting poor resolution of the phylogenetic relationships between Asian, European, and North American. Although the emergence of Ruminantia in the Paleocene appears unlikely, the analysis of the early evolution and definition of the basal Seconodontia is of critical importance for testing the validity of the clade Ceteruminantia.
Leptictida—Leptictis sp.; Apatotheria—Sinclairella sp.; Lipotyphla—Apterodipus sp., Micropternodus strophinodes, Dominia thompsoni and D. graudatu, Centodon chadronensis, Oligoryctes altitidum, and Cryptoryctes sp. Specimens of the possible chirotteran, Wallia sp., are also described.

Student Poster Session

AN ANALYSIS OF NORTH AMERICAN MERTES (CARNIVORA; MUSTELIDAE) CRANIA USING GEOMETRIC MORPHOMETRICS AND ITS IMPLICATIONS FOR THE STATUS OF THE EXTINCT TAXON MERTES NOBILIS
MEYERS, Jeffrey, Northern Arizona Univ., Flagstaff, AZ
First described by Hall in 1926, the taxon Martes nobilis (M. caurina nobilis), a Pleistocene variant of the North American pine marten, was initially recognized from specimens recovered from the Samwel and Potter Creek caves, Shasta County, California. Hall differentiated M. nobilis from the extant pine marten, M. americana, largely through qualitative observations based on the size divergence between the modern and extinct taxa, the latter being generally more robust. Since Hall’s description, the validity of M. nobilis as a taxon separate from M. americana has been controversial. For example, Anderson supported the division between M. nobilis and M. americana whereas more recent work by Youngman and Schueler, synonymized the two taxa. In my investigation of both modern and fossil taxa, geometric morphometric techniques, in addition to statistical and ordination analyses, were brought to bear on the issue of the binomial validity of M. nobilis. Using these techniques, a comprehensive examination of the modern cranial morphology variance of Martes was undertaken. Present data indicate that the use of geometric morphometrics can accurately distinguish members of the genus Martes, even at the subspecies level. A canonical variate analysis (CVA) was applied to the partial warp scores obtained from the basiocciput of 14 different modern subspecies of Martes. The program was able to correctly identify these modern crania (n=90) to subspecies with 99.8% accuracy. All crania were placed into their correct subspecies except for one specimen, which was incorrectly placed in the adjacent morphologically most similar subspecies. This likely suggests the existence of subspecifically specific divisions of the genus Martes can be accurately discerned using geometric morphometrics. As a result, it can be determined whether specimens of M. nobilis fall within the range of variance of modern North American, independent of linear body size.

Thursday 2:15
AN OVERVIEW OF PALEONISCOID ACTINOPTYERYGIAN VERTEBRAE FROM THE BEAR GULCH LIMESTONE OF MONTANA
MICKLE, Kathryn, Lawrence, KS
The Bear Gulch Limestone (Serpukhovian, Mississippian) of Montana presents a vast assemblage of palaeoniscoid actinopterygians, many of which preserve details of the vertebral column. In this study, the vertebral column of numerous specimens of undescribed Bear Gulch palaeoniscoids were examined. The condition and associations of neural arches and spines, haemal arches and spines, interdorsals, and interventraux surrounding an unrestricted notochord are described. The presence of supraneurals anterior to the dorsal fin is also discussed. These features are compared to those seen in previously described Bear Gulch and non-Bear Gulch palaeoniscoids. A caudal skeleton unlike the previously known Bear Gulch forms is described. This caudal skeleton is composed of vertebrae, supraneurals, and ventral hypurals, similar to the condition of the caudal skeleton in Pygopterus and a palaeoniscid from Hamilton, Kansas. After further examination, it is more likely that these castra-like bones are expanded bases of hypurals and that the notochord remains unrestricted caudal. These observations support Schultz and Chorn’s reinterpretation of the caudal skeleton in Pygopterus being composed of an unrestricted notochord with ventrally placed hypurals with expanded bases. This appears to be one of many vertebral patterns seen in Paleozoic actinopterygians, which range from completely unrestricted notochords with small hypurals to restricted notochords with well ossified centra. The specimens from the Bear Gulch Limestone, which preserve vertebral elements in relatively complete fish to disarticulated specimens, can provide additional clarification on the vertebral condition in palaeoniscoid fishes.

Friday 2:15
A NEW BRONTOTHERE FROM CALIFORNIA, ITS PHYLOGENETIC POSITION, AND REVISED STATUS OF THE GENUS Diplacodon
MIHLBACHER, Matthew, Old Westbury, NY; DEMÉRÉ, Thomas, San Diego Natural History Museum, San Diego, CA
Excavations at Ocean Ranch, northern San Diego County, exposed a regressive sequence of strata of Inner Mongolia, suggesting that these species are close to an immigration event that may have given rise to the eubrontotherium radiation consisting of advanced brontotheres such as Megacerops.

Poster Session III

PALEOENVIRONMENTAL RECONSTRUCTION OF THE MAMMALS FROM WADI MOGHRA, EGYPT
MILLER, Ellen, Wake Forest Univ., Winston Salem, NC; EL-BARKOOKY, Ahmed, MOHAMED, Hamdan, KORANY, Mohamed, Faculty of Sciences, Cairo, Egypt; NICHOLLS, Courtney, Wake Forest Univ., Winston Salem, NC
Wadi Moghra, Egypt, is an early Miocene fossil locality that preserves a large array of extinct mammals (21 genera, 23 species). Moghra has been an especially important site for primate evolution, because the site has yielded remains of one of the world’s earliest known Old World monkeys ( cercopithecoid) and an ape ( hominoid), shortly after the initial divergence of the two lineages. Recent work on the geology of Moghra has documented that the deposits were formed as part of a large river system trending southeast-northwest, combined with episodic marine transgressions trending in the opposite direction. Fossils of land mammals are recovered from fluvialite/estuarine channel deposits but not from marine facies. In 2005, a series of hypotheses were designed to investigate whether the animals recovered were transported or more likely to have been living further upland and were transported to this distal fluvialite/estuarine area after death by the actions of the river system (i.e., essentially whether mammalian faunal elements are primarily autochthonous or allochthonous). Each fossil recovered during the 2005 season was scored for a number of attributes (e.g., provenance, taxonomic, anatomical element), including degree of transport damage evident. Initial analyses support the hypothesis the Moghra fauna represents a combination of autochthonous and allochthonous species, however results are considered preliminary and were complicated by the diagenetic effects of recent sand erosion on some specimens.

Friday 11:00
TAPHONOMY OF TEMPERATE LARGE-MAMMAL DEATH ASSEMBLAGES: A DEAD-ANALYSIS OF YELLOWSTONE NATIONAL PARK
MILLER, Joshua, Univ. of Chicago, Chicago, IL
Understanding the taphonomic processes that influence the ecological composition of modern death assemblages is essential for accurate paleoecological interpretations of fossil communities. Previous live-dead studies of mammal communities have focused on African savannas and provided insight into the quality of ecological data housed in modern semi-arid systems. In this study, the taphonomy of centrarchid assemblages was examined to determine how individuals decompose and are destroyed, however, vary with body size, ontogenetic age, environment, and composition of the local scavenger community. A broader sampling of environments and ecologies is thus needed to more fully understand the taphonomic dynamics influencing ecological composition of large-mammal death assemblages. Yellowstone National Park, WY, with its abundant, diverse, and well-studied large-mammal community provides an excellent system for evaluating the fidelity with which a modern death assemblage captures the living community in a temperate environment. Surface skeletal bone accumulation of four Yellowstone habitats were surveyed and compared to living population census data for agreement in species composition, relative abundance, and habitat occupation. In addition, observations of the remains of carcasses with known dates-of-death illuminated bone decay rates and disarticulation patterns. Results indicate high ecological fidelity between the living community and the death assemblage in terms of species composition, relative abundance, and habitat preferences. Individual decomposition and loss rates in Yellowstone are slower than those previously documented for African localities and indicate prolonged time-averaging potential for cold-weather death assemblages. Comparisons between the Yellowstone death assemblage and surveys of the living community also suggest that terrestrial death assemblages are sources of historical ecological data useful for wildlife conservation and management efforts. Continued live-dead studies in diverse environments will expand understanding of the taphonomic filters influencing death assemblage composition and improve ecological interpretations of both modern and fossil skeletal accumulations.

Wednesday 5:30
SWIMMING BEHAVIOR IN EARLY JURASSIC THEROPOD DINOSAURS BASED ON SPECIFIC SWIM TRACKS FROM SOUTHWESTERN UTAH
MILLER, John, Denver Museum of Nature & Science, Denver, CO; HARRIS, Jerald, Dixie State College of Utah, St. George, UT; LOCKLEY, Martin, Univ. of Colorado at Denver, Denver, CO; HARRIS, Jerald, Dixie State College of Utah, St. George, UT; KIRKLAND, James, Utah Geological Survey, Salt Lake City, UT

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Numerous vertebrate track-bearing layers in the Whitmore Point Member of the Moenave Formation, within a 1 km² area of the St. George Dinosaur Discovery Site at Johnson Farm (SGDS) preserve a unique series of lacustrine deposits of Early Jurassic (Hettangian) “Lake Dixie.” The best-preserved track-bearing horizon, called the “Main Track Layer,” demonstrates dramatic lateral changes in facies and trace fossils from onshore to offshore. This bedding surface records a transition from exposed mudflats, with tracks and sedimentary structures formed onshore (e.g., deep mudcracks, salt casts, and rain drop impressions), to mud, silt, and sand scoured away by longshore currents that display definitive subaqueous sedimentary structures, invertebrate traces, fish swim trails, and hundreds of theropod swim tracks. Onshore firm substrate consistencies along the “Main Track Layer” surface resulted in a preservational bias of tracks by larger theropods rather than by smaller vertebrates. 

On the offshore “Main Track Layer” surface, the majority of swim (or floundering) tracks are referable to *Grallator*-type theropods. Exceptional details are preserved, including skin impressions, claw marks, and scale scratch lines in association with current-oriented sedimentary structures such as flut casts, scratch semi-circles, tool marks, groove casts, scorers, and current ridges. The simultaneous infilling of tracks and sedimentary structures by fine sand, along with high clay content in the underlying mud, accounts for this exceptional and detailed preservation. The majority of swim tracks are oriented both parallel to and opposite the current flow direction indicated by the scour marks, suggesting animals possibly reacting to being swept off-balance by N-S currents that flowed parallel to the paleo-shoreline. The SGDS swim tracks are by far the best-preserved and largest collection of such fossils known in the world.

**Wednesday 11:45**

**STE戈GS, A PROBLEMATIC SPIKY-HEADED TEMNOSPONDYL**

MILNER, Andrew, The Natural History Museum, London, United Kingdom; SCHÖCH, Rainer, Staatliches Museum fuer Naturkunde, Stuttgart, Germany

The spiky-headed temnospondyl amphibian *Stegos gavisciata* from the Middle Pennsylvanian coal of Linton, Ohio has remained neglected and enigmatic for several decades. It has been argued to be the ancestor of the Permian *Zatrachydia*idae, also spiky-headed temnospondyls, although there are few resemblances other than the spikes. An examination of previously undescribed material of *Steogs*, along with a re-evaluation of the original specimens, permits a redescription and partial systematic assignment of it. All specimens have bony spikes on the tabular, quadrafojugal and angular, but in apparent dimorphism, only some have squamosal and supratemporal spines. A phylogenetic analysis of 52 characters in 15 temnospondyl taxa places *Steogs* within the Dissorophoidea clade but leaves its position uncertain within that clade. The Zatrachydiaidae, represented by *Acanthostomatom*, fall outside the Dissorophoidea, and the zatrachyd affinities of *Steogs* asserted by previous workers are based on homoplastic similarities in ornamentation. Internal relationships of the Dissorophoidea remain unresolved and *Steogs* shares conflicting similarities with Amphibamidae in some resolutions and with an *Ecolsonia* + Dissorophidae + Trematopidae clade in others.

**Wednesday 1:30**

**NEW DATA ON AVIAN BRAIN EVOLUTION FROM FOSSIL BIRDS FROM THE LOWER EOCENE OF ENGLAND**

MILNER, Angela, WALSH, Stig, The Natural History Museum, London, United Kingdom

Recently recovered Cretaceous bird fossils (e.g. from Liaoning in China) have allowed important insight into the theropod-avian transition and the evolution of flight. However, despite over one hundred years of research, little is known about how the avian brain evolved in response to the development of flight, largely because very few avian endocranial casts are known. The CT-based analysis of the brain of *Archaeopteryx* led by ACM in 2004 has been followed by the investigation of braincases of two lower Eocene eneornithines from the London Clay of England. Our results show that *Odontopteryx tolicitica* and *Prophaethon shrubsolai* possessed brains comparable in size and shape to those of living seabirds, indicating that the bird brain had reached an evolutionary level close to that of Recent species by that time. However, the poor development of the eminentia sagittalis in *Archaeopteryx* refutes the earlier hypotheses of a general increase in avian brain size over time, but indicate a trend toward diversification in telencephalic architecture that culminated in the extreme cerebratures today seen in Psittaciformes, Strigiformes and some Passeriformes.

**Poster Session III**

**AN ENIGMATIC DINOSAUR FRONTAL FROM OLDMAN FORMATION (CAMBRIAN-SPANISH), SOUTHERN ALBERTA**

MIYASHITA, Tetutsu, Univ. of Alberta, Edmonton, AB, Canada

An isolated dinosaur frontal (TMP 87.89.8) was surface collected from the Oldman Formation (Bell’s River Group) in southern Alberta. The frontal exhibits unusual morphology. It is thick and longer than wide. The dorsal surface is covered with grooves along the moderately long orbital rim. The postorbital ridge rostrally bears the deep supratemporal fossa. This ridge is elevated from the dorsal surface and continues to become a low sagittal crest medially. The cross section at the midline suture becomes thickest under the ridge. A preserved part of the parietal suture suggests that the paired frontals caudally separated the parietals. Ventrally, the orbital cavity highly expands medially such that the ridge enclosing the orbital cavity reaches the midline suture, leaving an unusually narrow interorbital space. As a result, the lateral opharynx contact is displaced far medially and does not seem to continue to the postorbital. A shallow depression posterior to this contact probably marks the cerebral impression. Similarly, a depression at the broken anterior end may be the trace of an olfactory bulb. The specimen significantly differs from frontals of any dinosaur occurring in the Bell’s River Group. Cladistic analysis finds the specimen weakly associated with either basal neotheropods or basal ceratopsians, both without any unambiguous synapomorphies. Because many character states of the specimen such as the narrowed interorbital space are autapomorphic, its association with other taxa in the analysis mostly depends on proportional or general similarity in morphology. Neither a single pathologic cause seems to explain the unique suite of character states. The eroded lateral contacts of the frontal may be hindering its precise taxonomic identification. Had the contacts been preserved and made the identification possible, the novel combination of characters would nevertheless make the specimen unique in the taxon. With the discovery of additional diagnostic material, the specimen will undoubtedly add to the taxonomic diversity of the Oldman vertebrate fauna. The study also calls attention to similar frontals that may have been collected elsewhere.
ADDITIONAL SPECIMEN OF A NEW CORYPHODONTID PANTODONT (MAMMALIA) FROM THE EOCENE AKASAKI FORMATION, KUMAMOTO PREFECTURE, JAPAN, AND ITS TAXONOMIC AND ONTOGENETIC SIGNIFICANCE

MIYATA, Kazunori, Fukui Prefectural Dinosaur Museum, Katsuyama City, Fukui, Japan; TOMIDA, Yukimitsu, National Science Museum, Tokyo, Tokyo, Japan; UGAI, Hiroaki, HIROSE, Koji, Goshoura Cretaceous Museum, Amakusa City, Kumamoto, Japan

A new specimen of a coryphodontid (GCM-VP 133) from the Akasaki Formation (late early/early middle Eocene), Goshoura, Amakusa City, Kumamoto Prefecture, preserves left M1, mandible with complete permanent lower dentition except for left I3, and postcranial elements including some dorsal vertebrae and ribs. GCM-VP 133 is characterized by having a fused mandibular symphysis, triangular and spatulate incisors, small incisiform canines, p2 with no trigonid basin, posterior premolars (p3-4) with short talonid hoods and well-developed metastyles, and bilophodont hypsodont lower molars with distinct metaloaphids, hypolophids, and massive metaconids. The associated M1 is narrowly lingually and is bilophodont with protoloph, premetacrista, and stout protocone, although the lophs are considerably worn.

The characters of the upper and lower molars of the new specimen suggest that it belongs to an undescribed coryphodontid species—a previously recognized specimen consisting of a skull of a young individual (GCM-VP 101) also is known from the same formation and represents the same new species. This new coryphodontid taxon has a close affinity with Eudinoceras in having derived bilophodont molars, but it is a derived species differing from all other known Asian coryphodontids, based on the characters of the upper molar and lower premolars noted above. The new specimen, along with GCM-VP 101 which preserves the deciduous dentition, not only shows further morphological characters of derived coryphodontids, but also provides ontogenetic information, which has been poorly understood in Asian coryphodontids.

Saturday 1:30

SPECMEN OF THE PROCOLOPHONOID REPTILE SAUROPAEON ANOPLUS FROM THE KATBERG FORMATION OF SOUTH AFRICA

MODESTO, Sean, Sydney, NS, Canada; BOTHA, Jennifer, National Museum, Bloemfontein, South Africa; SMITH, Roger, Iziko South African Museum, Cape Town, South Africa

Collecting efforts in the South African Triassic indicate a stratigraphic separation between the procolophonid Procolophon tronicon, the predominant reptile of the arenaceous Katberg Formation, on one hand and, on the other, the omenettids and non-procolophonid procolophonoids (Coleta seca, Sauropaeon anoplus), which are known almost exclusively from the argillaceous Palingkloof Member of the Balfour Formation. Recent fieldwork has yielded the anterior half of the skull of a small procolophonid from lower strata of the Katberg Formation northwest of Middelburg in Eastern Cape Province. Weathering of the skull has resulted in loss of the median elements of the skull table and damage to the surrounding bones. Enough is preserved, however, to present a small suite of cranial characteristics, such as the presence of simple conical teeth, contribution of the parietal to the orbital margin, and the presence of a posteroventral facial process of the quadratojugal, which allow us to refer the specimen to the monotypic genus Sauropaeon. The new species is significant because Sauropaeon was known hitherto only from Palingkloof strata at Barendskraal, south of Middelburg. It allows recognition of a stratigraphic range for this procolophonoid species, one that extends from the Palingkloof Member into the lower part of the Katberg Formation. Together with the inferred range for Coleta seca, our discovery serves to narrow the stratigraphic gap, the predominant reptile of the arenaceous Katberg Formation, in the early/early middle Eocene, Goshoura, Amakusa City, Kumamoto Prefecture, preserves left M1, mandible with complete permanent lower dentition except for left I3, and postcranial elements including some dorsal vertebrae and ribs. GCM-VP 133 is characterized by having a fused mandibular symphysis, triangular and spatulate incisors, small incisiform canines, p2 with no trigonid basin, posterior premolars (p3-4) with short talonid hoods and well-developed metastyles, and bilophodont hypsodont lower molars with distinct metaloaphids, hypolophids, and massive metaconids. The associated M1 is narrowly lingually and is bilophodont with protoloph, premetacrista, and stout protocone, although the lophs are considerably worn.

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total biasing of the fossil assemblage and how much of the total biasing can be explained with the known species Longirostravis hani: 1) long, tapering and slightly curved rostrum, 2) dentition restricted to the premaxilla and rostral-most dentary, and 3) triradiate lateral processes on the sternum. The sternal lateral processes of the new specimen differ from the "multiradiate" form of the Longirostravis type in having a more complex, three-dimensional arrangement. Additionally, the new specimen has slightly smaller linear dimensions than the type and lacks the typical enantiornithine fusion of the tibiotarsus and carpometacarpus. These features suggest that the new specimen represents either a subadult Longirostravis hani or possibly, a younger individual of a different, as-yet-unknown species. This specimen also exhibits several unusual features. An unknown subtriangular element occurs on both sides of the specimen just lateral to the sternocoracoid contact. These paired elements have a more porous texture than the rest of the skeleton and may lack well-developed cortical bone. The pygostyle possesses two thick lateral flanges that extend roughly two-thirds the length of the element and is similar in overall morphology to that of Sinornis. The manus is highly derived for an enantiornithine. Each of the digits lacks unfused unguals and the phalangeal count stands at a very modern 1-2-1-0-0. If this generic identification proves true, Longirostravis would be the first avian from northeastern China to be found in both the Yixian and Jiufotang Formations.

3D Imaging Symposium, Friday 9:15
THE FIRST TRULY OBJECTIVE METHOD FOR 3D REMOVAL OF GEOLOGICAL DEFORMATION WITH AN APPLICATION TO THE BRAINCASE OF ARCHAEOPTERYX
MOTANI, Ryosuke, Univ. of California Davis, Davis, CA; MILNER, Angela, Natural History Museum, London, United Kingdom; SCHMITZ, Lars, Univ. of California Davis, Davis, CA
Most fossils have been distorted as an unavoidable consequence of geological processes. It is known in invertebrate paleontology that geological deformation has misled taxonomy and systematics but this significant bias has largely been neglected in vertebrate paleontology. In 2005, a book was published in paleoanthropology, implicitly stating that it was impossible to objectively identify the geological compaction axis from a deformed skull. If true, this would mean that any 3D treatment of fossil skulls, including morphometrics and biomechanics, could not avoid being arbitrary at a very basic level. We developed a method to objectively estimate the geological compaction axis by taking advantage of the minor asymmetry that exists in a skull. We then tested the method in three cases: 1) we present simulations to see if and under what idealized conditions the correct identification of the compaction axis was possible. Second, we virtually deformed a 3D image of a living monkey skull to see if the method could identify the known compaction axis when real biological asymmetry was present. Third, we applied it to the braincase of Archaeopteryx to see if the method was applicable to a real fossil. The true compaction axis was unknown for the third case so we tested the outcome from five different cases. Finally, we applied it to Archosaur with the known species Archaeopteryx: 1) long, tapering and slightly curved rostrum, 2) dentition restricted to the premaxilla and rostral-most dentary, and 3) triradiate lateral processes on the sternum. The sternal lateral processes of the new specimen differ from the "multiradiate" form of the Longirostravis type in having a more complex, three-dimensional arrangement. Additionally, the new specimen has slightly smaller linear dimensions than the type and lacks the typical enantiornithine fusion of the tibiotarsus and carpometacarpus. These features suggest that the new specimen represents either a subadult Longirostravis hani or possibly, a younger individual of a different, as-yet-unknown species. This specimen also exhibits several unusual features. An unknown subtriangular element occurs on both sides of the specimen just lateral to the sternocoracoid contact. These paired elements have a more porous texture than the rest of the skeleton and may lack well-developed cortical bone. The pygostyle possesses two thick lateral flanges that extend roughly two-thirds the length of the element and is similar in overall morphology to that of Sinornis. The manus is highly derived for an enantiornithine. Each of the digits lacks unfused unguals and the phalangeal count stands at a very modern 1-2-1-0-0. If this generic identification proves true, Longirostravis would be the first avian from northeastern China to be found in both the Yixian and Jiufotang Formations.
A NEW GENUS OF ‗SLUGANOIFORM STEM NEOPTERYGIAN FROM THE EARLY TRIASSIC OF WESTERN CANADA

MUTTER, Raoul, Natural History Museum, London, United Kingdom; NEUMAN, Andrew, Royal Tyrrell Museum, Drumheller, AB, Canada

The Early Triassic ichthyofauna of the Sulphur Mountain Formation in western Canada yields evidence of 20 specimens of a new genus of stem neopterygian. Although poor in preservation, this new genus shows highly interesting features including a long, partly edentulous lower jaw with coronoid process and a heteromorph dentition, entirely jointed segmentation in the paired fins, and poorly ossified, small scales. The conspicuous, extended dorsal fin, fin ray structure, and the small scales are reminiscent of various primitive Permio-Triassic actinopterygians, namely Etroynotodes (Late Permian, Russia), Evenki (Late Triassic, Russia), Fukangichthys (Middle Triassic, Xinjiang, China), Scanlepis (Late Triassic, Sweden), and Taboocytus (Late Triassic, North America). This analysis suggests, however, similarity in fin structure and squamation between the new genus and any of these Permio-Triassic genera represents plesiomorphy and the skull features in the Canadian genus are relatively more derived. The shape and size of the jaws, the structure of the cheek, the broad skull, and the extended snout approach the luganiform (Middle Triassic) and the macrosemiid (Late Triassic—Late Cretaceous) condition. Despite the new genus‘ overall poor preservation, it clearly reveals a remarkably unique mosaic of primitive and derived features, previously observed only separately, either in Late Paleozoic or Early Mesozoic actinopterygians.

Poster Session III
CALCIFICATION IN THE FOSSIL RECORD: WHAT CAN WE LEARN FROM RIBS?

NAPLES, Virginia, Northern Illinois Univ., DeKalb, IL.; ROTHCHILD, Bruce, Arthur Center of Northeast Ohio, Youngstown, OH

Many kinds of information can be inferred from the frequency of occurrence, life stage, apparent health, species associations or environment of extinct taxa in the fossil record. The amount and quality of information about a fossil specimen is further reduced by taphonomic processes that affect the likelihood of preservation of skeletal elements; larger, more robust bones often survive while gracile or smaller elements are less commonly identified or collected from a single locality. Ribs fall into the latter category. However, ribs are widely reported in both the paleontologic and archaeologic records as showing evidence of a high incidence of calcific plaques. Interpretation of the pathologic nature of these features requires study of the soft tissues associated with the skeletal elements that show them. Such a study of most fossil specimens is impossible, as few retain evidence of the condition of soft tissues associated with the most commonly preserved elements, i.e., osteolog- ic or dental materials. Few modern populations show a similar incidence of pathology; therefore the assumption that extinct species had high frequencies requires further examination. To test the hypothesis that calcific plaques indicate pathologic conditions in paleoontologic collections of species, dissections of cadaver thoracic regions were performed to identify the precise tissues involved, and to assess the validity of previous assumptions. Calcific plaques were clearly identified; however, they were localized in the visceral, but not the parietal pleura. This study provides a perspective on adhesions, specifically that adherence of structures that have been interpreted as calcified tissues to ribs was taphonomic, and did not reflect circumstances in the original living host.

Student Poster Session
MIDDLE AND LATE MIOCENE TERRESTRIAL MAMMALS FROM THE PANNONIAN BASIN, CENTRAL EUROPE

NARGOLWALLA, Mariam, Univ. of Toronto, Toronto, ON, Canada

Past studies of Eurasian Miocene terrestrial mammals define two geographic blocks, East and West, between which faunal diversity and dynamics are compared. Interestingly, these blocks are not confined within a single paleobiogeographic basin in Central Europe. Surrounding the Alps, Dinarides and Carpathians, the Pannonian Basin is a relatively closed system and corridors for faunal interchange during the middle and late Miocene were limited by topography and fluctuating paleoenvironments. The purpose of this study is to determine the extent to which the Pannonian Basin faunas support the current geographic division between East and West Eurasian faunas by assessing the degree of interbasin heterogeneity. The results of a three year survey and excavation effort together with localities recorded in the NOW Database were used to conduct a basin-wide analysis of faunal diversity and dynamics in the Pannonian Basin and adjacent regions. The spatial distribution of the Pannonian Basin faunas was mapped over a series of time slices using ArcGIS 9, together with digitized paleogeographic map overlays. Measures of sampling completeness, endemism, faunal diversity and faunal similarity were implemented to assess faunal heterogeneity within the basin system. The preliminary results of this study indicate that the Pannonian Basin faunas experience the same decline in sampling completeness in MN7-8 and MN10 (Neogene Mammal biochronological zones) as faunas in the West and East blocks. However, influenced by Hungarian localities in MN11 and MN12, the Pannonian Basin faunas experience the same respective increase and decrease in diversity as faunas...
from the East during these time intervals. In terms of diversity, the middle Miocene Pannonian Basin faunas behave more like faunas in the West, while towards the terminal Miocene, the Pannonian faunas behave like those of the East in the formation of an unification of taxa from the Eastern Mediterranean. Further analysis of these trends can potentially elucidate further details of faunal turnover and interchange, and perhaps directionality in the latter.

Saturday 11:15
DIGESTING THE COELOPHYYSIS-CANNIBAL HYPOTHESIS AND ITS IMPORTANCE TO PREY CHOICE IN THEROPOD DINOSAURS
NESBITT, Sterling, TURNER, Alan, American Museum of Natural History, New York, NY; ERICKSON, Gregory, Florida State Univ., Tallahassee, FL; NORELL, Mark, American Museum of Natural History, New York, NY
Direct evidence of prey choice in carnivorous dinosaurs is rare in the fossil record. The most celebrated example pertains to purported stomach contents in two specimens of the early carnivorous dinosaur Coelophysis bauri (AMNH FR 7223 and AMNH FR 7224), which besides revealing prey choice, also point to cannibalistic behavior as being commonplace among theropod dinosaurs. The Coelophysis-cannibal hypothesis is one of the most recognized paleobiological anecdotes presented in museum exhibitions, countless children’s books, and in popular press. Here, we test this hypothesis by conducting the first comprehensive anatomical and histological examination of the famed Coelophysis cannibals.

Reinspection of AMNH FR 7223 revealed that the ribcage ruptured sometime during burial and that the purported remains lie underneath the Coelophysis skeleton. Thus, no unambiguous stomach contents are present in AMNH FR 7223. The stomach remains in AMNH 7224 lie within the posterior region of the intact ribcage. The stomach contents include an ilium, left and right femora, a sacral vertebra, and many additional fragments. None of the stomach remains bear dinosaurian synapomorphies. Instead, the elements bear character states consistent with crocodylomorph archosaurs. The preserved femur has a proximal condylar fold, which is synapomorphic for Crocodylomorpha. Moreover, histological analysis of the femur supports assignment to Crocodylomorpha rather than a Theropoda.

The results unequivocally show that the gut contents derive from early crocodylomorphs rather than juveniles of Coelophysis. These findings exonerate this taxon as being cannibalistic and bring into question the commonality of this behavior among non-avian dinosaurs.

Postor Session I
THE ENIGMATIC CHONDRICHTHIAN LISTRACANTHUS
NEUMAN, Andrew, Drumheller, AB, Canada; MUTTER, Raoul, Natural History Museum, London, United Kingdom
A newly discovered species of Listracanthus, L. pectenatus, represents the first Mesozoic record of this group of enigmatic chondrichthyans and highlights survival of rare cartilaginous fishes across the Paleozoic-Mesozoic boundary. Listracanthus is only known by two kinds of dermal denticles. These denticles fall into two distinctive size classes. The Mesozoic species occurs abundantly in certain strata of Early Triassic age in the Sulphur Mountain Formation of western Canada. Seven Paleozoic species of Listracanthus have been named, and Paleozoic records are predominantly Late Carboniferous in age. The local- ly abundant occurrence of these denticles is interpreted to be due to predation influ- ences rather than the “Lazarus” effect. The Triassic species differs from all other known species in the structure of the large denticles, whereas the small denticles appear to be less diagnostic and are readily distinguished from other small denticles traditionally assigned to the genus Petrodus. The study of the histology of these denticles reveals that the large denticles were originally hollow and probably secondarily ossified as acellular bone, lacking enameloid cover entirely. The conclusion drawn by previous authors that Listracanthus may be a pelatodontid shark, based on ambiguous non-skeletal associations with Deloptychius, Petrodus or Calopodus, is not supported. The size of both types of denticles, the large number of denticles and their arrangement, and the lack of enameloid cover in these denticles suggest that Listracanthus was a large chondrichthyan of aberrant body shape and yet unknown systematic position.

Postor Session II
EVIDENCE FOR TWO TAXA OF HIODONTIDAE IN THE CRETACEOUS DINOSAUR PARK FORMATION, ALBERTA
NEWBREY, Michael, North Dakota State Univ., Fargo, ND; WILSON, Mark, Univ. of Alberta, Edmonton, AB, Canada; ASHWOOD, Allan, North Dakota State Univ., Fargo, ND
Isolated centra recovered from fluvial localities in the Cretaceous Dinosaur Park Formation (Campanian) are used to describe hiodontid age, growth, and longevity characteristics. Previous studies of Cretaceous centrum morphology have shown only one morphotype. Growth characteristics can provide additional information to test the hypothesis that more than one taxon existed in the Dinosaur Park Formation. An examination of the growth characteristics indicates that Campanian hiodontids were shorter-lived (i.e., about 7 years longevity) and significantly smaller than extant hiodontids (p < 0.001). The Cretaceous centra exhibit two significantly different (p < 0.001) growth patterns. Initially it was pre- dicted that two factors could explain the presence of the two growth patterns: 1) sexual size dimorphism, 2) variation in centrum size from multiple species. Sexual size dimorphism is dismissed based on two conditions; variation in extent H. asloides maximum total length significantly responds to mean annual temperature (R² = 0.559, p < 0.013), and the paleotem- perature fluctuation would result in a continuous distribution of growth patterns and not the discrete pattern of the Cretaceous centra. Regarding centrum size variation, the coefficient of variation (CV) observed in the Cretaceous centrum size data (0.24 CV) is 25% greater than that of the two extant species of Hiodon combined (0.18 CV), suggesting that at least two species of hiodontids were present in the Dinosaur Park Formation. The CV of each significantly different growth pattern can also be used to infer the presence of additional species. The larger Cretaceous growth pattern has a CV equivalent to that of a single extant species (0.10 CV). The smaller Cretaceous growth pattern has a CV that exceeds that for a single species (0.14 CV), but not for two extant species. Furthermore, the data does not support the presence of three taxa because the smaller growth pattern has a centrum size distri- bution that is significantly different than that of two extant species (p < 0.001), but not significantly different than that of one species (p = 0.428).

Wednesday 12:00
THE ROLE OF THE PLESIOSAURIAN LONG NECK—A NEW MODEL
NOE, Leslie, The Sedgwick Museum, Cambridge, United Kingdom
The order Plesiosauria was a long-lived and globally distributed group of Sauropterygian marine reptiles that existed throughout much of the Mesozoic. The Plesiosaurs has tradi- tionally been divided into the long-necked plesiosaurs and the short-necked pliosaurs, although this dichotomy has long been difficult to define. The pliosaurs are analogous to fish, whales, dolphins, or seals with a relatively large head and short neck, but the long- necked plesiosaurs (Superfamily Plesiosauroidea) have no direct living analogue.

Probably the most striking feature of the plesiosaurian bauplan is the extremely long neck. However the possession of a long neck in the marine environment poses a number of func- tional, biomechanical, ecological and physiological problems to the living animal: was neck flexible to permit feeding or stiff to allow rapid swimming, and how was the role of predation with such a long neck overcome? However, the plesiosaur neck was a successful adapta- tion to life in water, with its adaptive value demonstrated by its continued presence over a large geographical range and throughout the long evolutionary history of the group. The evolution and function of the plesiosaurian neck has remained enigmatic and long puzzled scholars.

Observation of the articular faces of contiguous cervical vertebrae, the associated neural arches and cervical ribs suggests the plesiosaurian neck was predominantly adapted for ventral movement, with dorsal, lateral and rotational movement all relatively restricted. Predominant ventral movement suggests the neck may have been an adaptation to feeding on the sea floor, and cranial and dental adaptations appear to reflect this role. Hard-part anatomy, together with aspects of functional morphology, biomechanics, associated fauna, sedimentary environment and comparison to modern analogues interweave to provide a convincing explanation of the plesiosaurian bauplan as a sediment/filter feeding apparatus (the head) mounted on a flexible tube (the neck) attached to a mobile feeding platform (the body). These insights provide an explanation as to why and how the plesiosaurian long neck evolved.

Student Poster Session
THE PALEOBIOLOGICAL IMPLICATIONS OF CLIMATIC INFLUENCE OVER VERTEBRATE FOSSIL DISTRIBUTION PATTERNS
NOTO, Christopher, Stony Brook, NY
Differential preservation of plant and animal tissues due to environmental conditions is gener- ally accepted by paleontologists as a wide-spread bias in the fossil record. Therefore, drawing paleobiological inferences based on fossil distributions can be problematic. Not all environments are preserved equally well in the fossil record, and some appear to be absent altogether. In turn, environmental distribution is driven by global climate patterns, which have varied considerably in the past.

Little attention has been paid to how the interplay of environment-specific tissue degra- dation and biased environmental preservation affect our ecological, environmental and cli- matic reconstructions of the past. Identification of these biases and how they affect the pat- terns we observe are required for an accurate interpretation of the fossil record. Failure to do this may lead to erroneous reconstructions. Here I examine how these biases may affect our interpretation of late Mesozoic biotic reconstructions.

Using published fossil databases, comparison of dinosaur and plant distributions suggest that both reached peak taxonomic diversity around the middle latitudes. However, the peaks are offset, with the plant peaks occurring at higher latitudes. This difference corresponds to our interpretation of late Mesozoic biotic reconstructions.

Using published fossil databases, comparison of dinosaur and plant distributions suggest that both reached peak taxonomic diversity around the middle latitudes. However, the peaks are offset, with the plant peaks occurring at higher latitudes. This difference corresponds to our interpretation of late Mesozoic biotic reconstructions.
POSTER SESSION III

O’CONNOR, Patrick, STEVENS, Nancy, Ohio Univ., Athens, OH; GOTTFRIED, Michael, Michigan State Univ., East Lansing, MI; RIDGELEY, Ryan, Ohio Univ., Athens, OH; ROBERTS, Erin, Univ. of the Witwatersrand, Johannesburg, South Africa

Four recent field expeditions (2002-2005) conducted in the Rukwa Rift Basin of southwestern Tanzania have yielded a growing diversity of terrestrial/freshwater vertebrates from the “middle” Cretaceous Red Sandstone Group (Unit I). This represents one of the most poorly sampled time intervals among continental sequences in Gondwana generally, and sub-equatorial Africa in particular. Represented among archosaurs are indeterminate crocodylians and multiple taxa of saurischian dinosaurs, including two theropods and at least two titanosaurian sauropods. Intensified prospecting and quarrying efforts during 2005 resulted in the discovery of multiple new archosaurian clades, including the first rebbachisaurid sauropod, but also other archosaur specimens of a new notosuchian crocodylomorph. The former is based on a near complete right humerus exhibiting a sub-circular midshaft cross-section, characteristic of rebbachisaurids. This clade of diplodocoid sauropods is known only from middle Cretaceous (Albian-Turonian) strata in circum-Saharan Africa and South America. Crocodylomorph specimens include both upper and lower jaws of a new notosuchian characterized by extreme size and shape heterodony. The sculpted external surface of the dentary and thin, cylindrical tooth roots are consistent with generalized crocodyliomorph morphology, yet the presence of multiple, multi-cusped “molariform” teeth and posterior maxillary teeth possessing a constriction at the crown-root junction suggest possible affinities with notosuchians such as Malawicus and Simosuchus. Derived features of the new taxon indicate the presence of a mesiodistally elongate trough interposed between lingual and buccal sets of shearing surfaces. This morphology suggests possible propalinal movements between the lower and upper dentition and represents another striking example of dental convergence between select Cretaceous crocodylians and mammals. Taken together, the developing archosaur fauna from the Cretaceous Red Sandstone Group appears to preserve representatives of higher-level clades (Notoosuchia, Rebbachisauridae) known from multiple locations throughout Gondwana.
HIND LEG STAND IN A SARRANTIVA: A BIOMECHANICAL TEST
OGRODNIK, Jeffrey, Orlando Park, IL; SERENO, Paul, University of Chicago, Chicago, IL

Whether any sauropod dinosaur was capable of the two-legged rearing pose sometimes adopted by the largest living herbivores has been a matter of speculation. Using the African elephant, *Loxodonta africana* as an extant model, we provide the first biomechanical test of rearing using *Jobaria tigmidentis*, a basal sauropod with conservative neck, limb, and tail proportions. The requisite variables to evaluate rearing stance (mass, center of gravity, limb bone orientation, stress and minimal muscle force) are measured or estimat- ed in *L. africana* and *J. tigmidentis*. Assuming no support from the tail, the structural model for *J. tigmidentis* suggests that a rearing pose would neither compromise the critical limb bone (femur) nor demand more muscle mass or tendon size than estimates suggest were present. Furthermore, a general relationship is presented for large-bodied quadrupeds that relates body mass, minimum humeral/femur diameter, and footprint area.

Romer Prize Session, Thursday 11:30

STRUCTURAL ANALYSIS OF DERIVED ORNITHOPTOR SKULL USING 3D FINITE ELEMENT METHOD: RECONSIDERATION OF THEIR FEEDING MECHANISMS
OHASHI, Tomoyuki, Univ. of Tokyo, Tokyo, Japan

Plaurokinesis is considered as one of the key adaptations for herbivory in the ornithopod evolution. Presence of the plaurokinesis has been suggested from the morphological fea- tures of the skull in derived ornithopods, but its feasibility has not been studied mechanical- ly. This study analyzed the stress and deformation of a subadult ornithopod skull in the stat- ic equilibrium using the 3D finite-element method (FEM), which is a numerical simulation method for solving complex field problems. The skull morphology is obtained from the X- ray CT images and the model generation is generated from the CT images using the voxel element which is a cuboid element uniformly dividing the material region. The voxel modeling and analysis are performed mainly using the commercial FEM code (VOXEL- CON2005 by Quint Corp., Japan). The chewing motion takes the following three steps: 1) adduction of mandibular muscles; 2) rotation of the mandible around the quadrato condyle as a fulcrum; and 3) crushing of food material between the upper and lower jaws. This study sets these three components as the static boundary conditions: the point loads are applied at the muscle origin as the bite force, the quadrato condyles are fixed, and virtual food is set under the upper tooth rows. Distribution of stresses were compared in two models: 1) a rigid model which considers the skull as a homogeneous unit and 2) a suture model in which some skull sutures are flexible. The sutures are represented by the lower Young’s modulus model which considers the skull as a homogeneous unit and 2) a suture model in which some skull sutures are flexible. The sutures are represented by the lower Young’s modulus in the second model.

In the rigid model, stresses mainly concentrated at certain sutures that are in fact flexi- ble in the plaurokinetic hinge system observed in actual ornithopod skulls. On the other hand, stresses spread almost uniformly in the skull in the second model and did not concen- trate any regions except for the loading points because of the model. The plaurokinesis at certain sutures releases the stress concentration resulted in the rigid model. It indicates that the plaurokinetic hinge system “disperses” the stress in wider areas of the skull. The system also controls the contact point of the teeth during the chewing.

Poster Session I

PLIOCENE HERPETOCETUS AND BURITINOPSIS FROM NORTHEAST JAPAN AS VALUABLE RESOURCES FOR ELUCIDATING EVOLUTIONARY HISTORY OF MYSTICETES
O’KEEFE, F. Robin, NYCOM, Old Westbury, NY; HILLER, Norton, Canterbury Museum, Christchurch, New Zealand

Elasmosaur cervical vertebrae are common fossils, but their taxonomic utility is limited due to a lack of understanding concerning their shape within and among taxa. In this paper, we analyze data from complete elasmosaur necks in an attempt to quantify and understand the variation in centrum dimensions. In accord with previous studies, variation in cervical cen- trum shape is found to stem from at least three sources: ontogeny, intracolumn variation, and intercolumn or taxonomic variation. Ontogenetic variability is reminiscent of that seen in *Cryptoclidus*, with an overall positive allometry in the length of all centra that is accen- tuated in the mid-cervical region. In adult elasmosaurs, the longest centra occur in the mid- dle of the neck, and centra in this region are longer than those at either end. This pattern yields a distinctively bowed shape curve when a shape metric such as VLI or PC score is graphed against vertebral position. Centrum length shows minor variation from centrum to centrum in all elasmosaurs, but a small group of extreme, elongate animals have a much higher degree of variability. The taxonomic utility of centrum measures is limited because there is no single pattern of centrum shape common to all taxa; variability is the rule, and therefore caution is necessary when using dimensions to diagnose taxa. There do seem to be two morphotypes of elasmosaurs, however. The first is a relatively conservative group with centrum dimensions similar to those of *Brachycentrodon*, and that achieves a long neck by adding vertebrae. A second, elongate group has centra that are very long, and there is great variability from one centrum to another in the same column. Surprisingly, the number of cervical centra is not a highly variable trait in most elasmosaurs. The elongate taxa appear to be restricted to the Western Interior Seaway in the Late Cretaceous, although there is some indication that *Tuarangisaurus* might be elongate as well. In general, elasmosaur vertebrae have some taxonomic utility, but only at the extremes of their shape range, and only if their position in the column is known with some certainty.

Thursday 2:00

PALEOGENOMICS OF PTEROSAURS AND THE EVOLUTION OF VERTERFLIGHT
ORGAN, Chris, EDMARDS, Scott, Harvard Univ., Cambridge, MA

Pterosaurs are of great interest to evolutionary biologists because they are one of three vertebrate groups that have evolved powdered flight. Many insights into pterosaur biology, including flight, have been elucidated using comparative approaches in disciplines ranging from morphology and histology, to biomechanics. However, neontological studies into the genetic and genomic characteristics associated with flight and endothermy, among other traits, have focused necessarily on extant birds and bats. For example, birds have the smallest average genome size of any amniote group and bats have among the smallest genome size of any mammalian group. The small streamlined genomes of birds and bats are prima- rily due to a reduced copy number of repetitive elements. The evolution of small cell size is commonly thought have driven genome-level adaptations for flight, such as small genome size. As a consequence, phenotypic correlates of genome and cell size in birds have been proposed, such as body size, developmental rate and metabolic efficiency. The genom- ic landscape of pterosaurs has been inferred, yielding critical comparative data, not only for understanding pterosaur genomes by themselves, but by providing insights into possible parameters important for the evolution of powered vertebrate flight. This was accomplished by first correlating a relationship between osteocyte size and genome size for a diverse array of extant vertebrates. Using this correlation and comparative methods for inferring genome size from paleohistological data, we have estimated genome size statistics for four different species of pterosaurs (*Dermoptodon, Rhamphorynchus, Pteranodon*, and *Pterodactylyus*). These data reveal that small genomes commonly associated with flight in bats and birds also evolved within Pterosauria. We postulate that, like bats and birds, the small genomes of pterosaurs resulted from the loss of repetitive elements during pterosaur genome evolution.

Poster Session III

ANTERIOR DENTAL GROOVES AND THE INFERENCE OF VENOM DELIVER SYSTEMS IN FOSSIL MAMMALS
ORR, Caley, TOCHERI, Matthew, SCOTT, Jeremiah, DELEZENE, Lucas, SCHWARTZ, Gary, Washington Univ., TEMPE, AZ

Paleontologists recently inferred the existence of a venom delivery system in the canines of the Paleocene pantolestid *Bisonalveus bronni* and in another unidentified mammalian spec- imen of similar geological age (*Fox RC, Scott CS. 2005. First evidence of a venom deliv- ery system in fossil mammals*). This interpretation raises the possibility that venom injection may have evolved more frequently in Mammalia than previously recognized. However, making sound inferences from fossil material requires com- parative analysis to determine a clear association between a structure and its hypothesized function. Such comparative studies should establish that 1) the trait of interest exists in extant analogue taxa and 2) the trait and proposed function are associated in all of those taxa. If extant taxa with the structure exist, but which lack evidence of the proposed func- tion, or phylogenetic history of the trait, then hypotheses relating the trait to the proposed function in fossil taxa are undermined. We show that deep, gutterlike longitudinal canine grooves similar to those exhibited by *B. bronni* and the unidentified mammal fossil appear in extant non-venomous mammals, thus complicating the inference of function from
structure in this case. Further study might demonstrate finer distinctions between ven-
omous and non-venomous canine grooves. However, the available evidence appears to be equivocal regarding the existence of a venom delivery system in these fossil specimens.

Poster Session II
PARACLUEPIDES OF EL ESPINAL QUARRY (MEXICO) AND THE INTERRELATION-
SHIPS OF ELLIMICHITYFORMIDAE

OVALLES-DAMIAN, Ernesto, Texila Gutiérrez, Chiapas, Mexico; ALVARADO-ORTE-
GA, Jesús, Universidad de El Estado do Rio de Janeiro, Rio do Janeiro, Brazil; ARRATIA, 
Gloria, Univ. of Kansas, Lawrence, KS

El Espinal Quarry is an Early Cretaceous (Late Aptian and or Early Albian) locality inten-
sively exploited recently. This quarry is located, near Ocozocuautla de Espinosa, Chiapas, 
Southeastern Mexico. The fossils assemblage found in this supposedly freshwater-marine 
alternating or estuarine deposit involves algae, plants, gastropods, crustaceans (lobsters), 
isopods (mudkrab), insects (odonats), and fishes (pycnodontiforms, macrosemids, 
ichthyodontiforms, ellimichityiforms, Saurornathus-like, Apateoplos-like, and a large 
number indeterminate teleostean larvae). The interrelationships of the order Ellimichityiformes are controversial. Two new ellimichityiforms from El Espinal and a revision of previous diagnostic characters and synapomorphies of the ellimichityiforms allows us to suggest a new hypothesis, in which this monotypic order includes two fam-
ilies. Paraclupeidae (including Scutatuspionus, Eutheberiza, Ellimma, Ellimichityx, 
Pararhapyx, Diplomystus solignacci and Triplomystus) and Sobrichinhyidae (involving 
Sobrichinhyx and the other Diplomystus species). Both ellimichityiforms from El Espinal belong to the Paraclupeidae. One is strongly supported as a new species belonging to 
Triplomystus, genus characterized by the occurrence of a postdorsal scute series. Whereas 
the other species shares similar meristic characters with the Chinese paraclupeid 
Pararhapyx in number of scutes in predorsal and ventral series and number of elements in 
anal and dorsal fins. This Pararhapyx-like fish has a low supraocipital crest and the dorsal 
border of its body shows a marked angle at the beginning of the dorsal fin, as occurs in other 
paraclepids.

Poster Session III
NEW RECORD OF TAXIDEA (MUSTELIDAE: CARNIVORA) FROM A LATE 
MIOCENE DEPOSIT IN THE HAND HILLS, ALBERTA, CANADA

OWEN, Pamela, Texas Natural Science Center, Austin, TX; BURNS, James, Royal Alberta 
Museum, Edmonton, AB, Canada

A nearly complete right dentary of Taxidea cf. taxus, the American badger, was recovered 
from the upper Miocene sands at the Courtenay Site in the Hand Hills, Alberta, Canada. 
Alveoli for the p2 and m2 are preserved and the p3, p4, and m1 are in place. The m1 trigo-
nid is large. The m1 protoconid and talonid are both broken and missing enamel, but not so 
extensively as to prevent generic identification. The dentition shows wear, the 
dentary is robust, and the mandibular fossa is deep, indicating the individual was an adult 
at death. The length of the dentary and m1 suggest a relatively small body size, but much 
larger than that of Plotoxidea, the small, closely-related badger of the late Miocene. The 
Hand Hills Taxidea did not attain the size exhibited by populations of extant Taxidea taxus (sub-
species taxus) of the plains and prairie regions of Canada and the northern United States. 
Adeleone, this specimen has morphological characteristics similar to those of other late 
Tertiary Taxidea, including specimens referred to Taxidea mexicana, warranting further tax-
onomic investigation.

The Hand Hills Taxidea is part of a late Hemphillian fauna that includes Plistogulo, 
Teloeoceras, Neotragoceras, Dipoides, and several equid and camelid species. At present 
it is the oldest known record for Taxidea. The Pliocene Yépméra fauna of Chihuahua, 
Mexico, has produced the only other Hemphillian Taxidea, and thus the Hand Hills speci-
men provides important range information, both chronological and geographical, for a 
taxon that was well distributed throughout the western and central regions of North America 
by the end of the Blancan.

Wednesday 5:00
THYROID HORMONES INCREASE RATES OF RESTING METABOLISM AND 
SKELETAL GROWTH IN HATCHLING ARCHSAURS

OWERKOWICZ, Tomasz, Univ. of California, Irvine, Irvine, CA

Resting metabolic rate (RMR) has been postulated to be a major determinant of bone 
microstructure in vertebrates. In general, endotherms exhibit higher rates of primary bone 
deposition and secondary bone remodelling than similarly sized ectotherms. This observa-
tion has led some palaeontologists to use microstructural features of fossils to infer whether 
an extinct animal was endo- or ectothermic. However, no experimental evidence exists to 
support the hypothesised relationship between RMR and skeletal growth.

I propose that thyroid hormones provide a mechanistic explanation for this relationship. 
Plasma levels of free thyroid hormones, T3 and T4, correlate with RMRs in amniotes— 
endotherms have higher levels of T3 and T4 than ectotherms. Thyroid hormones are also 
known to accelerate bone resorption and formation in mammals, and thus play a role in 
skeletal development and maturation.

In order to test the above hypothesis, plasma T3 and T4 levels were altered in hatch-
lings of the saltwater crocodile (Crocodylus porosus) and the emu (Dromaius novaeholland-
ianus). Normal thyroid gland activity was suppressed with methimazole in experimental 
emus. Experimental emus and crocodiles received daily doses of T3 and T4 orally, and con-
trol animals received saline. Animals were weighed and measured regularly over the course of 
12 weeks, and injected with fluorescent dyes to highlight contemporary changes in bone 
microstructure. Rates of oxygen consumption were measured with open-flow respirometry 
at the end of each experiment.

Both RMR and growth rate were elevated by supplements of T3 and T4. Growth in croco-
diles accelerated as plasma T3 and T4 levels rose, and the growth response was dose-
dependent. Growth rate in emus decreased as plasma T3 and T4 levels dropped, but was 
restored with greater doses of T3 and T4. A preliminary histological analysis of bone 
microstructure showed that faster-growing hatchlings formed new bone with higher vascu-
lar density than their slower-growing siblings. This suggests that both RMR and skeletal 
growth rate are dependent on plasma levels of thyroid hormones, and explains why 
endotherms grow faster than similarly-sized ectotherms.

Saturday 8:30
COMPARATIVE LONG BONE HISTOLOGY AND GROWTH OF SOME “HYP-
SILOPHODONTID” DINOSAURS

PADIAN, Kevin, Berkeley, CA; DE RICQLES, Armand. Univ. of Paris VII, Paris, France; 
HORNER, John, Museum of the Rockies, Bozeman, MT

We examined the long bone histology of the “hypsilophodontid” dinosaurs Orodromes 
maekelai, Dryosaurus altus, and Tenontosaurus tilletti, from perinate to largest available 
ontogenetic stages. We compared these ontogenies to each other, and to those of other 
dinosaurs, notably more derived ornithopods such as Maiasaura and Hypsilophodon. 
Orodromes is a small dinosaur, and its more moderate growth trajectory is consistent with 
those generally observed for relatively small dinosaurs and other small ornithosuchians. 
Tenontosaurus achieves a relatively larger adult size, and its bone histology through ontoge-
ny is more similar to those of hadrosaurs. Dryosaurus is thought to be a small dinosaur, 
but in its largest recognized ontogenetic stages it does not display the “adult” histological fea-
tures of other ornithopod adults, although it does suggest growth rates comparable to those 
of other ornithopods. Our results suggest that in the latter cases, growth is indeterminate 
(Dryosaurus) or is reported to have ended before sexual maturity (Tenontosaurus). We infer 
instead that the adult stage of Dryosaurus altus has not yet been recognized, and we pro-
pose some possible solutions to this paradox.

Thursday 3:00
UPDATES TO THE MAMMALIAN MEGAFANUA OF THE MIDDLE MIOCENE 
BARTSTOW FORMATION

PAGNAC, Darrin, South Dakota School of Mines, Rapid City, SD

The Barstow Formation (middle Miocene) crops out in the Mud Hills region of the Mojave 
Desert, San Bernardino County, California. The formation contains a rich and diverse mam-
mal fauna of late Hemingfordian (He2) age, and contains the type fauna for the 
Barstovian Land Mammal Age. The Barstovian component consists of three distinct faunal 
units, the Green Hills Division Fauna (Ba1), the Second Division Fauna (Ba1), and the 
Barstow Fauna (Ba2). The three Barstovian faunal components are compared with equiva-
 lent faunas throughout the western United States. The Green Hills Division and Second 
Division faunas compare most favorably with the Lower Snake Creek Fauna (Ba1) of 
Nebraska. The Barstow Fauna compares most favorably with the fauna from the Valentine 
Formation (Ba2). Of faunal composition within the Barstow Formation suggests that the most significant faunal turnover occurs between the Green Hills Division 
and Second Division Faunas, or within the Ba1 interval. A similar faunal turnover is not 
reported in any other Ba1 fauna. The Ba1 faunal turnover event corresponds with a 
notable floral turnover observed throughout the western United States. Classic interpreta-
tions suggest that the initial spread of grasses had a key impact on the evolution of mam-
als, particularly in the Great Plains. However, this scenario does not adequately account 
for floral and faunal events in the Great Basin. Grasses are a never a dominant component of 
the Great Basin flora, and floral transitions during the medial Miocene involve a shift from 
deciduous hardwood floras to conifer and chaparral associations. This shift in Great Basin 
vegetation corresponds to the Ba1 faunal turnover, represented by a loss of a number of 
brachydont browsing taxa.

Poster Session III
WHY PALEONTOLOGISTS SHOULD PICK THROUGH THE TRASH: MICRO-
MAMMALS PRESERVED IN SUBFOSSIL MATRIX YIELD VALUABLE INFOR-
MATION ON MADAGASCAR’S PALEOECOLOGY

PARENT, Sara, SAMONDS, Karen, Mount Holyoke College, South Hadley, MA

Due to the near lack of a Malagasy Cenozoic fossil record, little is known about the origin 
and evolution of Madagascar’s extant fauna. The Malagasy subfossil record has been 
important to filling in this informational gap by contributing details on past diversity 
and changes in distribution, but the emphasis in such studies has been on Madagascar’s larger 
animals (e.g., lemurs, pygmy hippos). Little attention has been paid to the Malagasy sub-
 fossil record of micromammals, despite the fact that the latter comprise the majority of the 
class. Even microfossils that could have been recovered from matrix during the preparation 
of larger vertebrates have often been ignored.

To demonstrate the potential presence of microfaunal remains in sediments associated 
with previously collected larger-bodied subfossil vertebrates, we conducted the following 
experiment. Approximately 1 kg of associated breccia material from Anjoibe Cave, north-
western Madagascar was removed from a nearly complete skull and mandible of
Archeoclemur cf. edwardsi and dissociated using acetic acid. The residue included microfau-
nal remains of three of the five extant Malagasy mammalian orders (Carnivora, Chiroptera, Rodentia), containing more than 1000 specimens, isolated teeth, and a possible subfossil carnivore scat. Genera identified include Elurius sp. (Rodentia), Hypsipiperus cf. commersoni and Triaeops sp. (Chiroptera), and Galidia cf. elegans (Carnivora), the latter having never been previously reported from this cave system. This research has demonstrated the potential of brecia sediments for producing subfossil micromammals, and the impending loss of information if these sediments are ignored and discarded. Detailed studies on other Malagasy subfossil groups (e.g., lemurs, birds) have produced valuable results, but more thorough sampling of Madagascar’s microfauna may better reveal these groups past diversity. In addition, this information may help elucidate recent changes in species diversity and geographic ranges due to environmental change and human impacts, and aid in reconstructing Madagascar’s palaeoenvironmental history.

Poster Session II

MORPHOLOGY AND SIZE OF AN ADULT SPECIMEN OF DEINONYCHUS AMNH 5761 (SAURISCHIA, THEROPODA)

PARSONS, William, PARSONS, Kristen, The Museum of the Rockies, South Wales, NY

Since the original description of Deinonychus there has been a certain amount of specula-
tion relating to the various ages of all the known specimens of this taxon. This determina-
tion of the actual size and morphology of adult forms of Deinonychus provides new data that are essential to any further studies of the ontogenetic morphological differences within the known specimens of Deinonychus. Presented here is newly discovered specimen, MOR 1182, that has been determined to be an adult, based on the presence of peripheral rest lines that were revealed in the thin section analysis of a fragment of the radius. These peripheral rest lines indicate determinate growth, which adds yet another avian character to the description of this taxon. Lines of arrested growth observed on a manual phalanx indicate the approximate age of this specimen. A comparison of the number of these LAGs with those observed on the sub-adult specimen MOR 1178 indicates the approximate age of ini-
tial maturity. Comparisons between the skeletal elements of MOR 1182, MCZ 4371 and AMNH 3015 reveal enough data to make descriptive statements regarding the morphology of the adult forms of Deinonychus. Some of the proportional ratios between the elements of the forelimbs and hind limbs can be further defined. The range in size between the onset of sexual maturity and full physical maturity can be estimated. Also, portions of the tail structure of the specimen, MOR 1182, have been preserved. Analysis of these elements indicates that the adult caudal rods possessed a surprising degree of flexibility. This new fossil mate-
rial raises questions about the nature of these caudal rods, the associated soft tissue and the manner in which they relate to the caudal vertebrae. Morphological differences between some adult and sub-adult manus and pes elements may indicate differences in behavior between adults and sub-adults. Also, other associated faunal remains from two Deinonychus sites may indicate a variety of smaller prey species.

Friday 2:45

VARIATIONS IN RARE EARTH ELEMENT (REE) SIGNATURES AND UNIT CHAOTIC DIMENSIONS (UCD) FOR PURPOSES OF STRATIGRAPHIC CORRELATION AND PALEOVENITRAL INTERPRETATION IN THE PIERR SHALE, SOUTH DAKOTA

PATRICK, Doreena, WEGLEITNER, Paul, GeoChemical Solutions, Fort Pierre, SD; MARTIN, James, South Dakota School of Mines and Technology, Rapid City, SD

Our recent research has involved new methods for stratigraphic correlation and paleoevi-
environmental interpretations including Rare Earth Element (REE) and unit cell dimension (UCDA) analyses of fossil bioapatites. REE analysis and UCDA use variations in REE sig-
natures and unit cell dimensions (UCD) within bioapatite from different lithostratigraphic units. During the permeralization process, bioapatite composition changes from a meta-
stable carbonate hydroxapatite to a more thermodynamically stable fluorapatite, incorpo-
rating Fluoride, REE and other trace elements during diagenesis. Substitution by REE and other trace elements into the cation sites and specifically into the seven fold Ca(II) site will change the crystallographic dimensions. The REE composition and UCD of fossil bioapatite are dependent upon the conditions of diagenesis and thus dependent upon availability of REE and other elements for substitution during bioapatite permineralization. Bioapatite acts as a “light recorder” for the environment of diagenesis and can be used to interpret the condition of the paleoenvironment. REE signature and UCD variations identify distinct inter-
vals within lithologic formations. Because these intervals represent an averaging of periods of certain depositional environments, these distinct intervals can be correlated over signifi-
cant areas. Fossil vertebrate samples were obtained from the Pierre Shale, at localities between Chamberlain and Pierre, Dakota in Buffalo, Hughes, and Hyde counties. Samples were collected from the Sharon Springs, Gregory, DeGrey and Verendyke members. REE signatures and UCD variations were found to be consistent within individual lithostrati-
graphic units but are significantly different between these units. Therefore, REE signatures and UCD are markers for their units and are used to discriminate between units for purposes of stratigraphic correlation and paleoenvironmental interpretation. Results of our research indicate that REE analyses and UCDA provide for a finer scale of resolution for stratigraphic correlation.

Poster Session I

FUSED CAMARASAURUS CERVICALS PRESERVE AN ERECT, NOT HORIZON-
TAL, NECK

PAUL, Gregory, Baltimore, MD

Computer simulated posture of sauropod necks including camarasaurs is consistently hori-
zontal. The minimal spacing between centra in these simulations is problematic. Actual neck posture is determined by a combination of bone and cartilage. The thicker the inter-
centra cartilage is the more dorso-flexed is the neck if the zygapophyses remain in 100% neutral articulation. In some giraffe specimens and Camarasaurus CM 11338 large gaps separate many cervical vertebra, when the neck is straight and the zygapophyses are in full neutral alignment, indicating the space was filled with thick cartilage. Centra may be pulled together when the intercentra cartilage dries after death, many dorsals are jammed tightly together in CM 11338. It is simply not possible to reliably restore sauropod neutral neck posture unless the cartilage is directly preserved.

Cervicals 11 and 12 of Camarasaurus AMNH 5761 are fused with the zygapophyses in 100% neutral articulation. The long axes of the centra are dorso-flexed 9 degrees, it may have been higher before modest dorso-ventral crushing. Because posterior cervicals of other specimens are straight or slightly depressed when the zygapophyses are neutrally aligned and intercentra spacing is minimal, thick cartilage padding apparently was present and ossi-
fied in 5761. If camarasaurs normally held their necks horizontal then the two vertebrae should have fused in a straight line. That the neck base fused dorso-flexed meant there were strong pressures to hold the neck erect. Sauropods had 6 or more cervo-dorsals, so 10 degrees of dors-o-flexion per joint along the neck-trunk juncture would add up to 60 degrees over all. Cartilage wedging may have forced habitual erect neck posture in many other sauropods. Only some diplodocids with short necks and/or low shoulders could not readily carry the head far above shoulder level. Had Osborn and Mook, who figured the 5761 cer-
vicals in 1921, described the flexion and used them to correctly restore an erect neck then the controversy over sauropod neck posture might never have arisen.

3D Imaging Symposium, Friday 9:30

COMPARATIVE PALEOECOLOGIES OF NORTH AMERICAN MIOLAENIDS AND “HYPOSODONTIDS” (MAMMALIA: “CONDYLARTHRA”) USING COM-
BINED DENTAL MORPHOMETRIC TECHNIQUES

PENKROT, Tonya, Johns Hopkins Univ. School of Medicine, Baltimore, MD

Two families of “condylarths”, Miolaenidae and “Hyposodontidae” (both as traditionally defined), comprised a significant portion of the small-bodied mammalian diversity during the Paleocene and early Eocene of North America. The paleoecologies of these families are poorly understood, despite their relative abundance in many assemblages. Consequently, aspects of the geographic and temporal distribution of miolaenids and “hyposodontids” including a pattern of regional endemism in the early Paleocene but a more homogeneous distribution of genera by the Eocene, and the apparent extinction of the North American miolaenids (but not of “hyposodontids”) shortly after the end of the Torrejonian NALMA, present paleoecological puzzles. Competitive exclusion between the two families, or unequal success in adapting to different climates, may be potential expla-
nations for the resulting distributions of these taxa through space and time. In mammals, dental morphology is a logical means for addressing paleoecological ques-
tions. Tooth counts of extinct taxa may be assessed as a proxy for ecological function. In this study, miolaenid and “hyposodontid” dentitions were analyzed relative to a compara-
tive sample of modern mammals of known diets, and to a subset of other contemporary condyarth, via a combination of linear measurements and occlusal surface characteriza-
tion through laser-scanning.

Results indicate that, when miolaenids and “hyposodontids” were contemporaneous during the Torrejonian, they occupied adjacent but distinct regions in dental morphospace. The position of “hyposodontid” subsequent to the extinction of miolaenids changed little, however, arguing against competition as an explanation for the disappearance of mio-
laenids. Variation within “hyposodontids” then expanded in the early Eocene with the immigration of Hyopsodus. This genus represents a possible ecomorphologic intermediate between traditional “hyposodontids” and Torrejonian miolaenids, complicating the paleoe-
cological pattern displayed by these two families of small-bodied condylarths.

Poster Session II

LATEST CRETACEOUS IBERIAN DINOSAURS: AN UPDATE

PEREDA-SUBERBIOLA, Xabier, Universidad del Pais Vasco, Facultad de Ciencia y

Tecnologia, Departamento de Estratigrafia y Paleontologia, Bilbao, Spain; TORICES, Angelica, Universidad Complutense de Madrid, Madrid, Spain; COMPANY, Julio, Universidad Politecnica de Valencia, Valencia, Spain; RUIZ-OMENACA, Jose Ignacio, Museo del Jurassico de Asturias, Colunga, Spain; CANUDO, Jose Ignacio, Universidad de Zaragoza, Ciencias de la Tierra, Paleontologia, Zaragoza, Spain

Dinosaur remains from the Campanian-Maastrichtian of the Iberian Peninsula were first described at the end of the 19th century, but most of the significant discoveries have bee

named in the last years. The most productive sites are Laño (Treviño) and Chera (Valencia), for the upper Campanian-lower Maastrichtian beds, and the Temp (Lleida) and Azín (Huesca) areas, in the southern foothills of the Pyrenees, for the Maastrichtian. Other locali-

ites are known in Alava, Barcelona, Burgos, Segoria, Valencia (Spain), and Beira Litoral (Portugal). Theropods include small to medium-sized dromeosaurids, the enigmat-
ic coelurosaur Paronychodon and abelasaurid-like cetosaurians. Ornithomimosauras and

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enanthornithine birds may also be present. Sauropods consists of the liisthotrostan Lirainosaurus astibiae and indeterminate titanosauriformes. Ankylosaurs are represented by the nodosaur Struthiosaurus; a new partial skull from Valencia resembles that of S. austriacus. Ornithopods include the basal iguanodontian Bahlododon priscus and hadrosaursid. The Iberian hadrosaurin record is the best of Europe, but only one taxon has currently been named: Parahbaldodon isomensis. Euhadrosaurian cranial remains from Huesca, Lleida and Valencia probably belong to taxa different from Parahbaldodon and Telmatosaurus. The presence of Lambeosaurinae in the southern Pyrenees seems likely. From a biogeographical perspective, the Iberian dinosaurs are closely related to those of southern France. Minor differences (e.g., distinct titanosaurian genera) could be due to provinciality within the Ibero-Armorican Realm. Most of the suprageneric taxa known in southern Europe (Dromaeosauridae, ?Abelisauridae, Liotostrota, Nodosauridae, Rhabdodontidae, Hadrosauridae) were already present in the Late Jurassic-Early Cretaceous of the Laurasian landmasses. Such a distribution suggests that the dinosaurian isolation by vicariance in the European archipelago during the Late Cretaceous may have played a major role, although dispersal events cannot be dismissed.

Poster Session I

TOOTH ROOT SIZE AND CHEWING MUSCLE LEVERAGE IN HOMUNCULUS, A MIocene PRIMATE FROM PATAGONIA

PERRY, Jonathan, Duke Univ., Durham, NC; KAY, Richard, Biological Anthropology & Anotomy, Durham, NC; COLBERT, Matthew, The Univ. of Texas at Austin, Austin, TX; Homunculus patagonicus from the early Miocene of Patagonia is the oldest South American monkey (Platyrrhini) for which one can assemble a composite of the cranial, the mandible, and the postcanine teeth sufficient to reconstruct the position of the temporomandibular joint, the centroids of the major muscles of mastication, the position of the canine and cheek teeth, and the area and volume of the tooth roots. Such measurements provide a picture of the force vectors of the muscles. They also provide information on the estimated tooth leverage at each tooth. Using CT-imagery, anatomical parameters were measured and compared with small- and mediu-sized extant platyrrhines. Findings include: 1) the distribution of muscle leverage on the canine and cheek teeth is similar to that seen in living platyrrhines, 2) leverage at each tooth position is less in Homunculus than in living species perhaps as a consequence of its greater degree of prognathism, 3) the pattern of tooth root areas and volumes is similar in all taxa, but Homunculus has more tooth root area and volume at each tooth position than do the extant platyrrhines. Its large tooth roots suggest that Homunculus experienced heavy loads in mastication, in spite of poor muscle leverage. Perhaps Homunculus had larger masticatory muscles than living platyrrhines, but several aspects of the anatomy make this unlikely: the zygomatic arch is not larger or more robust than that of living platyrrhines and there is no sagittal crest (despite a small endocranial volume). In Homunculus, cresting for the attachment of the chewing muscles is slight. However, the postcanine teeth in most specimens are heavily worn. If Homunculus had poor chewing muscle leverage and small chewing muscles, perhaps its great degree of tooth wear was caused by repetitive loading to break down tough and/or gritty foods. Repetitive loading might also explain the great size of the tooth roots in this extinct platyrrhine.

Friday 2:15

MORPHOSPACE OCCUPATION IN EXTANT AND EXTINCT CROCODILES

PIERCE, Stephanie, RAYFIELD, Emily, ANGIECZYK, Kenneth, Univ. of Bristol, Bristol, United Kingdom

Patterns of diversity among extant and extinct mesoeucrocodilians were studied from a morphological and functional perspective using geometric morphometrics and finite element modelling. An analysis of 125 extant crocodile skulls from all 23 living species shows that most modern crocodilians are morphologically conservative, with the main sources of shape variation being the length of the snout and the width of the skull. Ghialars, however, occupy a different area of morphospace reflecting their unique skull shape. Lastly, 3D finite element models representing extremes of the first principle component of skull shape (i.e., short/broad snout vs. long/narrow snout) produces a very similar distribution of stresses throughout the skull. Peak stresses in the longest, narrowest skull were roughly three times those of the shortest, broadest skull. This suggests that cranial strength is highly dependent on shape and that long-nosed crocodilians have sacrificed skull strength for increased tooth count and high velocity jaw closure.

A comparable pattern of diversity can be observed within the Thalattosuchia, Jurassic longirostrine marine crocodyliforms. An analysis of 48 skulls representing the Teleosauridae and Metriorhynchidae illustrates that thalattosuchian “species” are discrimi- nated by the length of the snout and the width of the skull with each family occupying a sepa- rate area of morphospace. When combined with modern crocodiles, thalattosuchians and gharials share a similar region of morphospace that is distinct from other extant species. This implies that gharials are convergent on the thalattosuchian skull shape and that there may be limited ways in which crocoids can evolve a long, narrow skull. As thalattosuchians and modern crocodiles each differ in major cranial and postcranial features, the thalattosuchians may represent a distinct morphospace.

Student Poster Session

CONSERVATION AND DESCRIPTION OF THE FIRST TYRANNOSAURUS REX SKELETAL MATERIAL FROM SOUTH DAKOTA

PINSFORD, Michelle, South Dakota School of Mines and Technology, Rapid City, SD

The sixth documented associated skull and skeletal material attributable to Tyrannosaurus rex was recovered from 1981 through 1983 from Butte County, South Dakota. It currently resides in the collections of the South Dakota School of Mines and Technology as SDSM 12047. Although portions of SDSM 12047 have been figured and measured for data with- in publications, the whole of the specimen has never been described. As a roughly 40% complete specimen, SDSM 12047 offers a great deal of potential to add to the currently popular studies of the Tyrannosauridae. In preparation for a Master’s thesis that will docu-ment and describe all parts of this specimen, all associated material is undergoing various degrees of preparation and/or conservation. Preparation activities include the removal of sediment and concretion materials with mechanical and manual processes. Conservation efforts include the removal of several kinds of aging consolidants and adhesives, and the replacement of gap-filling materials. The details of these processes, as well as preliminary findings, will be documented. Potential for further research is detailed in the photographs, measurements, and documentation of unusual features seen in certain parts of the skeleton. These include enamel spalling, wear facets, and split carinae on the teeth. Also included are potential pathologies exhibited in several bones, and characters that may cloud the speci- men’s affinity to T. rex.

Poster Session III

DATA MINING PHENOTYPES: DIETARY PREDICTION AS A CASE STUDY

PLUSVININ, Ilia, JERNVALL, Jukka, EVANS, Alistair, GIONIS, Aristides, Univ. Helsinki, Helsinki, Finland

The objective of this study is to build a fully automatic method that can predict diet of mammalian species from 3D scans of its postcanine teeth. The approach includes automatic measurement of multiple shape variables, such as number of cusps, crown relief and surface complexity. Common data mining algorithms are then used to search for a combination of shape variables and a relation model that perform best at predicting diet. As a result, a classification system was found that could label any scan in a data set of 58 species as herbivorous, omnivorous or carnivorous, with cross validation accuracy of 81%. The same approach can be applied to predict other classifications, such as phenotypic dis- parity among taxa and even developmental roles of genes from mutant morphologies. The main novelty of the data mining approach is that it can be applied fully automatically to sets of highly variable morphologies. The three-dimensional data is stored in MorphoBrowser database on dental shape and the data mining can be built directly into the database as a search interface with multiple search options.

Friday 3:00

MAMMOTH METAGENOMICS: NEW TECHNOLOGIES, NEW INSIGHTS, NEW POSSIBILITIES

POINAR, Hendrik, SCHWARZ, Carsten, McMaster Univ., Hamilton, ON, Canada; MacPHEE, Ross, American Museum of Natural History, New York, NY; MILLER, Webb, SCHUSTER, Stephan, Pennsylvania State Univ., Univ. Park, PA

Several important strides in ancient DNA (aDNA) studies have been made in the past two years, including the first utilization of new sequencing-by-synthesis technology to recover large quantities of genetic information from fossil remains of an extinct mammal (Mammuthus primigenius). In that study, we generated and analyzed 26 x 10⁶ base pairs (bp) of sequence data in a single 6 hr run from an exceptionally well-preserved 27,700-year- old mandible collected in the Lake Taimyr region of arctic Siberia (73ºN, 100ºE). Approximately half (13 x 10⁶ bp) of the data set proved to be alignable, at a high level of similarity (98.55%), with previously acquired genomic sequences of the African savanna elephant (Loxodonta africana). (Genomic sequence date for the Indian elephant are not yet publicly available.) Since our initial study we have completed 7X coverage of the mitochondrial (mt) genome of the Taimyr mammoth sample; fidelity of results is high (99.8% simi- larity to two other recently-published complete mtDNA genomes of the woolly mammoth, which in turn demonstrates the accuracy and reliability of the methods employed. Using these and other data, our preliminary estimates of late Quaternary woolly mammoth diver- sity indicates that populations were panmictic, with shallow diversity and small effective population sizes (at least during some intervals within radiocarbon time, i.e. the past 40-50,000 14C years). Assembling and interpreting such data provides a basis for evaluating both the promises and the pitfalls of high-throughput technology, especially in regard to estimating population dynamics and evolutionary distances within extinct or partially-extinct clades. We shall also discuss the importance of preservation conditions and sample-preparation methods to take advantage of recent technological improvements.

3D Imaging Symposium, Friday 11:45

3D BIOMECHANICAL MODELS AND THE EVOLUTION OF CARNIVORE KINESIS IN MOSASAURID SQUAMATES

POLCYN, Michael, Southern Methodist Univ., Dallas, TX

Increased cranial size has been considered a key innovation in squamate evolution and much has been written on the subject. In derived mosasaurs both the metakinesis and the mesokinetic axes of the skull are obliterated by increasingly complex relationships of the constituent bones. Basal mosasaurs have long been considered to possess a more ketin-
ic skull than later forms. However, it is only in recent decades that discovery of well preserved specimens of early mosasaurs allows examination of cranial morphology in sufficient detail. As such, there is little agreement on the sequence of evolutionary change within this clade. This study used a finite element analysis and computational inverse kinematics operating on threedimensional models of mosasaur skulls derived from laser and CT scanning and allows both experimental and quantitative analysis of motion, forces, and stresses to assess the possible selective pathways for loss of cranial kinesis in later mosasaurs. Reduction of mobility in the metatokinetic axis is already apparent in Middle Turonian russellosaurian mosasaurs and by the Coniacian some members of that clade have limited mobility in the mesokinetic axis. In mosasaurs, the skull transition occurs later, consistent with the more recent cladogenesis of that subfamily. However, those two groups of mosasaurs attain the loss of kinesis by different means and suggests that fundamental reorganization of feeding mechanisms required for submarine prey capture and consumption occur early in the evolution of mosasaurs and are achieved independently in multiple clades. Retention of the pleosomorphic mode of cranial kinesis in Halsaurus may indicate a later entry into the marine realm of that genus. Thus, mosasaurs provide an example of the application of new analysis, simulation, and visualization techniques to investigate a classic problem of vertebrate palaeontology and morphology, resulting in a greater understanding of the functional evolution of feeding and kinesis.

Poster Session I

SUBCHONDAL BONE DENSITY AND JOINT POSTURE IN SUBFOSSIL MALAGASY LEMURS

POLK, John, SCHWARZ, Jennifer, Univ. of Illinois, Urbana, IL; GODFREY, Laurie, Univ. of Massachusetts, Amherst, MA

This study uses an experimentally validated methodology to infer habitual knee and hip joint posture in a sample of subfossil Malagasy lemurs. More specifically, this study analyzes the spatial patterns of subchondal bone density on femoral condyles in five subfossil lemurs: Microcebus, Archaeolemur, Mesopropithecus, Pachylemur and Hadropithecus. Subchondral density was measured using Computed Tomography (CT) scans of a single femur for each of these genera. Amira software was used to reconstruct the three-dimensional structure of the femora from CT slices and to apply color maps to regions of differing bone density. Two-dimensional slices were obtained through the center of the femoral head and through the medial condyles of each specimen. Relative joint angles and the range of joint loading were estimated by measuring the angular position of the center of the region of maximum relative density (RMD) on the condyle. Our results suggest that Megaladapis used extremely flexed knee and hip postures which is consistent with previous positional interpretations. The range of the RMD for the remaining taxa suggest that they used moderately extended knee postures and are not well distinguished. However, both Pachylemur and Mesopropithecus have more subtle density patterns that suggest some use of highly extended postures. The juvenile Hadropithecus had lower density and a broader spread of the RMD, suggesting a wider range of habitual knee postures. While it is likely that these species moved in different ways than extant lemurs, further analyses of other mammals are necessary to determine the locomotor behaviors that caused these patterns of bone density.

3D Imaging Symposium, Friday 18:30
CHARACTERIZATION AND COMPARISON OF 3D SHAPES USING EIGENSURFACE ANALYSIS: LOCOMOTION IN TERTIARY CARNIVORA

POLLY, P. David, Indiana Univ., Bloomington, IN; MACLEOD, Norman, The Natural History Museum, London, United Kingdom

Eigensurface Analysis is a new geometric morphometric technique for the characterization and quantitative comparison of 3D surfaces. The core of Eigensurface Analysis is interpolation of a point grid with consistent sampling characteristics irrespective of the nature or complexity of the surfaces included in the sample. Like Procrustes landmark and eigen-shape outline analyses, the 3D point grids are standardized to remove size, rotation and translation. At present the eigensurface grid must be applied to each object in a comparable orientation. Procrustes analysis using a small number of surface landmark points is used to accomplish this. Once a set of comparable grids have been obtained, shape analysis proceeds as in standard eigenshape analysis by a singular value decomposition of the covariance matrix of the objects. Resulting eigenvectors serve as shape variables for further analysis, with scores of objects on them being used to represent shape ordinations, serve as the basis for shape models, etc.

As an example, Eigensurface Analysis was used to infer the number of toes, stance, and locomotor mode from the calcaneum morphology of six Tertiary carnivorans. Ten extant species were used to determine mean calcaneal shape for four- and five-toed species, for plantigrade, semifemurigrade and digitigrade species, and for arboreal, semiaquatic, terrestrial, semifemurigrade, and natural species. The best match for each fossil to these categories was then determined by Procrustes distance. Locomotor inferences were mostly accurate, but with two errors. Ictitherium viverrinum, a Miocene hyaenid, was correctly identified as being a four-toed digitigrade terrestrial animal and Paramachairodus orientalis, a Miocene saber-tooth felid, was incorrectly identified as five-toed and semi-digitigrade. The Miocene otter Enhydridon latipes was correctly identified as a five-toed and semi-digitigrade, but incorrectly inferred to be terrestrial. The Oligocene amphicynodont Cynelos lemanensis was correctly identified as five-toed and terrestrial, but incorrectly inferred to be digitigrade (it was probably plantigrade).

Poster Session III

DISTINCTIVE CHARACTERISTICS OF SUBFOSSIL MAMMAL BURROWS (FROM THE ARGENTINE PORELLO DE LA INVERNADA) — INTERPRETATION OF THE TRACEMAKER)

PONOMARENKO, Dmitri, RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada

Vertebrate burrows provide evidence of both morphology and behaviour of the animal that constructed them, but there exists no reliable method for the identification of the tracemaker. We have studied modern analogues of fossil burrows to develop methods of their identification from quantitative as well as qualitative characteristics. Diameter and angle of descent are features of the vertebrate burrow that relate primarily to the animal’s dimensions and can therefore be used to identify the tracemaker. However, the certainty with which burrow architects can be distinguished is poorly defined even for living species of mammals. Variation in cross-sectional size and shape can depend on the size of the animal and on taphonomic processes.

Three-dimensional mapping of subfossil burrows at a locality in Gatieau, Quebec allowed us to describe the variability of burrow dimensions, nature and probable mode of their infill, as well as the collapse structures for two living species of sciurid mammals. Plaster casts of open burrows were used to compare the difference in variability of several parameters between open burrows and infilled burrows in soil. Taphonomic processes were examined through excavation of partially collapsed Marmota monax and Tamias striatus burrows.

Literature descriptions of burrowing movements and examinations of cadavers were used to relate burrow dimensions to anatomical and behavioural characteristics (joint range of motion, girth, shoulder width, stroke sequences, quiet standing position). Although the diameter of a mammal burrow does not correspond to any single skeletal measurement, it can be used to formulate hypotheses that involve both skeletal dimensions and the mode of digging.

Poster Session III

A REVIEW OF MESOZOIC AND CENOZOIC CHIMAEROID FISHES (HOLOCERHALI, CHIMAEROIDEI) FROM TERRITORY OF THE FORMER USSR

POPOV, Evgenii, Geological Faculty, Univ. of Saratov, Saratov, Russia

During two last decades our knowledge about Mesozoic and Cenozoic chimaeroid fishes (Holocerhalii, Chimaeriformes, Chimaeroidae) from territory of the former USSR are increased greatly. Their remains (isolated tooth plates mainly, a lot of head eluspers and fin spines, rare egg cases’ imprints) were found in Russia (80+ localities, Narian to Oligocene), Ukraine (5: Albain to mid Eocene), Kazaskhstan (20+: Albain to lower Oligocene), Uzbekistan (6: Albain to mid Eocene), Kyrgyzstan (1: Yprisean) and Lithuania (3: Albain). Some of these localities are very rich in chimaeroid material: 4500+ remains of 9 genera and 10 species were collected from Albain-Cenomanian of Stolienski and Lebedinski quarries in Belgorod Province, Russia.

Taxonomic composition of Chimaeroidae consists of three families (Callorhinichidae, Rhinocerhinaeidae and ‘Edaphodontidae’ [probably of paraphyletic origin]), 17 genera (C: ‘Emonodon’, Callorhinichus, Brachymylus, Dufindos, plus 1 undescribed new genus; R: Belgorodon, Harriotta, Kushmurunia plus ’Rhinocerhina’ egg case; E: Ichysodus (dominated), Edaphodon, Elasmus, Elasmocrates, Lebediodon, Amylodon, plus 2 still undescribed genera) and about 50 species. Collected materials were come from marine (mainly locs) paleoenvironments, desalinated (some Middle Asia locs) and even freshwater ones (Mid Jurassic ‘Pesci’ loc near Moscow).

So diverse and large material allowed us to revise the terminology, to study tje morphology and variability of chimaeroid dentitions (basic available for research chimaeroid remains) and to make changes in systematics and evolution of Chimaeroidae. Following stage of the research will be revision of collections from Western Europe, Australia etc for solving some nomenclature and taxonomic problems of the Chimaeridae and for obtaining a complete conception of the fossil chimaeroid systematics and evolution.

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therefore is here regarded as a member of the Carnotaurinae. MUPiC 1125 resembles Gemusaurus, confirming that the latter is also a member of that clade. The discovery of this pelvis of a Carnotaurinae increases the knowledge of this group and suggests that those theropods played a major as predators during the Upper Cretaceous of Patagonia.

Student Poster Session

CRANIATE BIOMECHANICS OF BASAL ORNITHISCHIANS USING FINITE ELEMENT ANALYSIS
PORRO, Laura, Univ. of Cambridge, Cambridge, United Kingdom

Ornithischian dinosaurs were the dominant terrestrial herbivores of the Late Mesozoic, developing a wide range of feeding strategies to process vegetation. These feeding styles diversified rapidly amongst early ornithischians; yet the jaw mechanics of the most basal clade of ornithischian dinosaurs, the heterodontosaurs, remain unresolved. It is of importance to uncover the feeding strategy utilized by heterodontosaurs to better understand the early development and evolution of herbivory within Ornithischia. In this study, the engineering technique of finite element analysis (FEA) was applied to 2D models of the skulls of the primitive ornithischians Heterodontosaurus, Lesothosaurus, and Hypsilophodon. Although all three animals were herbivorous, cranial and dental morphology suggests they utilized very different feeding strategies. In addition, the basal theropod Eoraptor was included as a biomechanical outgroup. Results from analyses of a 3D finite element model of the skull of Heterodontosaurus are also presented. The aims of this study are: 1) to uncover differences in the mechanical response of the skulls that may represent specializations to different feeding strategies, 2) to examine key structural differences that may have evolved in early ornithischians during the transition to herbivory, and 3) to assess the value and limitations of 2D finite element models.

Results of the 2D analyses reveal both similarities and differences in the mechanical behavior of the skulls of these early dinosaurs. Stress trajectories and areas of peak stress were generally similar across all taxa and remained unchanged despite variations in bite force. Notable differences include the relative strength of the skulls of different taxa during various modes of biting; stress distribution and trajectories during biting on the premaxillary teeth; the effect of the size of the antorbital fenestra on relative skull strength; and the transmission of stress through the lacrimal of Eoraptor. Results from testing on the 3D model of Heterodontosaurus allow assessment of the value and limitations of 2D finite element models.

Student Poster Session

SMALL CARNIVORES AS TAPHONOMIC AGENTS ATTRIBUTING TO THE ACCUMULATION OF FOSSIL BIRD ASSEMBLAGES
PRASSACK, Kari, Rutgers Univ., New Brunswick, NJ

Taphonomic and skeletal part profiles, of bird bone assemblages produced by carnivores, should differ depending on the size relationship of predator to prey. Smaller carnivores feeding on larger or similar-sized avian prey should produce non-digested bone assemblages with a high number of tooth markings that are smaller than those produced by larger carnivores. Fragmentation rates should be low and whole elements common. Proportionally larger carnivores and/or scavenged bird bone assemblages are expected to be highly fragmented, with a low potential for element or taxonomic identification. Masai dogs were fed chicken and found to either completely consume bone or produce small unidentifiable fragments, supporting this hypothesis. Neotaphonomic observations were then conducted to test the effects of small carnivorous mammals (<15kg). Small carnivores were fed carcasses of chicken, duck, and turkey. Data was obtained on the placement and size of tooth pits, punctures, and scores, fragmentation rate, carcass consumption sequence, removal of choice parts from the site, and resulting skeletal part profiles. This data was then used to analyze two modern lesser flamingo assemblages, an attritional accumulation from Lake Natron, Tanzania and a catastrophic accumulation from Lake Nakuru, Kenya. These assemblages fit the taphonomic and skeletal part profiles attributed to modification primarily by smaller carnivores. Both sites exhibit a high number of complete elements, low fragmentation, modification in the form of small tooth markings, and an abundance of forelimb versus hind limb elements. Fossil birds are common in many paleontological and archaeological localities, but taphonomic analyses are rarely conducted on them. Results of this study suggest much more attention should be lent to the taphonomic study of smaller carnivores and their effects on the survivorship of fossil bird assemblages.

Poster Session III

A NEW FOSSIL CANID ASSEMBLAGE FROM THE LATE PLEISTOCENE OF NORTHERN SOUTH AMERICA: THE CANIDS OF THE INCIAIRE ASPHALT PIT (ZULIA, VENEZUELA), FOSSIL RECORD AND BIOGEOGRAPHY
PREVOSTI, Francisco, Museo de La Plata, La Plata, Argentina; RINCÓN R., Ascano, The Univ. of Texas at Austin, Austin, TX

Canids invaded South American during the Pleistocene (2.8-3.1 Ma BP) as part of the Great American Biotic Interchange, but their record on the continent is relative poor until the Pleistocene. However, even the Pleistocene record of the group is patchy and biased, with few records for the northern part of South America. In this paper we describe a new assemblage of canids found at the Inciarte asphalt pits (Zulia, Venezuela). These remains are associated with a variety of extinct Pleistocene mammals dated between 25-27 Ka BP. Canids in this assemblage include Protocyon troglodytes, Protocyon sp., Canis dirus, Urocyon cf. U. cineroargentus, and an indeterminate canid. This is the first record of Urocyon from the Late Pleistocene in South America and constrains the timing of its dispersal to South America prior to 25-27 Ka. The distributional record of Protocyon and P. troglodytes is expanded 1,500 km north of previous records and constitutes the first record of these taxa in Venezuela. The presence of C. dirus at Inciarte constitutes the fourth locality for this species in South America.

Neoceti Symposium, Saturday 9:15

EXTRAPOLATING FROM EXTANT TO EXTINCT: RECONSTRUCTION OF EARLY NEOCETE LIFE-HISTORY STRATEGY AND ECOLOGY
PRIETO-MARQUEZ, Albert, JOSHI, Shantanu, PARKER, William, Florida State Univ., Tallahassee, FL

The pelvic girdle of hadrosaurid dinosaurs is known to contain phylogenetic information. However, most of the currently used characters usually separate hadrosaurids from less derived forms. We explore the morphological variation of the ilia (n = 104), ischia (n = 84), and pubes (n = 63) of sixteen hadrosaur and two non-hadrosaur genera with the goal of revealing new phylogenetically informative characters and test currently recognized ones. In doing so, we also aim to separate taxonomic from individual and ontogenetic variation. The morphometry of the bones is done implementing the newly developed Geodesic Distance Analysis (GDA). This method represents shapes as continuous curves invariant to translation, rotation, and uniform scaling, without resorting to salient finite dimensional landmarks. Shape differences are computed by finding geodesics (or shortest length paths) intrinsic to the shape space. GDA allows posing intrinsic statistical inferences in the infinite dimensional space consisting of full contours of shapes. We summarized GDA shape differences by generating cluster linkages (arithmetic averaging) and non-metric multidimensional scaling plots. Each pelvic element was decomposed into homologous regions or process es. GDA is implemented for the samples of each one of these homologous structures. Osteological attributes with patterns of variation that allow separation of taxa and that could be phylogenetically informative include: the dorsoventral position of the medial longitudinal iliac crest, as well as its distance from the dorsal border of the bone; the location of the ischiatic notch of the supraacetabular process relative to the caudal protuberance of the ischiadic peduncle; the distance or degree of caudal extension of the lateral rim of the supraacetabular process; the dorsoventral or mediolateral compression of the iliac postacetabular process, as well as the angle between its dorsal surface and the prasagittal plane; the degree of cranial indentation and concavity of the ventral margin of the pubic ischiadic peduncle; and the lateral profile of the iliac peduncle of the ischium, especially the shape of its dorsal margin. Previously known characters supported by this analysis include changes in the morphology of the prepubic process of the pubis and the morphologic of the distal end of the ischial shaft. Our results also reveal more patterns of variation within footed and non-footed ischia than previously recognized.

Wednesday 11:15

THE EFFECTS OF OVERSPLIT TAXONOMY ON DIVERSITY CURVES: THE DROMOMERYCID DATA BASE
PROTHERO, Donald, LITER, Matthew, Occidental College, Los Angeles, CA

The subfamily Dromomerycinae is an endemic radiation of North American Miocene cursorial ruminant artiodactyls characterized by variety of bony cranial appendages. Their species-level systematics has not been reviewed since Frick’s 1937 monograph, and the group is oversplit with many redundant subgenera and over 50 named species, most of which were nomina nuda (no diagnosis provided) and have not been analyzed since 1937. We used modern biological concepts and statistical methods to greatly reduce the number of valid taxa in the subfamily. Among the Aletomerycini, the late Arikareean immigrant Aleotomeryx contains three species, A. gracilis (with three junior synonyms), A. marlensandensis, and A. occidentalis. The peculiar curve-horned Sinclairomeryx is monotypic. Among the Dromomerycini, Dromomeryx (Mathomeryx) matthewi is a junior synonym of D. falconeri. The last hoplotherium, Subdromomeryx, is monotypic with five junior synonyms. Straight-horned Dromomeryx boralis is also monotypic (with three synonyms), as is Sabrodromomeryx antilopinus (raised to generic rank), which has four junior synonyms. As part of the separate immigration event of the Cricrogenatini in the late Arikareean,
there is only one valid species, *Barbourouyrux trigonocorneus*, with two additional invalid subgenera and three invalid species. The common genus *Barbourouyrux*, which had been split into eight species, has only two, the smaller late Hemingfordian *B. submilleri*, and the Barstonian *B. americanus*. The monotypic three-horned *Procrociocras skinneri* remains valid, but elevated to generic rank. *Cranioyrux*, which has two straight supraorbital horns and its occipital horn pointed posteriorly, once contained seven species, but now consists of the larger *C. unicornis* and the smaller *C. teres*. Thus, 50 invalid species are reduced to just 17 species in 11 genera (most of which are now monotypic) with no subgenera. This clarification of the taxonomic confusion of such an important group greatly enhances their usefulness in biostratigraphy and paleoecology. For example, diversity curves based on the old taxonomy show a peak in the late Hemingfordian, while the new diversity data peak in the early and late Barstonian, and continue higher in the early Clarendonian than previously published curves suggest.

**Neoceti Symposium, Saturday 9:45**

**HOW DID EARLY TOOTHED WHALES ECHOLOCATE? AN INVESTIGATION OF MORPHOLOGICAL EVIDENCE USING PHYLOGENETIC AND SOFT TISSUE INFERENCE**

**PYENSON, Nicholas, Univ. of California Museum of Paleontology, Berkeley, CA; MCKENNA, Megan, Scripps Institution of Oceanography, La Jolla, CA**

Toothed whales (Odontoceti) echolocate using sound pulses generated and received via a complex arrangement of soft and bony craniofacial structures. Inner ear morphology suggests early Neoceti had the ability to hear low-mid frequencies sounds underwater; high frequency and directional hearing are apomorphic in Odontoceti. In contrast to sound reception, the evolution of the sound generation (echolocation) in Odontoceti has not been addressed quantitatively. Echolocation has not been convincingly demonstrated in living mysticetes nor inferred in archaeocetes. The presence of osteological correlates for an air sac system (e.g., premaxillary sac fossae) has been used to identify echolocation ability in fossil odontocetes, but these correlates are not discrete novelties in this clade. Some extinct odontocetes likely echolocated as well as living taxa, but it remains unclear how early odontocetes echolocated using even more plesiomorphic facial morphologies.

To evaluate echolocation ability of extinct odontocetes, we developed a suite of functional correlates in craniofacial morphology related to sound generation in living taxa. Living odontocetes echolocate using different configurations of bony tissue and soft tissue complexes, but three key components drive this system: a power generator, a sound production mechanism, and a signal propagator. Using 2-D images and X-ray CT scans, we quantified three osteological proxies of these drivers (angle of the nasal pasageway relative to the skull anteroposterior axis; nasal pasageway volume; and estimated melon size). These criteria clarify the sequence of skull transformations associated with the evolution of the sound generation complex, as well as quantifying the morphological space needed for echolocation. Our pilot study analyzed outgroup taxa (basal archaeocetes, actinoctid mysticetes) and multiple ingroup taxa (e.g., *Simocetus, Squidodon, Prosquiddon, Albirole, Odobenocetops*) that are represented by near-complete and nondistorted crania. Mapping nasal pasageway angle (NPA) values indicates that some basal odontocetes had NPA similar to outgroup taxa, and NPA only increases past 90˚ in derived crown lineages (with a reversal in *Odobenocetops*).

**Friday 2:00**

**INNER EAR MORPHOLOGY AND ITS RELATIONSHIP WITH THE PTERYGOID SINUS IN FOSSIL AND EXTANT PORPOISES (CETACEA: PHOENICIDAE)**

**RACICOT, Rachel, BERTA, Annalisa, San Diego State Univ., San Diego, CA**

The morphology of the cetacean inner ear and other hearing-related features, such as the pterygoid sinus system, are sources of functional and phylogenetic information. However, the functional relationships between these various structures are not well known. Features of the cochlea related to hearing capability include the basilar membrane length and the number of turns of the cochlear spiral, both of which correlate with the range of high and low frequencies hearing. Scans of isolated and *in situ* tympanoperiotics of all six extant porpoise species and one fossil porpoise were obtained using high-resolution X-ray CT data. This method provides a means to assess morphological changes over time. Measurements from these data, including basilar membrane length, were used to infer frequencies potentially heard by fossil and modern porpoises. These were compared with sonograms from extant species when available. Digital endocasts were also isolated from *Phocoena spinipinnis* and *Phocoenoides* in which fossil bonebeds and microvertebrates sites located worldwide were formed.

**Saturday 11:30**

**THERIOPOD DINOSAURS FROM THE LATE JURASSIC OF TANZANIA AND THE ORIGIN OF CRETACEOIDEAN GONDWANAN THERIOPOD FAUNAS**

**RAUHUT, Oliver, Bayerische Staatsammlung für Paläontologie und Geologie, Munich, Germany**

Our understanding of Cretaceous theropod faunas from the Southern Hemisphere has been greatly improved in recent years, due to numerous discoveries mainly in South America, Africa and India/Madagascar. However, the origin of these faunas is still poorly understood, owing to the paucity of theropods known from the Jurassic of Gondwana. The famous Late Jurassic theropod faunas of Tendaguru, Tanzania, are thus of special interest, since they have yielded the only identifiable Late Jurassic theropod remains from Gondwana so far. Unfortunately, theropods are poorly represented in the material collected from that locality, but even the sparse material can give important insights in the light of the recent discoveries from the Cretaceous of the Southern Hemisphere.

Only one of the taxa described from Tendaguru is based on adequate material and can currently be regarded as valid, *Elaphrosaurus barbouri*. *Elaphrosaurus* is a very unusual taxon that combines coelophysoid-like presacral vertebrae and ilium with abelisaurid-like limbs. All other taxa described are based on undiagnostic material. The type tibia of *Allosaurus tandoPurvanis* represents a large basal tetanuran. The type material of *Ceratosaurus roehlingi* includes remains of a very large probable allosaurid and a small *Ceratosaurus*-like neoceratosaur. *Ceratosaurus*-like animal is also indicated by the premaxillary teeth described as *Labrosaurus stechowi*, whereas the teeth of *Megalosaurus* show allosaurid and even eocarchodontosaurid characteristics. Thus, potentially only two taxa are represented by all this material, a possibly caenirhodontosaurid allosaurid and a *Ceratosaurus*-like neoceratosaur. Further theropod taxa are indicated by isolated remains, including rib of a small basal tetanuran and a small to medium-sized abelisaurid, as well as remains of a further, slenderly built, large basal tetanuran and a robust, large abelisaurid. In summary, the theropod fauna from Tendaguru is dominated by neoceratosaurs (at least 3, probably 4 taxa) and basal tetanurans (at least 3 taxa), whereas coelurosaurians are conspicuously absent. Thus, this fauna is more similar to Cretaceous Gondwanan faunas than to contemporaneous faunas of Europe and North America, in which neoceratosaurs are rare and coelurosaurians are abundant.

**Poster Session I**

**COMPARATIVE MORPHOLOGY AND IDENTIFICATION OF DISSOCIATED CROCODYLIFORM OSTEODERM FROM THE UPPER CRETAEOID MEGVARANO FORMATION, MADAGASCAR**

**RAVELOSON, Miky Loa, Univ. of Tanararive, Antananarivo, Madagascar; WHATLEY, Robin, Smithsonian Institution, Washington, DC**

Since 1993, many hundreds of isolated crocodyliform osteoderms have been recovered from the Mvarano Formation of northeastern Madagascar by joint expeditions of Stony Brook Univ. and Univ. of Tanararive researchers. Although crocodyliform skeletal elements are common in these deposits, they are rarely preserved with articulated osteoderms, making taxonomic identification of isolated osteoderms problematic. Characteristics of size, shape, and texture of osteoderms associated with skeletal material of *Mahajangasuchus*, *Simosuchus*, and *Arripesuchus* contribute to a rubric for identifying dissociated osteoderms of these taxa. *Mahajangasuchus* osteoderms have deeply sculpted dorsal surfaces with accentuated or blade-like longitudinal keels and irregular margins. Although
and Simosuchus) possess quadrangular and ovoid osteoderms, the rugose dorsal surface, ventral surface grooves, and large size of Mahajangasuchus osteoderms discriminate these two taxa (maximum diameter of examined Simosuchus osteoderms is approximately two and a half centimeters, versus five centimeters maximum diameter for Mahajangasuchus osteoderms). In addition, an apex or slight ridge that does not traverse the entire dorsal surface of the osteoderm of Simosuchus is present instead of an exaggerat- ed keel. Araripesuchus osteoderms are thin, rectangular, and comparatively much smaller. We also find osteoderms with unique features likely belonging to one or more of up to four additional crocodyliforms known from this extraordinarily diverse local fauna.

3D Imaging Symposium, Friday 11:30
THE EVOLUTION OF PISCIVORY IN THEROPOD DINOSAURS
RAYFIELD, Emily, Bristol, United Kingdom; MILNER, Angela, Natural History Museum, London, United Kingdom
Craniodental morphology and fossilised gut contents from spinosaurid theropod dinosaurs indicate at least a partially piscivorous diet, a unique trophic adaptation among large, non-avian dinosaurs. Furthermore, spinosaurids represent a striking example of convergent evo- lution towards a crocodylian-like cranial morphology; the significance of this is unclear, and partly based on the fact that the biomechanical and adaptive significance of key croco- dylian characters remains to be fully explored.

Here we present new anatomical information from CT scan data, which was subsequent- ly used to create 3D comparative Finite Element models of the skulls of the spinosaurid theropod Baryonyx walker i and two extant crocodylians (Alligator, Gavialis) that are com- monly interpreted as functional analogues for spinosaurids. We conducted a series of FE- analyses to determine the differential stress response of each skull during bending and tor- sional loading.

Spinosaurids and extant gavial crania consistently function in the same manner, thus high- lighting an example of extreme morphological and functional convergence towards a pis- civorous trophic niche based on the acquisition of shared ‘crocodylian’ characters. The bony secondary palate confers strength to the alligator-type skull in torsion, but provides resist- ance to bending in gavials and spinosaurids. Loss of the antorbital fenestra strengthens nar- row or tubular theropod and gavial snouts, but has limited influence on the broader-snout- type. Consequently, the mechanical impetus for palatal development and fenestral closure observed in crocodylian evolution is more complex than previously suggested and most theropod skulls were surprisingly sub-optimally constructed to accommodate feeding relat- ed bite loads. A set of biomechanical constraints may have governed the acquisition of par- ticular functional complexes, and influenced the sequence of character acquisition in both crocodylian and theropod evolution.

Poster Session III
PLIO-PLIO-PLEISTOCENE PALEOVIRONMENTAL STUDIES FROM THE SERENGETI, TANZANIA, AND AMBOSELI, KENYA
Using calibrated methods based on modern faunas we test hypotheses of environmental change and habitat structure at the Plio-Pleistocene age Bed I assemblages from the FLK site at Olduvai. The calibration is based on modern, taphonomic assemblages of mammals weighing less than 1kg from the Serengeti ecosystem, Tanzania and Amboseli National Park, Kenya.

Modern micromammal assemblages created by owls were sampled from four localities in Amboseli and twelve localities in Serengeti. The faunas from these taphonomically gen- eralized and assemblages were compared to the surrounding habitats to test whether faunal com- position is consistent with the known habitat preferences of the micromammal taxa. These empirically derived micromammal communities were then plotted in a species ordination space using non-metric multidimensional scaling to demonstrate community response to habitat variation within the Serengeti and Amboseli ecosystems. Fossil species were then added to the ordination to assess their position in the species ecospace.

The Serengeti long has served as the preferred analogue for the paleoenvironments around paleo-lake Olduvai, with many researchers arguing that the Plio-Pleistocene envi- ronments were more wooded and similar to areas in the northern part of this modern ecosys- tem. However, the small mammal fossil assemblages at Olduvai are distinct from modern Serengeti communities in having large abundances of fossil Groove-tooth rats belonging to the genus OMOYLA. This genus is present at some localities in Amboseli, suggesting that this ecosystem, which shares many geomorphological features with paleo-Olduvai, may be a better modern analogue than the Serengeti. This calls into question the assumption that the nearest modern faunal community is the best analogue for mammalian fossil assemblages such as Olduvai.

Saturday 2:30
MANUAL PATHOLOGY INDICATIVE OF POSTMOTOR BEHAVIOR IN TWO CHASMOsaURINE CERATOPID DINOSAURS
REGA, Elizabeth, Pomona, CA; HOLMES, Robert, Canadian Museum of Nature, Ottawa, ON, Canada
We present evidence for a pathological process bearing on locomotion in the first manual digitar ray in two chasmosaurs. The holotype of Chasmosaurus irvinensis (CMN 41357) includes a complete, articulated right manus. The angle of articulation of the first metacar- pas and proximal pollical phalanges — based upon articular surface congruence — is abnormal; the metacarpophalangeal joint is medially deviated and the distal proximal pollical phalanx curves sharply laterally toward the second digit. The first metacarpus and proximal pollical po- phalangeal surfaces are also highly rugose; however this rugosity is not consistent with infectious periostitis. The distal articular surface of the first metacarpus and proximal articu- lar surface of the proximal phalanges are abnormally deeply grooved. Similar abnormal mor- phology, also involving these same elements of the first digital ray, is exhibited by both the right and left manus of Chasmosaurus bellus (ROM 843). The angulation of joints is most con- sistent with a condition in human feet known as hallux valgus, a condition caused primari- ly by forced habitual adduction of the distal first hallical ray causing deformity and abnor- mal joint angulation at the more proximal metatarsal-proximal phalangeal joint. Articulated manual elements are extraordinarily rare in ceratopsians. Given the apparent prevalence of the condition and the modern-day etiology of the hallux valgus, we propose habitual forced adduction of the pollux which led to the observed joint angulation deformity. Implications for manual pronation during normal chasmosaur locomotion are discussed.

Saturday 11:00
ORIGIN OF DENTAL OCCLUSION IN TETRAPODS: SIGNAL FOR TERRESTRIAL VERTEBRATE EVOLUTION
REISZ, Robert, Univ. of Toronto at Mississauga, Mississauga, ON, Canada
Evolutionary changes of the tetrapod dentition can be associated with major events in ter- restrial vertebrate history. In the Carboniferous, terrestrial vertebrate communities had low diversity and abundance, and little variation in dental morphology. Dental occlusion, the process by which teeth from the upper jaw come in contact with those in the lower jaw, appears first in cotylosaurs (amniotes+diadectomorphs) near the Permo-Carboniferous boundary. It coincides with the appearance of the oldest known high fiber herbivores and a dramatic increase in tetrapod vertebrate diversity. This evolutionary innovation permit- ted a dramatic increase in oral processing of food in amniotes and diadectids, and has been associated with herbivory. Whereas herbivory in extinct vertebrates is based on circumstan- tial evidence, dental occlusion provides direct evidence about feeding strategies because jaw movements can be reconstructed from the wear patterns of the teeth.

Examination of dental occlusion in Paleozoic tetrapods within a phylogenetic frame- work reveals that this innovation evolved independently in several lineages. Occlusion first appears among diadectomorphs, the sister taxon of amniotes. Although basal diadecto- morphs have conical, non-occluding teeth, diadectids show various levels of occlusion and tooth wear. This is achieved by transverse expansion of the marginal dentition in diadectids, bringing the lingual shoulder of the upper teeth in occlusion with the labial shoulder of the lower teeth. Among amniotes, the synapsid Edaphosauridae and the parareptile Bolosauridae show the earliest examples of occlusion and tooth wear, using palatal and preauricular teeth in the former and marginal teeth in the latter. The independent, multiple acquisition of this feeding strategy represents an important signal in early terrestrial vertebrate diversification and the development of complex vertebrate communities. However, this innovation pre- dates significantly the modern type of terrestrial ecosystem that first appears in the Late Permian, with large numbers of primary consumers supporting few top predators.

Tuesday 12:15
AN ONTOGENETIC SERIES OF THE CERATOPSID DINOSAUR EINIOSAURUS PROCURVICORNIS AS DETERMINED BY LONG BONE HISTOLOGY
REIZNER, Julie, HORNER, John, Montana State Univ., Bozeman, MT
Histologic studies have been utilized in paleontology to determine rates of growth for sev- eral types of dinosaur, including sauropods, theropods, hadrosaurs, and the basal ceratop- sian Psittacosaurus. However, dinosaurs of the family Ceratopsidae have largely been excluded. Several (MNI of 15) disarticulated skeletons of the centrosaurine Einiosaurus procurvicornis Sampson 1995, varying in size, have been found in the Upper Cretaceous Two Medicine Formation of northwestern Montana. Long bones (humeri, femora, and tib- iae) were sectioned, due to their minimal remodeling (infiltration of secondary osteons). After they were ground to appropriate thickness, the bone microstructure was viewed on a Nikon microscope (magnified 10×). The individuals’ ages at death, age at maturity for the species, and possible longevity are assessed. Tissue types and degrees of remodeling are discussed, and visible lines of arrested growth (LAGs) were used to calculate a maximum number of LAGs that were likely present before remodeling occurred. Specimens were then placed into age classes, based on size of the bone as well as number of LAGs, and growth rate was assessed. The rate of growth appears to be highest when the animal is 1— 2 years of age, and after 3 years growth slows, signifying that this may be the age at which sexual maturity is reached. Thus far, the oldest individuals are about 6 years old. This information on growth dynamics has implications for physiology, and possibly behavior, of ceratopsid dinosaurs.
and other hesperornithiforms are often compared to grebes or loons in
Crocuta crocuta spelaea
sp. (Crocodylia) skeleton. Because dorsal surface of the specimen is
has dorsoventrally broad jugals, very elongate nasals, and paired frontals
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, is also significantly similar to these three extinct
terms of their life habits, means of locomotion, and hind limb morphology. This compari-
Grebe,

bone length ratios, pelvis shape, and position of the acetabulum on the pelvis. The Western

are compared to determine if hoof wall thickness increases with geologic age and phylo-

are the middle Irvingtonian NALMA, suggesting an evolutionary trend toward thicker hoof

increases in the Barstovian, but remains within certain limits (1.0–1.6) through the late

One of the key characters of the sauropod dinosaurs is their obligate quadrupedalism, which is
also one of the necessary preadaptations for gigantism in this group. However, to date it
has never been shown how the functional transition from “prosauropod” to “sauropod” fore
limbs, i.e. from short arms with grasping hands in primary bipedal ancestors, to columnar,
weight-bearing forelimbs in quadrupedal descendants might have occurred. In this work, a
detailed study of bone morphology of the pectoral girdle and forelimb in a large variety of
sauropossoromorphs, basal saurischians, and basal saurisauromorphs was integrated with
reconstructions of the forelimb musculature, which were achieved by applying the Extant
Phylogenetic Bracket approach of Witmer. The results permit new insights on how this tran-
sition took place.

In the pectoral girdle, the coracoid rotate from a ventral position parallel to the verte-
bral column counterclockwise, facing anteroventrally in higher prosaurosaurs and anterior-
ly in basal saurosaurs. Thus, the humerus rotates from a ventrally directed, semi-erect
position to a fully erect condition, and the primary adductor-adductor muscles (M. pector-
als, M. deltoideus, and others) change their function or are reduced, respectively. Other
muscles become more important, e.g. the posterior Mm. triceps complex takes over the
function of the primary retractor of the humerus. A fully erect stance of the forelimb in
prosaurosaurs is impossible due to the posteroventrolateral orientation of the glenoid and the
inability to fully pronate the hand, a problem that is avoided when a semi-erect stance is
assumed. In the forearm, the proximal end of the radius rotates at the elbow joint from lat-
eral to anterior, allowing for a full pronation of the manus, and the flexor-extensor muscu-
ature of the forearm and the manus becomes reduced. However, the forearm pronators and
supinators are still large in basal saurosaurs and likely played an important role in stabiliz-
ing the limb during walking. On the line to nassocurosaurs, these key adaptations were fur-
ther optimized.

Student Poster Session
HIND LIMB AND PELVIS PROPORTIONS OF HESPERORNIS REGALIS: A COM-
PARISON WITH EXTANT DIVING BIRDS
REYNAUD, F., Fort Hays State Univ., Hays, KS
Hesperornis regalis and other hesperornithiforms are often compared to grebes or loons in
terms of their life habits, means of locomotion, and hind limb morphology. This compari-
sion is widely used and accepted, and dates back to O. C. Marsh’s 1859 monograph on
the toothed birds. However, no quantitative analysis has previously been published to deter-
mine whether this is an accurate morphological comparison. Ratio, multivariate, and aver-
age Euclidian distance analyses of five modern species of foot-propelled diver, including
one loon and two grebes, shows that the Common Loon, Gavia immer, is significantly sim-
ilar to Hesperornis regalis, H. gracilis, and Parahesperornis alexei in terms of hind limb
bone length ratios, pelvis shape, and position of the acetabulum on the pelvis. The Western
Grebe, Aechmophorus occidentalis, is also significantly similar to these three extinct
species when overall body size is removed from consideration; however, the Red-necked
Grebe, Podiceps grisegena, is not. Based on these results, the species closely analogous to
Hesperornis regalis, H. gracilis, and Parahesperornis alexei, and, therefore, a good model
on which to base study of their hind limb musculature and locomotion.

Poster Session II
IMPRINTS OF HORSE HOOFES IN THE SOUTHWESTERN NEOGENE FOSSIL
REYNOLDS, Robert, LSA Associates, Inc., Riverside, CA
Neogene horse tracks in southern Nevada and California are reported from only six locali-
ties. These limited tracks do not represent all horse tribes known from fossil record. New
and previously undescribed horse tracks in the Calico Mountains, California and Meadow
Valley Wash, Nevada prompted a review of ichnite morphologies from: Prosperity Canyon,
Calico Mountains, CA: late Hemingfordian (He2) NALMA Fossil Canyon area, Mud Hills,
CA: middle Barstovian (Ba2) NALMA Shadow Valley Basin, north of Baker, CA: late
Barstovian (Ba2) NALMA Muddy Creek Formation, Moapa, NV: late Hemphilian (Hb4)
NALMA Copper Canyon Formation, Death Valley, CA: early Blancan (Bl I) NALMA Lake
Teocopa Sediments, Shoshone, CA: late Irvingtontian (Ir II) NALMA Track measurements
are compared to determine if hoof wall thickness increases with geologic age and phylo-

tic time; if the surface area of the hoof sole increases over time; and if increases in these

specimen consists of a skull and fragmentary postcrania preserved in association with a par-
tial Diplocynodon sp. (Crocodilia) skeleton. Because dorsal surface of the specimen is
imbedded in an opaque epoxy plate, only the ventral view of the specimen has been avail-
able for description. Analysis of the exposed morphology led to an early referral of
Eosaniwa to Nesorauroidae. Earlier cladistic analyses including Eosaniwa were unable to
resolves the relationships of these platychoangeth. Although these analyses included numerous fossil anguimorphs, they did not include mosasaurids.

We used high-resolution X-ray computed tomography (HRXCT) for improved morpho-
logical analysis of Eosaniwa, including the previously unknown dorsal surface of the spec-
imen. Eosaniwa has dorsoventrally broad jugals, very elongate nasals, and paired frontal
with well-developed subcortical processes that do not meet at midline. We also identified
the sphenoid, basioccipital, and humerus of the specimen among other new observations.
We incorporated these data into a new cladistic analysis of 28 ingroup platynotans rooted
to two shinisaurid outgroups scored for 155 informative morphological characters. A strict
consensus of three shortest recovered trees suggests that Eosaniwa is the sister-taxon to a
cade composed of Paravaranus, Dolichosaurusidae, and Massosauroidae. This clade is the
sister group of a clade containing Telmasaurus, Sinuwides, and crown varanids within
Varanoidea.

Poster Session III
LOCAL EVOLUTION OF LATE PLEISTOCENE CAPRINAE AND HYAENIDAE IN
THE NEOTROPICAL PART OF THE PYRENEAN MOUNTAINS (FRANCE)
RIDGELY, Ryan, WITMER, Lawrence, Ohio Univ., Athens, OH
Medical CT scanning at local hospitals is often the best option given constraints on costs,
fossil size, travel risks, etc. Advances in medical scanning have allowed greater resolution
fgnial data acquisition. If 3D visualization is a goal, then contiguous helically-acquired slices
pivat details (such as foramina), and must modern scavengers can reach sub-millimeter resolutions (500-600 microns). For large
fossils, a separate thinly sliced dataset of, say, the braincase region can be digitally ‘insert-
ed’ into a coherent dataset of the whole skull. Contrast between fossil and matrix is better at
lower energies (120kV), although higher energies (140kV) may be necessary. A ‘bowtie fil-
treaty greatly improves image quality by pre-hardening the X-ray beam. CT techs typically
seek to minimize radiation dose, but high-dose scans (currents up to 200mA, slow table
speeds) pose no risks to fossils and produce better results. The standard medical grayscale
is optimized for the human body and can be the most severe limitation to the scanning
of dense fossils; many scanners, however, have an Extended Hounsfield or High Dynamic
Range mode, which provides a grayscale broad enough for very dense objects. The speci-
men should be aligned in the scanner to minimize the amount of material through which X-
rays must travel; restoration of canonical orientation can be done later with software.
Specimens plagued with the ‘wringing’ artifact can be scanned in more than one orientation
with differing protocols, and the resulting datasets can then be registered. Slice reconstruc-
tion with a bone algorithm is typically preferred to the ‘standard’ (soft tissue) algorithm.
Data should be output in digital DICOM format rather than film for subsequent analysis.

Wednesday 9:15
MORPHOLOGY AND PHYLOGENETICS OF EOSANIWA (SQAMATA: REP-
TILLA) BASED ON HIGH-RESOLUTION X-RAY COMPUTED TOMOGRAPHY
RIEPEL, Olivier, Field Museum of Natural History, Chicago, IL; CONRAD, Jack,
American Museum of Natural History, New York, NY; MAISANO, Jessica, Univ. of Texas,
Austin, TX
Eosaniwa koehni from the Eocene of Geiseltal (Germany) originally was described nearly
three decades ago, but it has remained an enigma since its discovery. The only known
specimen consists of a skull and fragmentary postcrania preserved in association with a par-
tial Diplocynodon sp. (Crocodilia) skeleton. Because dorsal surface of the specimen is
imbedded in an opaque epoxy plate, only the ventral view of the specimen is available for
description. Analysis of the exposed morphology led to an early referral of
Eosaniwa to Nesorauroidae. Earlier cladistic analyses including Eosaniwa were unable to
resolves the relationships of these platychoangeth. Although these analyses included numerous fossil anguimorphs, they did not include mosasaurids.

The Pyrenean Mountains are characterized by high levels of endemism in modern faunas
and floras (e.g. Pyrenean desman or water-mole, Galemys pyrenaicus; Pyrenean salaman-
der, Euproctus asper; or Pyrenean rock lizard, Lacerta bonnali). This endemicism was to be
the result of glaciations which geographically isolated some areas of southern Europe dur-
ing Pleistocene. We tested this hypothesis by studying the evolution of Caprinae and
Hyaenidae found in three late Pleistocene localities of the northeastern Pyrenean Mountains
(France), dated from 90,000 to 60,000 years B.P. (Caune de l’Arago, Arche cave, and Portel-
ol cave). The data obtained on populations of la., (Hemigaleus cedrensis), Ixops (Capra
caucasica), and cave hyena (Crocuta crocuta spelaea) were compared with those of the French Massif Central populations (Bouxés, Hortus, Baume Maugny-Gueray, Saint-Marcel-
d’Arèche) and Provence ones (Adouste, Bau de l’Aubesier). This study is mainly based

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upon dental and postcranial characters and measurements. Typical dental features were found on the northeastern Pyrenees species only, for Caprinae and hyraxes as well. Iber, for instance, shows a reduced metastylar wing on the M3, narrow parasymphyseal space with low relief. The two species of Caprinae present also a reduction in size of all anatomical parts, especially on metatarsal and phalanges. Populations of the Massif Central and Provence do not display such a reduction. Pyrenean populations of hyaena show a narrow P4 in its anterior part and a p4 with a short protoconid. All these features suggest a local evolution of Caprinae and Hyaeinae during the late Pleistocene, supporting the hypothesis that the northeastern part of the Pyrenees was geographically isolated from the Iberian Peninsula and the rest of continental Europe during the coldest periods of the late Pleistocene.

Poster Session II

BRIEF REPORT ON NEW PTEROSAUR (PTEROSAURIA, PTERODACTYLOIDEA) SPECIMENS FROM THE CRETACEOUS OF MOROCCO

RODRIGUES, Taissa, KELLNER, Alexander, Museu Nacional/UFRJ, Rio de Janeiro, Brazil; MADER, Bryn, Long Island Natural History Museum, Levittown, NY; RUSSELL, Dale, North Carolina State Univ., Raleigh, NC

PTEROSAUR remains from Africa are rare. Most of them were found in Morocco, particularly in the terrestrial Cretaceous (Albian-Cenomanian) red beds that outcrop in several areas of the country. Among the most significant is Sriroccopteryx moroccensis (Anhangueiridae), which is based on the rostral part of an upper jaw, an azhzhadchid cervical vertebra, and isolated teeth referred to the Pteranodontidae, Azhdarchidae and Tapejaridae. Here we report three more specimens that were collected from the Albian/Cenomanian strata of Taifallit, southeastern Morocco. The first one is a right humerus (NMC 50814), which is broken in two parts and has an estimated length of 300 mm. The deltopectoral crest was broken off, but the distal end of the humerus is quadrate, similar to the condition observed in the Tapejaroida. A large pneumatic foramen is present ventrally at the base of the deltopectoral crest. There is also a large and high muscle scar on the dorsal surface of the shaft and a small one on the ventral side, both more developed in this specimen than in other pterosaurs. This humerus differs from other pterosaurs and is tentatively referred to the Azhdarchidae, which due to its size represents an animal of a wingspan around 5.5-6 m, making it one of the largest African pterosaurs known so far. The second specimen is an elongated mid-cervical vertebra (length: 104 mm), bearing a neural spine, condition present in all the Azhdarchidae. Three pneumatic foramina border the neural canal, one on each side and another dorsal to it. It lacks the ventral pneumatic openings lateral to the hypopophysis present in a previous azhdarchid cervical (LINHM 014) reported from this country, suggesting the presence of at least two azhdarchid pterosaurs in this deposit. The third specimen (CMN No. 50859) is an edentulous rostral tip of a jaw, 43 mm long, which belongs either to Pteranodontidae or Azhdarchidae, the latter being favored here. Despite being incomplete, the specimens recorded from Morocco indicate the presence of a diverse pterosaur fauna in the middle part of the Cretaceous in this region.

First evidence of venenation salivary apparatus in fossil shrews (Mammalia)

ROFES, Juan, CUENCA-BASCÓS, Gloria, Zaragoza Univ., Zaragoza, Spain

Predation using salivary venom apparatuses is extraordinary in mammals. The only venom salivary apparatus known for a living mammal is that of the Caribbean Solenodon, while for a fossil mammal it was described quite recently in a known Paleocene Cimolesta, Bisontiaevus. Venomous salivary apparatuses are somewhat more common; yet only Eulipotyphlans as the shrews Blarina, Crocidura, Neomys, and the solenodontid Solenodon are the living mammals with poisonous saliva. A new anatomical trait for shrews reveals the first example of an envenomation salivary apparatus. Evidence of this character emerges in two soricine fossil taxa from the Pleistocene of Atapuerca, Burgos, Spain. Both taxa are documented by well-preserved specimens from two of the Early Pleistocene cave deposits of the Sierra de Atapuerca: the Sima del Elefante (ca. 1.25-1.5 Ma) and a yet non-published deposits from the Gran Dolina (ca. 0.78-0.9 Ma). Two different species of large shrews, Beremendia fissidens and a yet non-described soricine have evolved specialized teeth with gutter-like grooves along the medioposterial remains, that will provide a much broader comparative basis for this enigmatic triconodontid. This humerus differs from other pterosaurs and is tentatively referred to the Azhdarchidae, which due to its size represents an animal of a wingspan around 5.5-6 m, making it one of the largest African pterosaurs known so far. The second specimen is an elongated mid-cervical vertebra (length: 104 mm), bearing a neural spine, condition present in all the Azhdarchidae. Three pneumatic foramina border the neural canal, one on each side and another dorsal to it. It lacks the ventral pneumatic openings lateral to the hypopophysis present in a previous azhdarchid cervical (LINHM 014) reported from this country, suggesting the presence of at least two azhdarchid pterosaurs in this deposit. The third specimen (CMN No. 50859) is an edentulous rostral tip of a jaw, 43 mm long, which belongs either to Pteranodontidae or Azhdarchidae, the latter being favored here. Despite being incomplete, the specimens recorded from Morocco indicate the presence of a diverse pterosaur fauna in the middle part of the Cretaceous in this region.

FIRST JURASIC TRICONODONT FROM SOUTH AMERICA

ROUGIER, Guillermo, University of Louisville, Louisville, KY; GARRIDO, Alberto, Museo Carmen Funes, Plaza Huincul, Argentina; GAETANO, Leandro, Universidad de Buenos Aires, Buenos Aires, Argentina; PUERTA, Pablo, Museo E.Feruglio, Trelew, Argentina; NOVACEK, Michael, American Museum of Natural History, New York, NY; ROLDAN, Eduardo, Museo Nacional de Ciencias, Buenos Aires, Argentina; CHUBÚ, province Argentina is so far the only South American locality providing Jurassic mammal remains. The australosphenid Asfaltomyctus paragonicus and a closely related form have been reported from that locality. We report here on the first discoveries of a triconodont from that locality. The first specimen and type of a new species is an isolated lower molariform. The tooth is dominated by five mesiodistally aligned cusps. The main cusp (a) is the tallest, while b and e are subequal in height; two small accessory cusps (d and e) occur on the mesial and distal extremes of the molariform. The largest cusps (a and e) are recurved, in particular a and e. There is a poorly differentiated cusp g but no distinct cingulum is present. The roots or crown are not grooved for molar interlock, as which suggested by the flaring of cusp d was probably in echelon. The whole tooth is extremely buccolingually compressed, determining a very gracile cusp morphology. The compression of the tooth, and recumbency of cusps is reminiscent of the Early Cretaceous Ichthyosuchus jaworowski- rum from Morocco, but the relative cusp proportions are different. The new taxon is similar to the very incomplete Triconostes curvicuspis from the Jurassic of Utah in cusp proportions and recumbency, but far more compressed. The retention of a primitive cusp g and the derived nature of the remnant of the crown suggest a peculiar taxon possibly related to the generalized Jurassic triconodonts of the northern landmasses, but exhibiting a certain degree of unique evolutionary features drawn for the australosphenidans from Queso Rallado. The molariform shows a mosaic of features present among Triconodontidae and the plesiomorphic “amphilestid” Previously reported Cretaceous triconodonts from South America are probably best interpreted as dryolestoid premolars. New Jurassic specimens have just been collected, including cranial and postcranial remains, that will provide a much broader comparative basis for this enigmatic triconodontid.

Poster Session III

QUANTITATIVE METHODS FOR EXTRACTION OF LIFE HISTORY DATA FROM PROBOSCIDEAN TUSK GROWTH RECORDS

ROUXTREY, Adam, FISHER, Daniel, Univ. of Michigan, Ann Arbor, MI

Structural features of tusk dentin in mammoths and mastodons living under temperate-latitude conditions include an intermediate scale of lamination (between years and days) marked by dark-light couplets recurring in a pattern of about 26/yr (in mastodons) or 52/yr (in mammoths). These “second-order” increments apparently form at a fixed periodicity, and a time-series of the thicknesses of consecutive increments thus monitors the rate of addition of tusk dentin, which is related to nutritional status. Previously, identification of phases in life history defined by major physiological or social changes (e.g. eviction from the matriarchal family unit, onset of musth) was based on qualitative assessment of growth increment profiles. In this study, statistical methods were used to identify: (1) atypial annual profiles that might mark life history transitions, and (2) sets of similar profiles reflecting stages between transitions. Growth profiles for each of the 32 full years represented in a tusk of a male American mastodon were treated as separate time-series, normalized to 26 increments by linear interpolation, and analyzed using pairwise Kolmogorov-Smirnov tests and principal components analysis. Results from the Kenobi Queso Rallado tusk in the Middle Jurassic of Calloet Asfaltofilm, Mexican desert, indicate that the timing of principal component space portray a life history divided into three phases by two unique years. In agreement with the previous qualitative assessment, these tests identify the thin, asseasonal year 12 as an atypial year ending the juvenile phase and probably associated
ed with eviction from the matriarchal family unit. A homogeneous sequence of late teen years is punctuated at age 20 with a year in which growth rate is relatively high. The remaining portion of the young adult's life consists of flights that show similarities interpreted as reflecting annually recurring muth episodes. Qualitative and quantitative results are thus closely comparable, but quantitative methods enhance our ability to summarize patterns underlying the similarities and differences among years.

Friday 2:15
TITANSAURS FROM THE ATACAMA DESERT
RUBILAR-ROGERS, David, Universidad de Chile, Santiago, Chile
Titanosaurs are the best represented dinosaurs in Mesozoic rocks from the Atacama Desert. Although all the specimens of those sauropods are restricted to two localities of northern Chile, the remains are comparatively abundant and well preserved. The fossils come from the Cretaceous outcrops in the Quebrada Cortadera locality (Tolar Formation), a sequence of red sediments with conglomerates, sandstones and siltstones, in the Antofagasta region; and from the Quebrada la Higuera locality (Hornitos Formation), a sequence of lacustrine deposits, in the Atacama region. The Quebrada la Higuera locality has the best preservation, presenting only slightly distorted elements. The material recovered until now, in both localities, includes several postcranial elements, but skull elements have not been recovered yet.

The bones are particularly slender compared with other titanosaurs of the same size.

A preliminary phylogenetic analysis of the titanosaur specimen (SNGM-1) found in the Quebrada la Higuera, indicates that this taxon shares more affinities with the laurasiain form Opisthocoelicaudia sharyznoki and the titanosaurine indet. (DG series B) from Brazil, than other titanosaurs such as Saltasaurus from South America. The paleogeographic distribution of these specimens was restricted to a slender continental border surrounded for epicontinental seas only connected to the mainland by its southern portion, a predominant condition during the Cretaceous in the north and central Chile. The slender bones found in these specimens could be related to this condition of restricted area, which could be compared with the "island rule" of the ecological theory.

Saturday 9:15
A NEW PACYRHINOSAURUS-LIKE CERATOSPIN FROM THE UPPER DINOSAUR PARK FORMATION (LATE CAMPAÑIAN) OF SOUTHERN ALBERTA, CANADA
RYAN, Michael, Cleveland Museum of Natural History, Cleveland, OH; TANKE, Darren, BRINKMAN, Don, EBERTH, David, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; CURRIE, Philip, Univ. of Alberta, Edmonton, AB, Canada
In 2001 an almost complete, but disarticulated, adult-sized ceratopsid tooth was collected from the transgressive Dinosaur Park Formation (DPF) at Dinosaur Provincial Park (DPP) near Idylestle, Alberta. The skull resembles new, undescribed Pachyrhinosaurus-like material from the Late Campanian Wapiti Formation of Grand Prairie, Alberta, located approximately 640 km NE of DPP. The nasal ornamentation is a large pachytyicox boss, whereas the postorbital ornamentations are deeply excavated bosses. Surface features indicate that this is an old individual. Extreme pathological deformations are present in the anterior parietal bar and in many of the phalanges, possibly indicating the cause of death. A preliminary phylogenetic analysis indicates that it is the sister taxon to the clade containing Pachyrhinosaurus canadensis and the new taxon from Grande Prairie.

The specimen occurs near the top of the DPF in a stacked channel succession that cuts out the lowest coal of the 15 m thick Lethbridge Coal Zone. The specimen was deposited on a point bar in a meandering channel that experienced seasonal-to-subseasonal variations in flow regime and depth, as a result of tidal influences and/or episodic rainfall. Dates from procurement areas show similarities interpreted as reflecting annually recurring muth episodes. Qualitative and quantitative results are thus closely comparable, but quantitative methods enhance our ability to summarize patterns underlying the similarities and differences among years.

Friday 2:00
CROCODYLAN CRANIAL SHAPE: PHYLOGENY VS. ECUMORPHOLOGY
SADLEIR, Rudyard, Univ. of Chicago, Chicago, IL
Crocodile phylogeny remains problematic and characterized by conflicting phylogenetic signals, character homology, and character atavisms. Most phylogenetic ambiguity relates to Gavialidae and Tomistoma, where a secondary signal associated with their longirostrine condition accounts for 70% of morphological characters supporting incongruent topologies. The longirostrine (slender-snout) condition is one of five identified eusuchian cranial morphotypes thought to reflect functional and/or ecological specializations. Using concentrated changes, the effect of ecomorphology on cranial character state gains in phylogeny was tested for transitions among generalization, blunt, and slender snouted ecomorphs. 120 published cranial characters were tested on the gains of three skull ecomorphs using 92 taxa on morphological phylogenies, 13 taxa on molecular phylogenies, and 62 taxa on combined data phylogenies. In addition, trees were reduced to 11 taxa to test the effect of taxonomic sample size on hierarchical signals identified by reverse successive weighting. For concentrated changes tests, minimizing or maximizing the number of steps for ecomorph gains under both ACCTRAN and DELTRAN optimizations resolved tree polytomies. Because resolving polytomies limits the analytical power of concentrated changes tests, “tree-free” character compatibility tests of character independence were also conducted on the morphological data matrix. Test results suggest ecomorphs affect cranial character state gains in phylogeny. Of 120 cranial characters, concentrated changes identify 52 character state changes that significantly correlate with transformation to the slender-snout condition, and 40 character states significantly correlate with transitions to generalized and blunt-snouted ecomorphs. Character concentrations are found for transitions to each of the generalized, blunt, and slender ecomorphotypes on morphological, molecular, and combined data tree topologies. Cranial character state transitions are affected by cranial ecomorphotypes, suggesting crocodylian phylogeny could be misled by non-phylogenetic variables affecting cranial morphology.

Saturday 3:30
THE FIRST 120 MILLION YEARS OF TETRAPOD EXPANSION: TERRESTRIAL COMMUNITY EVOLUTION THROUGH THE PALEOZOIC
SAINIEY, Sarda, BENTON, Michael, Univ. of Bristol, Bristol, United Kingdom
Recent computational advancements have allowed palaeontologists to employ databases to develop an understanding of the diversification of life. In this study a dataset of 40 communities was collected in a relational database system to track changing tetrapod alpha (community) diversity through the Paleozoic. These communities were limited to ‘excellent faunas’ with good preservation and collection history in order to accurately represent community diversity. Overall, the pattern of tetrapod community diversification reflects that of global diversification.

As changing geography and climate reshaped the environment through the Paleozoic, terrestrial tetrapods expanded greatly and their interactions grew increasingly complex. Late Devonian single-species communities gave way to ecologically complex and taxonomically diverse Late Carboniferous communities of 20+ species. During the first 400m of tetrapod history, global speciation rates exploded, a trend correlated with alpha diversity. A few families conquered many geographic regions, and created global simplicity. In the Moscovian, increasing endemicism developed in terrestrial communities. Herbivores filled empty niches, gaining a strong foot hold by the Kasimovian and carnivores began adopting new, varied diets by feeding on insects and each other. The pattern of tetrapod alpha diversification may reflect a Late/Early Carboniferous extinction. During the stages crossing the Carboniferous-Pennsylvanian boundary, there is a distinct drop in alpha diversity. Though a range of body sizes existed throughout the Paleozoic, large animals were largely absent in Kasimovian communities. Changes in alpha diversity may also lend support to the suggestion that the end-Pennsylvanian crisis was preceded by an earlier extinction event. Global and alpha levels both drop significantly during the end of the Roadian (Uffmann). Herbivores dominated these communities and piscivores, which were already in steady decline, largely disappeared at this time. The proportion of insectivores also dropped, correlating with a continued decline in insect diversity.
NEW INFORMATION ON THE LATE TRIASSIC REPTILE LEPTOPLEURO LACERTINUM AND ITS IMPLICATIONS FOR THE PHYLOGENY OF PRO-COLONPHONOID PARAREPTILES
SÁILÁ, Laura, Univ. of Bristol, Bristol, United Kingdom
Procolophonoides is a group of Perno-Triassic parareptiles that has been linked to the origi- n of turtles, and several taxa have potential biostratigraphic usage in some sedimentary basins. The detailed morphology of many procolophonoid taxa, however, remains poorly understood, and this makes it difficult to resolve procolophonid interrelationships. The leptopleurin procolophonid Leptopleuron lacertinum, from the Upper Triassic of Scotland, is represented by numerous specimens collected since the species was described in 1851. Nevertheless, apart from a recent description of the braincase, a detailed osteological description has not been forthcoming. This is mostly due to the fact that specimens are preserved as natural molds in fine-grained, cemented sandstone. These molds, however, preserve considerable detail when modern methods, employing PVC and silicone rubber as casting material, are used, as in this study.

This redescription of Leptopleuron is drawn from new casts of nearly 40 specimens, including several articulated skeletons and skulls with good preservation. The new casts allow description of the suture patterns of the skull of Leptopleuron for the first time. The detailed structures of the vertebral column, pelvic and pectoral girdles and limbs are also revealed. In contrast to statements made in previous studies, intercentra and three pairs of sacral ribs are present in Leptopleuron. Study of the casts allows a composite reconstruction of the whole skeleton, which depicts Leptopleuron as a 250-mm-long reptile with a long tail. The high fidelity of the casts allows detailed comparisons with Haploprosanthus fenneri and other leptopleuronine procolophonids. The new osteological information warrants a reanalysis of procolophonoid phylogeny, with special emphasis on the interrelationships of leptopleuronine and procolophonine procolophonids.

Poster Session II
SCALING BITE FORCE IN PREDATORY ANIMALS: HOW DOES T. REX COMPARE WITH LIVING PREDATORS?
SAKAMOTO, Manabu, Univ. of Bristol, Bristol, United Kingdom
Estimating bite forces accurately is of utmost importance in understanding the function of the cranial skeleton as a feeding apparatus; bite forces can be used to quantitatively compare biting performance, to deduce feeding strategy or prey preference, or as loading parameters for methods such as beam theory and finite element analysis. Many studies have recorded in-vivo bite forces of extant animals and various methods estimated bite forces where in-vivo measurements are not available. Researchers have also scaled bite force with respect to body mass, however only a handful of studies have extended this to extinct species.

In this study, I compare bite force estimates in theropods with bite forces of extant predators. Bite forces were plotted against body masses to visualise scaling patterns. With one exception, previous bite force estimates in theropods do not follow the same scaling trend as measured in extant predators; bite force estimates of theropods are significantly lower than expected. Theropod bite force estimates scale in similar fashion to theoretically estimated bite forces in extant taxa, which are lower than in-vivo measurements. However, theropod bite forces are not in contradiction with the maximum bite force estimate in Tyrannosaurus rex based on fossil bite marks has shown that significantly higher values are obtained under more detailed theoretical modelling. Different assumptions on muscle pennation also increase bite force estimates.

Saturday 10:30
A NEW TITANOSAURIFORM SAUROPOD FROM THE MID-CRETACEOUS (ALBRIAN-CENOMANIAN) WINTON FORMATION OF CENTRAL-WESTERN QUEENSLAND, AUSTRALIA
SALISBURY, Steven, Flagstaff, AZ; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA
Sauropod body fossils are well known from the latest Albrian-earliest Cenomanian Winton Formation (middle-late Cretaceous) of central-western Queensland, Australia. The material that has been described to date was discovered between 1913 and the 1970s, and comprises seven isolated and fragmentary skeletons, none of which has detailed collection data. Initially, this material was referred to Austrasaurus spp., based primarily on its close geographic proximity and similar age to the holotype of Austrasaurus meliklopi. A reassessment of this material has revealed that none of it can confidently be referred to Austrasaurus, since features previously considered diagnostic of this genus are in fact shared with other titanosauriforms. Although some of the material previously referred to Austrasaurus spp. does display characteristicsthat would ally it with Titanosaurus, it is too fragmentary to permit the establishment of a new taxon.

Excavations at a new locality near the township of Winton between 2001 and 2004 have produced the associated remains of at least two titanosauriform sauropods. A single femur represents the larger of these two individuals—an animal nick-named ‘Elliot’. cervical, thoracic and caudal vertebrae, fore- and hind limb elements, and several teeth rep- resent the smaller individual—‘Mary’. The bones of both animals are preserved in a laterally discontinuous band of fluvial siltstone, interpreted as the remnants of either an exobiv lake or a crevasse splay from a flood event. The material referred to ‘Mary’ provides the first detailed look at the osteology of an Australian Cretaceous sauropod. It exhibits strong similarities with non-titanosaurian titanosauriforms from the mid-Cretaceous of Patagonia, in particular Chubutisaurus insig- nis. Some characteristics of the vertebrae and the tibia, however, are more derived, indicat- ing affinities with basal titanosaurians such as Argentinosaurus huinculensis and Epachthosaurus sciucoi. The apparent close relationship with broadly contemporaneous Patagonian sauropods provides one of the first clear links between Australian and South American dinosaur faunas during the mid-Cretaceous.

Poster Session III
QUATERNARY MAMMALS FROM CENTRAL BRAZIL
SALLES, Leandro, GUESDES, Patricia, FRACCASSO, Maria Paula, CARDOSO, Karoline, Museu Nacional, Rio de Janeiro, Brazil; PERINI, Fernando, Institute of Biology—UF RJ, Rio de Janeiro, Brazil
Quaternary deposits in Central Brasil are abundant and rich in fossil mammals. Yet, despite this abundance of remnant material, much is left to be done even to have a glimpse of major faunal patterns of change in the continent. During the last few decades, paleontological surveillance have been consistently carried out in two Karstic environments in the region: Serra da Mesa, in the middle east part of State of Goiás, and Serra da Bodoquena, south west part of State of Mato Grosso do Sul—Pantanal. Both regions are rich in limestone caves, but Serra da Bodoquena plateau differs from Serra da Mesa for its abundance of underwater systems that were successfully explored. The results so far show a remarkable rich fauna of small mammals in the Holocene savannas of Serra da Mesa and an extremely diverse Pleistocene megafauna in the plains of the Pantanal. Most osteological remains sampled are composed of very fragmentary remains of cranium (maxillae, mandibulae, isolated teeth) and post-cra- nium (scapulae, pelvic girdles, vertebrae, long bones, etc.). Whenever appropriate these were compared with extant mammals recorded for the region and, subsequently, to other Quaternary faunas in Brazil. Based on the first comparative studies, Serra da Mesa showed a particularly great diversity of small didelphid marsupials, rodents and bats, but medium-size mammals also represented, like procyonid carnivores and artiodactyls (Tayassuidae and Cervidae). Most of the sampled taxa in Serra da Mesa are still extant in the region. The region also presents the highest diversity of bats in Quaternary deposits in Brazil up to date (28 species and six families). Serra da Bodoquena, in contrast, harbors a rich extinct megafauna including ground sloths (Mylodontidae and Megatheriidae), glyptodonts (Glyptodontidae), horses (Equus), mastodonts (Gomphotheriidae), and extinct endemic South American ungulate orders (Litopterna and Notoungulata). Other fossil mammals were also reported such as didelphid marsupials, rodents, deer, tapires and Necrophorus.

Wednesday 4:00
EVOLUTIONARY MORPHOLOGY OF THE POSTCRANIAN OF IN-FAVO-MAL-A-SAY TENREC IDE (MAMMALIA)
SALTON, Justine, Bard College, Annandale-on-Hudson, NY; SARGIS, Eric, Yale Univ., New Haven, CT
Extant tenrecids employ several different positional behaviors, including terrestrial running and walking, climbing, digging, and swimming. Forelimb and hindlimb morphology was compared among 12 tenrecid, 1 macroscelid, 1 solenodontid, and 1 Erinaceus species. Quantitative data have been derived from positional behavior in Tenrecidae. Fossorial and semi-fossorial taxa (Oryzorictes, Hemicentetes, Solenodon) exhibit a suite of characters related to digging: short, wide humeri with pronounced deltoid and pectoral crests, long medial epicondyle, well-developed bicipital grooves (sometimes forming a complete tunnel), elliptical humeral heads, long olecranon processes, and short, wide radii. Microgale cowani also exhibits some of the characters characteristic of a digger. Hindlimb (and carpal) morphology of Geosarcule that it is not oryzorictine, and Geosarcule may have diverged early from other tenrecids.

Forelimb morphology is quite different in the swimmers Limnogale and Potamogale. Limnogale has a larger acromion process (which is nearly absent in Potamogale), larger lesser tuberosity, smaller greater tuberosity, shorter humerus, wider distal humerus with longer medial epicondyle, and a more rounded capitulum. Hindlimb morphology also dif- fers between these two swimmers: Potamogale has a laterally-bowed femur with a small, distally positioned third trochanter and a narrow troclea, whereas Limnogale has a short, wide femur with a large, projecting third trochanter and broad patellare groove, and a tibia with a proximal sigmoid curvature. Limnogale shares several of these features with other members of Oryzorictinae, whereas similarities shared with Potamogale were likely evolved convergently in relation to swimming. If Limnogale is an oryzorictine rather than the sister-taxon to potamogales, then extant Malagasy tenrecs represent a single mono- phylectic radiation.

Preparators Symposium, Thursday 10:30
BUILDING A BETTER MOUSETRAP: USING NEW MATERIALS TO IMPROVE PROCESSING OF BULK MATRIX
SAMPLE, Lloyd, LSA Associates Inc, Irvine, CA
To maximize durability and function and to reduce replacement costs, LSA Associates Inc. (LSA) has developed classification devices for dry screening sediment from new industrial materials that resist fatigue, water, heat, impact, and corrosion. Modeled after standard wooden prototypes, LSA used easily accessible polyvinyl chloride (PVC) extruded plastic tubing and planks that provide exceptional durability and reduce the overall weight of a
standard pine device by six pounds. Additional features are added to the design to expedite matrix processing and increase functionality. These include self-supporting A-frame legs for stand-alone loading and unloading, and a horizontal tray locking mechanism. Curved inside corners help protect against sample cross-contamination. The ergonomic design reduces operator fatigue and increases output.

Wednesday 9:00

**GEOMETRIC MORPHOMETRIC ANALYSIS AND COMPARISON OF SKULL SHAPE IN FOSSIL RODENTS**

SAMUELS, Joshua, UCLA, Los Angeles, CA

Most rodent families include species with some fossorial habits and subterranean rodent species are known from 5 extant families. The cranial and postcraniar morphologies of these rodents display similarities related to three types of digging: scratch digging, chisel-tooth digging, and head-lift digging. In chisel-tooth digging, procumbent incisors powered by head and jaw muscles break up soil, followed by removal of the soil with the feet. Head-lift digging uses the incisors and skull together as a "drill and shovel" combination. In their most pronounced forms, both of these digging types have recognizable cranial and dental features. Adaptations associated with these digging types are seen in distinctly related families, reflecting widespread convergence over the course of rodent evolution. As cranial material from rodents is very common in the fossil record, comparative analysis of skull shapes might reveal previously unrecognized fossorial species.

This study uses a geometric morphometric approach to examine skull shape characteristics associated with fossorial habits in rodents. Digital photos were taken and a set of landmark coordinates were scored for the skulls of 71 rodent species with a wide range of locomotor and dietary habits. The Procrustes procedure was used to scale, align, and transform data for analyses. Relative warp and thin-plate spline methods were used to characterize skull shape. Preliminary results show modifications of the skull in chisel-tooth and head-lift digging rodents relative to species not adapted for digging. The skulls of these rodents show highly procumbent incisors and elongate tooth rows, and head-lift diggers also show an anterodorually inclined occipital region. Canonical variates analysis was used to infer the behavior of 14 extinct species from the family Castoridae based on their skull shapes. These extinct beavers displayed diverse digging habits, including chisel-tooth digging and head-lift digging forms similar to living subterranean rodents. This diversity of digging habits likely contributed to niche partitioning and prolonged co-occurrence of multiple fossorial beavers in the same habitats.

Wednesday 4:15

**TALPID MOLE EVOLUTION IN SPACE AND TIME**

SANCHEZ-VILLAGRA, Marcelo, BARROW, Eugene, MACLEOD, Norman, The Natural History Museum, London, United Kingdom; MOTOKAWA, Masaharu, Kyoto Univ. Museum, Kyoto, Japan; HORIZINTZ, Imés, Univ. of California, Los Angeles, CA

Talpid moles exhibit one of the most specialized suites of morphological characters among any small mammal group. Specialized fossorial and more generalized shrew-looking moles inhabit both North America and Eurasia but both faunas are endemic. A rich Eocene-Recent fossil record makes this biogeographic picture even more puzzling. We have investigated the origin of the characters with a maximum parsimony analysis of 157 morphological characters using species from all 17 living mole genera and four eulipotyphlans as outgroups. The resulting cladogram is in partial agreement with previous, more restricted groupings and head-lift digging forms similar to living subterranean rodents. This diversity of digging habits likely contributed to niche partitioning and prolonged co-occurrence of multiple fossorial beavers in the same habitats.

Saturday 8:15

**THE EVOLUTION AND DEVELOPMENT OF PAIRED FINS: NEW DATA FROM THE OSTEOSTRACI (AGNATHA)**

SANSOM, Robert, Bristol Univ., Bristol, United Kingdom; JANVIER, Philippe, UMR 5143, CNRS, Museum National d'Histoire Naturelle, Paris, France; DONOGHUE, Phil, Bristol Univ., Bristol, United Kingdom

A growing body of evidence indicates that the extinct Osteostraci (cephalaspids) are the closest relative of jawed vertebrates. As such, the Osteostraci provide a much better perspective on the nature and origin of the primitive jawed vertebrate condition than any other group, living or extinct. Most significantly, evidence from osteostracans indicates that paired fins are not an apomorphic of jawed vertebrates but evolved earlier, in the common ancestor of Osteostraci and jawed vertebrates. The mixture of finned and finless forms within the group complicates scenarios of paired fin evolution, especially in the absence of any established computerized phylogenetic framework for the group.

Here, a comprehensive phylogenetic study of the Osteostraci is presented for the first time, the impact of which is far reaching. Loss of paired fins is found to have occurred within the Osteostraci (tremataspids) and further more, reversals from a finned to finless condition are suggested. New findings of exceptionally well-preserved Ilemoraspis kirkontskaiae Obruchev (Middle Devonian of Khakassia, Siberia) demonstrate the presence of pectoral fins in this unusual, previously poorly known, osteostracan. Illemoraspis is firmly allied with the Siberian Tannuaspida and nested the finless tremataspids, by a number of morphological features despite the presence of fins. The implication is that at an early stage in the evolution of vertebrate paired appendages, the acquisition, loss and possible reacquisition of fundamental character complexes, like paired fins, was not as exceptional or rare as previously envisaged. Rather, in this case at least, development programmes were quite plastic with the loss and reversal being common. This may have implications for understanding the staggered acquisition of pectoral and pelvic paired appendages, and the presence of forms that appear to possess supernumerary fins, amongst basal jawed vertebrates.
INTegrating Paleobiology and Developmental Genetics: Contributing Insights of the Fossil Record to the Study of Fin Loss in Teleost Fish

SANtInI, Francesco, Univ. of toronto, toronto, on, Canada; CARNEVAle, giorgio, Università di Pisa, Pisa, Italy

With over 28,000 specimens, teleost fish represent the largest vertebrate clade. Most teleosts rely on the movement of a combination of paired and median fins for their locomotion. As such, fins might be thought to be highly conserved structures. A survey of the morphological diversity of extant and fossil teleosts, however, reveals that some kinds of fins can be very easily modified or lost, while others are much more highly conserved. The pelvic fins, for example, have been lost at least 70 times independently, while the caudal fin is very rarely lost.

Until now, relatively little attention has been paid to how fins are reduced or lost. In our presentation we will discuss briefly the pattern of fin loss in teleosts. We will employ the extant and fossil pufferfish and allies (Tetraodontiformes) as a case study to more closely investigate the morphological and genetic phenomena that might play a role in causing a convergent loss of the pelvic and first dorsal fin. We will discuss evidence that morphological modules can be identified within the skeletal system of these fishes. We will also show how some of these modules can be modified—likely through processes taking place during the early stages of development—until their final disappearance in adult individuals. Finally, we will formulate some hypotheses about the relationships between morphological complexity and developmental regulatory genes in this clade. These hypotheses could perhaps be tested experimentally using developmental genetic methods. We will also show how fossils play a key role in the study of fin loss in many groups, by providing intermediate stages that illustrate how morphological transitions occurred in lineages now characterized by extant taxa with highly divergent morphologies.

Marine Reptiles Symposium, Wednesday 3:00

AN ELASMOsaURID PLESiOSAUROs FROM JAPAN AND ITS PHYLOGENETIC RELATIONSHIPS

SATO, Tamaki, National Science Museum, Tokyo, Japan; BRYANT, Harold, Royal Saskatchewan Museum, Regina, SK, Canada; HASEGAWA, Yoshikazu, Gunma Museum of Natural History, Tomioka, Japan; MANABE, Makoto, National Science Museum, Tokyo, Japan

A new genus and species of elasmosaurid plesiosaur is recently described based on a partial skeleton from the Lower Santonian (Upper Cretaceous) Tamayama Formation, FutaBgu Group, in Fukushima Prefecture, Japan. Indeterminate elasmosaurs are common in the Upper Cretaceous of the circum-Pacific region, but the holotype of the Japanese taxon is the first elasmosaurid diagnosable at the species level from the Western Pacific, and the oldest in the Northern Pacific.

Phylogenetic relationships of the new taxon and other elasmosaurs were analyzed using 176 characters coded for 33 operational taxonomic units (OTUs). More than a half of the OTUs have more than 50% missing data, but there were only two MPTs. CI and RI were low in comparison with those in previous studies of plesiosaur phylogeny, indicating a high level of homoplasy. In the strict consensus, all Cretaceous elasmosaurs except for Brachiosaurus formed a clade, and the Japanese taxon appeared as a basal member of this clade, within which most species from the Upper Cretaceous of the North American Western Interior Seaway formed a subclade. Microcleidus and a clade of cryptocleidoids were successive outgroups of the large elasmosaur clade. Bootstrap support for these clades was very low (less than 50%), and the relationship within the elasmasaur clade is very sensitive to the selection of OTUs and characters. For example, in a re-analysis in which a small number of OTUs represented only by juvenile specimens were removed, although most Cretaceous elasmosaurs still formed a clade, relationships within the clade changed drastically. Poorly known elasmosaurs from the Southern Hemisphere such as Turangasaurus and Aritsonectes appeared outside of this clade. The subclade of Western Interior elasmosaurs was recovered but its internal relationships were different from the first analysis, and the Japanese taxon was more closely related to this subclade than in the first analysis.

Neoceti Symposium, Saturday 11:30

FEATURES IMPLYING THE BEGINNING OF BALEEN GROWTH IN AETIOCETIDS

SawaMurA, Hiroshi, Ashoro Museum of Paleontology, Ashoro, Japan; oTANI, Seiji, The Institute of Cetacean Research, tokyo, Japan; Ichishima, Hiroto, Fukui Prefectural Dinosaur Museum, Fukui, Japan; Ito, Haruka, National Research Institute of Fisheries Science, yokohama, Japan; ishiKawa, Hajime, The Institute of Cetacean Research, tokyo, Japan

Aetioctetidae, which shows the most diverse features in Oligocene toothed mysticetes, is expected to narrow the gap between Archaeoceti and the true (baleen-bearing) Mysticeti. Two crown genera of Aetioctetidae, Aetioctes and Morawanocetus, not only have teeth but suggest to have the incipient baleen in the upper jaw. But features about the baleen and the feeding behavior are different between these genera, showing the mosaic pattern when being compared to balaenids or minke whale fetuses.

Characters of the genus Aetioctes include: homodonty, pointed cusped and single root-ed molars with small denticles, large diastema with irregular width, increase in tooth num-

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Danian Hornerstown Formation of New Jersey, is represented by cranial elements and an unusually complete post-cranial skeleton.

Skull elements include a nearly complete maxilla, a partial premaxilla, a caudal premaxilla, a posterior six teeth, and a fragment of the frontal bone. The skull possesses a large exoccipital fenestra, which previously has been a matter of some debate. The presence of incompletely fused sutures between vertebral centra and dorsal processes, and between the frontal and prefrontals, indicate that this individual was a sub-adult at the time of its death.

The specimen was recovered from glauconitic sands, interpreted as a shallow, biologically productive, paralic environment. This environmental setting is consistent with other occurrences of Thoracosaurus sp. throughout North America.

Poster Session III

QUARRYING IN THE PASCAGOULA FORMATION: FIRST MIocene (HEMPhilIIAN) FAUNA OF TERrestrial MAMMALS FROM THE CENTRAL GULF COAST EAST OF THE MISSISSIPPI

SCHIEBOUT, Judith, HILL, Julie, TING, Styuin, HAGGE, Mark, WILLIAMS, Michael, Louisiana State University, Baton Rouge, LA; BOARDMAN, Grant, BATON ROUGE, LA

The Pascagoula Formation is not even shown on the most recent Louisiana geologic map, because of its occurrence in steep creek walls and under modern creek sands, but more fossils from spots similar to the Tunica Hills Site are now expected throughout the Tunica Hills area. Trial screening for small forms has yielded a single molar of the rodent *Cynosurus* and a natricine snake vertebrae, along with fish, turtle, and crocodilian remains similar to those recovered from Fort Polk.

Friday 3:00

ARCHIVING THREE-DIMENSIONAL MODELS OF SPECIMENS WITH HIGH-RESOLUTION PHOTOGRAPHIC IMAGES—TEXTURE-MAPPING THE REAL ON THE VIRTUAL

SCHLAIDER, Robert, Idaho State Univ., Pocatello, ID; CHAPMAN, Ralph, PETERSEN, Christian, CLEMENT, Nicholas, Idaho Virtualization Laboratory, Pocatello, ID

One of the biggest complaints about virtual models of paleontological specimens is that they only preserve the shape—the visual detail of the specimen is not conserved in rendered images. This serves to optimize the quality of the archived specimen while providing an additional impetus to thoroughly photograph these important specimens. The end result is a product that will better serve education, exhibition, and research needs. Examples are given from various vertebrates, including dinosaurs, Tertiary mammals, and humans.

Poster Session II

DESCRIPTION OF A NEW SPECIES OF PLESIOSAUR FROM THE UPPER CRETACEOUS TROPIC SHALE, SOUTHERN UTAH

SCHMEISSER, Rebecca, Northern Arizona Univ., Flagstaff, AZ

A closely associated pliosauromorphant (short-necked plesiosaur) skeleton was excavated in 2005 from a site in the Upper Cretaceous (Cenomanian-Turonian) Tropic Shale. The site is located within Glen Canyon National Recreation Area and is the first nearly complete individual recovered from this region. The skeleton is remarkably well preserved, although heavily fractured. The specimen consists of nearly a complete skull and jaws, teeth, an incomplete set of vertebrae and ribs, scapulae, coracoids, nearly complete forelimbs, ilia, ischia, pubes, nearly complete hindlimbs, and associated pectoralgirdles.

Following preparation and description, the new plesiosaur skeleton can be placed within the family Polycotylidae. Several characters are similar to those seen in other polycotylid plesiosaurs. However, the unique combination of characters found in the new specimen, as well as the presence of several previously unrecognized characters permits the assignment of a new species. Additionally, several characters are similar to one genus of polycotylid (*Dolichorhynchops*) while several other characters are similar to another genus of polycotylid (*Trinacromerum*). This suggests that the new specimen could be an intermediate between the two genera. Therefore, specimens of *Dolichorhynchops* and *Trinacromerum* should be reevaluated to determine whether they should be synonymized.

Vertebrate Development Symposium, Wednesday 9:00

OSIFICATION SEQUENCES AND SKULL EVOLUTION IN LOWER TETRAPODS

SCHOCH, Rainer, Staatliches Museum fuer Naturkunde, Stuttgart, Germany

Recent discoveries of ossification sequences in several temnospondyls have prompted comparisons with other temnospondyls. The least vertebrates known from smallest sizes on, which preserve the early patterning of skull formation. In branchiosaurids, cranial ossification proceeded rather slowly, with circumorbital, visceral, and braincase elements remaining rudimentary throughout their known lifespans. In other temnospondyls, only the latest phases of skull development are known from fossils, but the formation of the postcranial skeleton is well preserved. The best sequences are known from *Sclerocephalus*, *Onchiodon*, and *Micromelerpeton*, which all diverge from the developmental pattern of branchiosaurids in that the skull ossified early and was rapidly completed, whereas the postcranial required a long period to be fully ossified, particularly the axial skeleton. The studied developmental sequence includes dorsal and braincase bones and various postcranial elements. The comparison reveals that the ossification sequence of branchiosaurids is similar to that of extant limniscamshians, notably nobbytid salamanders, while the other temnospondyls preserve an apparently more plesiomorphic pattern. Both fossil and extant outgroups (*Eusthenopteron, Polypterus*) indicate which of these sequence similarities may be derived and which plesiomorphic. Mapping event-pair data on a phylogeny suggests that branchiosaurids and some limniscamshians share derived character-states, but a large amount of similarity is due to the shared possession of plesiomorphic character-states.
Marine Reptiles Symposium, Wednesday 5:15

A NEW PROGNATHODON (SQUAMATA: MOSASOURIDAE) FROM THE TREATACEOUS OF ANGOLA
SCHULP, Anne, Naturhistorisch Museum Maastricht, Maastricht, Netherlands; MATEUS, Octávio, Museu da Lourinhã, Lourinhã, Portugal; POLCYN, Michael, JACOBS, Louis, Southern Methodist Univ., Dallas, TX

Recent field reconnaissance in Angola provides a new sample of rich marine Cretaceous faunas including mosasaurs, fishes, turtles, and plesiosaurs. The new material includes two partial mosasaur skulls from the Namibe province tentatively assigned to the globidensine mosasaur genus Prognathodon. However, the new Prognathodon possesses a dentition document- ing broader variation of dental morphologies in that genus than previously recognized. The new material includes well-preserved premaxillae, maxillae and dentaries, and preserves the entire marginal dentition. It has slender teeth with constricted bases and displays the characteristic prostate condition, reduced number of marginal teeth and wrinkled enamel diagnostic of the genus.

In the context of prey preference and feeding guild models recognized by previous workers, the new taxon overlaps with the genus Mosasaurus and suggests that Prognathodon may have adapted to a broad variety of feeding niches. The taxic assemblage of the Maastrichtian of Angola is reminiscent of that seen in the Maastrichtian of northwest- ern Europe and allows a comparative exploration of habitat segregation and prey preference.

We present the new material and discuss the geographic, temporal and ecological distribution of globidensine mosasaurs, and review prevailing prey preference guild models in light of recently documented diversity of tooth morphologies in globidensine mosasaurs.

ANALYSES OF LOWER ACTINOPTERYGIAN INTERRELATIONSHIPS, CONTRADICTIONARY HYPOTHESES
SCHULTEZ, Hans-Peter, ARRATIA, Gloria, Univ. of Kansas, Lawrence, KS

There is great controversy concerning the interrelationships of lower actinopterygians. The disagreements are clearly illustrated by major changes in the relationships of living polypteriforms, acipenseriforms, amiiforms, and leptoseliforms to fossil forms and also to teleosts. Polypterus is in most cases placed as the most basal actino- pterygian, nevertheless different Paleozoic taxa (Lophothis, Dialipina, Cheirolepis) are displac- ing Polypterus to a higher position. There is no agreement concerning the interrelationships within palaeonisciforms and neopterygians. Several hypotheses of sister-group relationship to teleosts have been proposed based on morphological evidence (e.g., mobile maxilla, presence of supramaxilla, position of symplectic); i.e.: (other actinopterygians + [Lepisosteus + [Amia + Teleostei]]) or (other actinopterygians + [Amia + [Lepisosteus + Teleostei]]). Different results are obtained when fossil taxa (i.e.: Pycnodontiformes, Dapedium) are added as sister groups. The discrepancies are caused by different reasons, as for instance the selection of taxa and different assumptions over homologies. An analysis of different hypotheses of actinopterygian interrelationships will be presented, the role of fossils will be discussed, as well as the major problems concerning homologization of structures in lower actinopterygians.

ANALYSES OF LOWER ACTINOPTERYGIAN INTERRELATIONSHIPS, CON- TRADICTIONARY HYPOTHESES
SCHULTZE, Hans-Peter, ARRATIA, Gloria, Univ. of Kansas, Lawrence, KS

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Poster Session III
AMPHIBIANS AND REPTILES OF THE MIO-PLIOCENE GRAY FOSSIL SITE AND THEIR PALEOECOLOGICAL IMPLICATIONS
SCHUBERT, Blaine, WALLACE, Steven, ETSU, Johnson City, TN

Identification of fossil reptiles and amphibians from the Gray fossil Site to lower levels of classification has proved to be a difficult endeavor. Herein the challenges are discussed, and tentative designations are reported.

Two families of salamanders are represented based on trunk vertebrae, the Plethodontidae and Ambystomatidae. Vertebral variation in plethodontids limits identifi- cations to the family level. Ambystomatids however, are congreneric (genus Ambystoma) and vertebrae from the site are indistinguishable from this taxon.

Testudines are primarily represented by carapace and plastron elements, and are identi- fied here to the family or generic level. The most abundant taxa are the emydids Trachemys and Chrysemys. Two other turtles, Terrapene and Chelydridae, are represented by isolated individuals. Alligatoridae material is limited to a partial cranium, postcranial elements, and osteoderms; unfortunately cranial and mandibular characters are required for a more specific taxonomic assignment. The excavation of a partially articulated specimen is underway and may assist in this classification. Squamates are only represented by snakes of the families Viperidae and Colubridae. As with other localities, trunk vertebrae are the primary fossil elements. The most common snakes from the site are colubrids in the subfamily Natricinae; much less common are colubrine colubrids and vipers.

Despite the fact that lower levels of classification have not been determined, paleoeco- logical inferences can still be made based on phylogenetic bracketing. In sum, the reptiles and amphibians from the site are indicative of a ponded environment; a reconstruction that matches the site’s lacustrine sediments.
Wednesday 4:30

FIRST SKELTAL MATERIAL OF *LITOCHERUS NOTISSIMUS* (SIMPSON) (MAMMALIA, ERINACEOMORPHA) FROM THE LATE PALEOCENE OF SOUTH CENTRAL ALBERTA, CANADA

SCOTT, Craig, Univ. of Alberta, Edmonton, AB, Canada; BOYER, Doug, Stony Brook Univ., Stony Brook, NY

Although modern eulipotyphlans (hedgehogs, moles, shrews, solenodons) are unknown from the fossil record prior to the Eocene, dentitions attributed to possible archaic members of the group are known from Paleocene-aged localities in North America, Europe and Asia. Due in part to a lack of non-dental information, many of these attributions remain tenuous. We report recovery of the first non-dental material of one such taxon, *Litocherus notissimus*, initially classified as a “hypospondodont” condylarth, but now regarded as an erinaceomorph eulipotyphlan. Dentally-associated remains from the late Paleocene DW-2 locality of Alberta document petrosals, bassispheonid, partial maxilla, dentary, incomplete inominate, femur, astragalus, calcaneum, cuboid, entocuneiform and phalanges. The basicranium and tarsus resemble those of many eulipotyphlans (promontorium with rostral tympanic process, grooves for stapedial and promontory arteries, no evidence of ossified bulae, calcaneal shaft laterally convex, calcaneal facet concaveconvex, astragalar body relatively short proximodistally) and differ in these ways from *Hyposodus*. Characters that unite apleisphine “condylarths” with macrocusceldines (astragalar cotylar fossa, calcaneal tuber relatively long, long axis of astragalar head oriented sagittally) are also lacking. The tarsus of *Litocherus* most closely resembles that of Paleogene nyctitherids (possible eulipotyphlan) with some similarities between the two also present in many eucarionthман mammals (astragalarfibular facet dorsoplantarly deep, fossa on fibular facet proximally positioned, no superior astragalar foramen, astragalarovulacinar facet ascends medial side of neck). Despite similarities to arboreal eucarionthманs, the postcranium of *Litocherus* suggests a cursorial or saltatorial locomotor mode (femur with third trochanter large and shaft mediolaterally narrow and anteroposteriorly deep, astragaloitibial facet grooved, astragalovulacinar and sustentacular tubercles separate, calcaneocuboid facet oriented obliquely, phalanges with straight, robust shafts). Cladistic analyses using published character matrices support eulipotyphlan affinities of *Litocherus*

Wednesday 9:45

ANAGENESIS OR CLADOGENESIS IN THE ORIGIN OF *EQUUS*: A REVIEW OF PLEOCENE EQUIDS FROM ANZA-BORREGO DESERT STATE PARK, CALIFORNIA

SCOTT, Eric, San Bernardino County Museum, Redlands, CA

The genus *Equus* is interpreted to have arisen from *Dinohippus* during the Pliocene Epoch. The nature of this speciation event, by anagenesis or cladogenesis, remains unresolved. Fossils from the Anza-Borrego Desert State Park (ABDSP) are critical to this question. Remains assigned to cf. *Dinohippus* from the Deguynos Formation (early Pleocene), the Imperial Group-Palm Spring Group transition (early Pliocene), and the Hueso Formation (middle to late Pliocene) in the ABDSP. A partial mandible from the Hueso Formation was considered to potentially represent the youngest occurrence of *Dinohippus* in North America. Fossils of pleissepine Equus are also known from the Hueso Formation, leading to suggestions that *Dinohippus* and Equus may have co-occurred at Anza-Borrego. II confirmatory and indicator cladogenetic species for Equus. Co-occurrence of *Dinohippus* and Equus has not been demonstrated elsewhere.

Fossils assigned to cf. *Dinohippus* from the ABDSP include isolated upper cheek teeth, a partial maxilla with associated cheek teeth, and a partial mandible. Upper cheek teeth have short crown heights, likely due to advanced wear, and exhibit simple enamel patterns and small protocenes resembling both *Dinohippus* and pleissepine *Equus*. Buccalconvolution curvature of most teeth is not as pronounced as in *Dinohippus*, but falls within the range for *Equus*. The partial maxilla has a shallow facial fossa, similar to *Equus (Pleispinus)* and some later equids. The partial mandible assigned to cf. *Dinohippus* also resembles pleispine *Equus* in the morphology of the incisors, the penetration of the molar ecfoxils, and the position of the canine tooth. Previous referral of this fossil to cf. *Dinohippus* was based upon estimates drawn from broken or reconstructed portions of the specimen. A more conservative assignment of this specimen to *Equus (Pleispinus)* is preferred. The fossil record from the Anza-Borrego does not demonstrate a late Pliocene occurrence of *Dinohippus*, provides no data validating co-occurrence of *Dinohippus* and Equus, and consequently does not support cladogenetic evolution of Equus from *Dinohippus*.

Vertebrate Development Symposium, Wednesday 12:00

THE CORRELATED EVOLUTION OF RUNX2 TANDEM REPEATS AND FACIAL LENGTH IN CARNIVORA

SEARS, Karen, Univ. of Colorado Health Sciences Center, Aurora, CO; GOSWAMI, Anjali, London Museum of Natural History, London, United Kingdom; FLYNN, John, American Museum of Natural History, New York, NY; NISWANDER, Lee, Univ. of Colorado Health Sciences Center, Aurora, CO

Currently, general consensus is that evolutionary changes in morphology are driven primarily by changes in the cis-regulatory regions of genes. In this study, we test the hypothesis that mutations within the protein-coding region of Runx2, specifically within glutamine-alanine (QA) tandem repeats, provide a major source of variation that can drive morphological evolution in a group evolving under natural selection, the mammalian order Carnivora.

Runx2 (run-related protein 2) is a transcription factor essential for bone formation.
from Mexico, or it may reside at a basal position with-mediated pelvic reduction in sticklebacks. These multiple lines of evidence suggest that the genus Megalonyx, used caves throughout their lives.

The base of Squamata, represented by a nearly complete skull, comes from the Oshik Formation (Valanginian-Barremian, ca. 130 Ma) of Mongolia. The small skull (18 mm length) has large orbits and a relatively broad, low snout. Basal squamate status is suggested by the narrow width of the nasals, the simple transverse frontoparietal suture, broad interpterygoid vacuity, and absence of pterygoid-vomer contact. Features that may be pleiomorphic within Squamata include paired parietals, a pineal foramen, and a rudimentary row of teeth on the pterygoid. Probable apomorphic features within Squamata include a pendant prootic flange extending onto the hasipterigyoid process and a well-developed frontal subfactory process. The new taxon may well lie just outside Squamata, like the younger (Albian) Huchuucmetzapsill from Mexico, or it may reside at a basal position within Squamata. At present the new Mongolian skull cannot be linked with confidence to any squamate subclade, including Gekkota, Scincoida, Lacertoida, Anguimorpha or Iguania.

Wednesday 11:30

RIFT VALLEY DINOSAURS: A NEW LATE CRETACEOUS VEERBATE FAUNA FROM KENYA

SERTICH, Joseph, Utah Museum of Natural History, Salt Lake City, UT; MANTHI, Frederick Kyolo, National Museums of Kenya, Nairobi, Kenya; SAMPSON, Scott, LOWNEN, Mark, GETTY, Mike, Utah Museum of Natural History, Salt Lake City, UT

The Cretaceous vertebrate record of the Gondwanan landmasses—including South America, India, Antarctica, and Madagascar—has received considerable recent attention, resulting in a multitude of hypotheses regarding phylogenetic and biogeographic relationships during this period. Africa has provided significant insights into Gondwanan biogeography during the Early and early Late Cretaceous. However, knowledge of vertebrates from post-Cenomanian Late Cretaceous horizons on this continent remains woefully inadequate, precluding meaningful biogeographic comparisons with other Gondwanan landmasses for which fossils from this interval are much better known. In 2004, a joint National Museums of Kenya-Univ. of Utah expedition was undertaken to explore the Lubur sandstone (Turkana Grits) of northern Kenya. This brief reconnaissance foray yielded a relatively diverse vertebrate fauna including turtles, crocodyliforms, and dinosaurs. Crocodyliform material is referable to at least two taxa, a longirostrine dyrosaurid and an unidentified large-bodied brevirostrine form. Among dinosaurs, dental and appendicular materials suggest the presence of two abelisaurid theropod taxa, one large-bodied and the other gigantic. Distinct vertebral morphologies are consistent with at least two taxa of lithostrotian titanosaurians. The deposits also yielded remains of an intermediate-sized ornithopod. Unfortunately, to date, efforts to establish solid chronosтратigraphic dates for the Lubur sandstone have not met with success. However, preliminary faunal analysis suggests close similarities with post-Cenomanian Cretaceous faunas recovered on other Gondwanan landmasses. If this age hypothesis is confirmed by additional evidence, these deposits will offer some of the first significant terrestrial vertebrate remains from Africa during this critical interval, providing important evidence for testing biogeographic hypotheses.

Poster Session I

THE CAVE OF SLOTHS: A DESCRIPTION MEGALONYX JEFFERSONI REMAINS FROM ALC-B3 CAVE, COLBERT COUNTY, ALABAMA

SHAVER, Wendi, SCHUBERT, Blaine, WALLACE, Steven, East Tennessee State University, Johnson City, TN

The purpose of this project is to better understand the life history of Megalonyx jeffersoni in the context of cave paleoecology. ALC-B3 Cave, located in northwestern Alabama, has provided the largest sample of ground sloths from any single cave. Excavated from 1984-1987, ALC-B3 was part of a series of digs organized by the Red Mountain Museum. These collections are now housed at the McNair Center, Birmingham, Alabama. According to those who excavated the sloths, as many as sixteen individuals are represented. Many age classes are present, which may indicate that Megalonyx used caves throughout their lives. A description and faunal analysis of this remarkable sample is now underway that will 1) establish the total number of individuals present in the collection, 2) determine which age classes are represented, 3) determine the taphonomic history of the remains, and 4) record skeletal part frequencies. The results of these analyses should answer the following questions: 1) did all age classes utilize ALC-B3, 2) did the specimens die in the cave or were they there for other factors responsible for their deposition (e.g., predators or transport) 3) there are signs of disease or injury that may have contributed to the death of these animals, or that may provide some insight into the "typical life" of this taxon.

In addition to the remains at the McNair Center it is possible that ALC-B3 may have been the site that provided the specimens for Joseph Leidy's 1855 comprehensive study of the genus Megalonyx (curated at the Philadelphia Academy of Natural Sciences). Rare Earth analyses are being performed on sloth remains from both collections to determine whether or not they originate from the same cave. This not only has the potential of increasing the sample size of the current study, but may also verify the location of Leidy's Megalonyx collection.

Student Poster Session

SLOTHS ET AL. TEACHING THE "E" WORD: USING EXTANT AND EXTINCT XENARTHAN CRANIAL MATERIALS TO EXEMPLIFY FOR MIDDLE SCHOOL STUDENTS CHANGE THROUGH TIME AND HOW SCIENCE WORKS

SHAW, Barbara, Portland State University, Portland, OR

K-12 science education in the United States is in crisis. According to the National Science Foundation, the public by and large does not understand how science works or even what science is. Specifically, they do not understand the reasoning for evolution as the best explanatory framework for the diversity of life currently exists; further, a Battlefield has been drawn in a struggle for teaching evolution vs. creationism under the guise of so-called intelligent design. In Oregon, state benchmarks include an inquiry portfolio. However, testable questions are not required until the 10th grade! Standardized test scores have become the golden calf of the current political administration. Those tests do not evaluate the process of science, but rather the rote memorization of basic facts in all disciplines. Students do not without guidance automatically transform knowledge learned in inquiry formats into concepts. Using skills from 42 and extinct Xenarthra, 86 students grades 4-8 engaged in an inquiry based curriculum on the testable question, change though time and creation of time. A pre- and post-assessment of the cognitive, biological and geologic time scale, and the testable question, were given to the students on the first and last days of class. In addition, students were assigned to write one benchmark style question and present it to the class to help them transform their inquiry experience into conceptual understanding. Paired student-t test was used to evaluate overall learning and various cognitive skills, and significant differences were observed between pre- and post-tests results.

Poster Session II

MESOZOIC ORIGIN FOR MEGAMOUTH SHARK (LAMNIFORMES: MEGACHASMIDAE)

SHIMADA, Kenshu, DePaul University, Chicago, IL

The extant megamouth shark, Megachasma pelagios (Lamniformes: Megachasmidae), is a large (up to ca. 5.5 m), enigmatic filter-feeding elasmobranch, that is regarded as one of the most spectacular ichthyological discoveries in the twentieth century. Some megachasmid teeth have been recovered in the Early Cretaceous of Wyoming, but it has only been suspected that the megachasmid lineage originated during the Mesozoic. A recent re-examination of shark teeth collected from the basal Greenhorn Formation (Upper Cretaceous: Middle Cenomanian) in southeastern Colorado, suggests the Mesozoic origin for the megachasmid lineage. The specimens, that were previously identified as teeth of a Cretaceous odontaspidid lamniform, cf. Johnlongia sp. (e.g., FHSMP VP-15095 and VP-15176 housed in Fort Hays State University, Sternberg Museum of Natural History, Hays, Kansas), measure up to 6 mm in height and are characterized by osteodent histology, sharply pointed, lingually curved, hook-like crown, and an exceptionally deep nutritive groove on its massive root. The discovery marks not only the geologically oldest megachasmid, but also putatively the oldest filter-feeding elasmobranch in the fossil record. The Cretaceous megachasmid may be a new taxon, and it could have measured at least 3.3 m in total body length. Certain dental features in the Cretaceous megachasmid resemble Johnlongia, posing an intriguing phylogenetic problem regarding the systematic relationships among Megachasmidae, Odontaspidaeidae, and another lamniform family, Psuedocarcharidae. The evolution of the fossil megachasmid is considered to represent a part of the adaptive radiation of lamniform sharks during the Cretaceous.
ASIOPLESIADAPIS YOUNGI also lacks the diagnostic features of most other plesiadapiform families, lacking features that would be expected in any plesiadapid, such as an m3 hypoconulid lobe (a plesiadapoid trait), no p4, and in the most primitive micromomyid, Chronolestes. THE MOST PRIMITIVE p4-m3, and alveoli for p2 and p3 from the Early Eocene of the Wutu Formation, China. This genus on m1 (found in all plesiadapoids but saxonellids). As such, it seems unlikely that Asioplesiadapis youngi (found in all plesiadapoids but saxonellids). As such, it seems unlikely that Asioplesiadapis youngi also lacks the diagnostic features of most other plesiadapiform families, lacking features that would be expected in any plesiadapid, such as an m3 hypoconulid lobe (a plesiadapoid trait), no p4, and in the most primitive micromomyid, Chronolestes. THE MOST PRIMITIVE p4-m3, and alveoli for p2 and p3 from the Early Eocene of the Wutu Formation, China.

ENSUING the long-term integrity of the data sets is vital to their scientific use. Manipulation of large data sets requires that they be kept either on a local hard drive or on a dedicated file server. Regular backup of the server is necessary to protect against catastrophic failure. In addition, projects are backed up on DVDs. The DVD format has a limited shelf life and must be replaced from time to time, but they can be easily transported for storage off site, and provide an inexpensive third layer of protection for data.

Student Poster Session

GEOMETRIC MORPHOMETRIC, EIGENSHAPE AND FINITE ELEMENT ANALYSIS OF CRANIAL VARIATION IN TYPHANOSSAURID DINOSAURS

SHYCHOSKI, Lara, Univ. of Bristol, Bristol, United Kingdom

Significant research has progressed our understanding of biomechanics in extinct animals as well as contributed to our knowledge of anatomy, form and evolution. However, few studies have been developed to address scaling and its associated effects on functional efficiency, particularly within dinosuarian crania. Similarly, ontogenetic evaluation of morphological variation to understand functional adaptations in response to these changes in size deserves more consideration; specifically in regards to tyrannosaurids for which there are fairly complete ontogenetic series known. In this study, data collected from geometric morphometrics and finite element analyses are presented regarding tyrannosaurid interspecific and ontogenetic adjustments to evaluate the effects of biomechanical scaling in cranial design. Geometric morphometric landmark analyses and Eigenshape analyses were conducted on various tyrannosaurid crania to observe principal components of cranial modification and the results are illustrated utilizing thin-plate spline graphics. Finite element analyses identified principal areas of stress and strain within each morphologically unique cranium through data obtained via virtual modeling of soft tissue. Conducting these analyses on various morphologies within theropod crania have allowed insights into the biomechanical aspects of scaling and increased our knowledge of efficient cranial design in small-scale and large-scale tyrannosaurids.

Saturday 2:15

THE AFFINITIES OF ASIOPLESIADAPIS YOUNGI: THE MOST PRIMITIVE ASIAN PRIMATE?

SILCOX, Mary, Univ. of Winnipeg, Winnipeg, MB, Canada

Asioplesiadapis youngi Fu, Wang, and Tong, 2002 is known from a single dentary with i1, p4-m3, and alveoli for p2 and p3 from the Early Eocene of the Wutu Formation, China. This specimen was described as a plesiadapid plesiadapiform on the basis of its reduced lower dental formula (1-0-3-3) and the presence of a margoconid and margocristid on the enlarged i1. However, features are also present that are plesiadapoid in origin, such as stout robust forelimbs have been associated with digging behaviors in living forms. Tree frogs possess expanded toe pads, whereas aquatic forms tend to have more fully webbed feet. And morphologies such as the presence of spade like metatarsal tubercles, skull modifications such as a snout with a hardened tipped tip and stout robust forelimbs have been associated with digging behaviors in living forms. Yet fewer studies have employed modern analogues to assist in the interpretation of the locomotor ecology and habitat types in fossil anurans. A diversity of new fossil anurans has recently been discovered in Oligocene deposits in the Rakw Riph Basin of Tanzania. Representing the largest sample of vertebrates recovered from these localities to date, many specimens consist of postcranial elements, some of which have been found in articulation. Specimens range in snout vent length between 20 mm and 80 mm. A preliminary examination of pelvic morphology indicates at least one form preserving Emerson's Type II B pelvis, which has been associated with strong jumping in modern forms. This information, combined with other vertebrate fossil evidence and geological interpretations may assist in deciphering the paleoenvironments of these newly discovered localities.

Preparators Symposium, Thursday 9:00

CHARACTERIZATION OF FOSSILIZED DINOSAUR BONES

SIRROPS, P., Canadian Conservation Institute, Ottawa, ON, Canada; KAMINSKA, Elzbieta, InfoSciTech, Orleans, ON, Canada

The paper summarizes a number of physical and chemical properties of fossilized dinosaur bones used in a study of the degradation of cyanocrylate adhesives in the presence of a fossil material. To fully characterize bone samples from various sites, a wide range of instrumental analytical techniques was applied. The heterogeneity within the samples was investigated by determining the elemental composition of distinct areas by scanning electron microscopy/energy dispersive x-ray spectrometry (SEM/EDS). The samples were analysed for overall elemental composition by inductively coupled plasma (ICP), and major crystalline compounds were identified by X-ray diffraction (XRD). Additionally, extractable pH, apparent porosity, as well as moisture and ash content of selected bone samples were determined.
mannered by conventional analytical methods. A wide variability in composition and physico-
chemical properties of the analyzed bones was observed.

Poster Session III

TAXONOMIC DIVERSITY OF ESTIVATING SPECIES IN THE LOWEST PERMI-
AN OF NORTH AMERICA: ONSET OF SEASONALITY AND COMMENTS ON PHYSIOLOGICAL PLASTICITY
SMALL, Bryan, Denver Museum of Nature and Science, Denver, CO; PARDO, Jason, Univ. of Colorado, Boulder, CO; HUTTENLOCKER, Adam, California State Univ., San Bernardino, San Bernardino, CA

Recently described localities in the Eskridge Formation (Council Grove Group) near Humboldt, Nebraska document a diverse earliest Permian (Asselian) vertebrate fauna from the mid-Continent of North America. The presence of vertisol and aridosols, petrocalcic horizons, and root traces and burrowing structures in the fossil-bearing mudstones suggests seasonal drying. Much of the skeletal material recovered from these localities is attributable to lysiophi-
an lepospondyls and gnathorhizid lungfishes. The lysiophorans Brachydectes elongatus and B. newberyi are both represented, and can be differentiated by mandible morphology, skull morphology. These localities represent the first appearance of B. elongatus and the last appearance of B. newberyi and are the only documented co-occurrence of these species. This also represents the earliest unequivocal record of G. dikelola. The lysiophorans B. elongatus and the gnathorhizids G. dikelola and Monongahela show an extensive record of estivation at these localities and throughout the lower Permian, as evidenced by burrows containing skeletal material. The presence of estivation burrows cor-
borates studies suggesting the mid-continent experienced increasing monsoonal seasonal-
ity across the C/P boundary. The evolution of estivation during this transition reflects con-
served physiological adaptations, increased environmental stress within marginal freshwa-
ter environments. The appearance of conspicuous estivating behavior in two distinct taxa (lysiophorans and lungfishes) at this transition suggests that evolution of some physiologi-
cal characters may occur relatively quickly as a response to environmental stress or that mechanisms underlying this environmental-physiological response are highly conserved across vertebrate taxa.

Marine Reptiles Symposium, Wednesday 2:15
CRANIAL ANATOMY AND SYSTEMATICS OF LOWER JURASSIC PLOISOAURS—NEW INFORMATION FROM THE NATIONAL MUSEUM OF IRE-
LAND
SMITH, Adam, Univ. College Dublin, Dublin, Ireland

The type material of the plesiosaur Rhomaleosaurus cramptoni from the Toarcian of Yorkshire, England, has a long and convoluted history, but it is now in storage in the National Museum of Ireland (Natural History). This complete skeleton is of vital impor-
tance in resolving the taxonomy and understanding the evolution of plesiosaurs. A recon-
struction of the dorsal surface of the skull is possible, however, the current state of the type material is poor and parts of the specimen as mounted are erroneous. The specimen will be transferred to the Palaontological Conservation Unit in the Natural History Museum, London, where it will be cleaned and prepared to allow a more detailed description. Rhomaleosaurus sensu stricto contains a maximum of only four species, all from the Toarcian of Yorkshire (cramptoni, zetlandicus, propinquus) and Northamptshire (thorn-
toni). Thus, many other species previously pertaining to Rhomaleosaurus require revised generic names. A newly prepared plesiosaur skull from the Hettangian of Street, Somerset, has been identified as ‘Rhomaleosaurus’ megacephalus and provides new information on the cranial and pectoral anatomy of this species. Notable features of the newly exposed palate include clear lateral palate fenestrae, a large ectopterygoid contacting the medial border of the suborbital fenestra, and an elongate jugal exposed on the palatal surface and contacting the posterior border of the suborbital fenestra, bounded laterally by the maxilla. All four species of Rhomaleosaurus share very similar skull construction and proportions, and possess the following synapomorphies—a large dorso-median foramen between the external nares. The validity of these four species shall be re-examined after the holotype is pre-
pared. Another plesiosaur skull, from Barrow, Leicester, is also undergoing preparation (in
London), and will shed further light onto the systematics of Lower Jurassic plesiosaurs.

Poster Session II

JAW MUSCULATURE AND FUNCTION IN OVIRAPTOROSAURS
SMITH, Masiakasaurus
SMITH, Jason, Univ. College Dublin, Dublin, Ireland

and M. pseudoraptoris and M. adductor mandibulae profundus are larger than expected, with a correspondingly large adductor chamber. Placement of muscle attachment points suggests the presence of partial checks enclosing the back of the jaw.

The observed suite of characters indicates that a suitable functional modern analogue for the oviraptorid skull would probably be a parrot or turtle, rather than the cassowary. Points of similarity with turtles include a short, deep skull and a strong adductor moment arm and extension. Convergences with parrots include the overall jaw form with a trough-like sym-
physis and elevated dorsal margin; elevated nares; a ridged palate; and the location of the orbit in the middle of the skull. In this case the convergence of skull and mandibular mor-
phology is such that it suggests evidence for similar diets—not leaf consumption in the eden-
tulous species as was previously argued, but some form of frugivory.

Poster Session II

LATE CENOZOIC HISTORY OF COLORADO RIVER FISHES DATED WITH FOSSILS AND DNA SEQUENCE DIFFERENCES
SMITH, Gerald, Univ. of Michigan, Ann Arbor, MI; SPENCER, Jon, Arizona Geological Survey, Tucson, AZ; DOWLING, Thomas, School of Life Sciences, Tempe, AZ

Ages of volcanic rocks in sedimentary sequences at the mouth of the Grand Canyon con-
strain the initial age of Colorado River in the canyon at about 5 Ma, but current hypotheses do not account for where the upper Colorado drainage drained prior to its connection to the lower Colorado basin. Fossil and recent fish distributions indicate possible explanations while supporting the young age of the canyon. Fish DNA sequence differences provide age estimates of Pliocene to Pleistocene barriers among the segments of the Colorado River. Genetic distances, calibrated with ages of appropriate a morphologies of fossil fishes (correct-
ed with the methods of Marshall and others) and adjusted for effects of metabolic rate on mutation rates, indicate several constraints: The upper Green River did not flow to the North Platte and the Upper Colorado River did not flow to the Rio Grande. Fossil cyprinid fishes in the lacustrine upper Bighaohoci formation in NE Arizona include close relatives of mod-
ern fishes in the Colorado River; their body sizes, fin sizes, and body shapes indicate con-
nection to a sizeable river. By contrast the Great Basin segment (Lower Colorado River Basin below Grand Canyon) has an ancient, endemic fish fauna that has experienced only partial mixing with the upper basin following establishment of the Colorado River in Grand Canyon.

Friday 9:15
NEW Dinosaur DISCOVERIES FROM THE EARLY Cretaceous of LIBya
SMITH, Joshwa, Washington Univ., St. Louis, MO; TSHEKREEF, Sefaiu, Petroleum Research Center, Tripoli, Libya; RASMUSSEN, D., Washington Univ., St. Louis, MO; LAMANNA, Matthew, Carnegie Museum of Natural History, Pittsburgh, PA

Although the interval has been rather well sampled, a solid understanding of the nature of the Cretaceous tetrapod faunas of mainland Africa remains elusive. This is particularly true of Libya, which has produced only a few fragmentary Cretaceous tetrapod remains. For example, from the Early Cretaceous of the Tubatulaq area of Libya, bones and teeth from the ?Early Cretaceous (provenance is unclear for some of the remains) of the Jabal Nafusah area (between Tunisia and Tripoli) and several bones from the Late Cretaceous (probably Cenomanian, ~99-93 Ma) of the Ghadames and Draa Ubari regions. In August 2005, as an expansion of ongoing research in the Late Cretaceous of Egypt, we conducted what appears to have been the first joint Libyan-American dinosaur expedition. Over three weeks we traveled ~4000 km in northeastern and south-central Libya, penetrating to ~50km north of the Chad border. Along Jabal Nafusah we produced fossil vertebrates from 13 localities in the Apintian-Albian (~125-99 Ma) Chiola Formation and the underlying uppermost Cabao Formation (uppermost strata regarded as upper Neocomian, ~125 Ma). The assemblage from these sites consists largely of shark, turtle, lungfish, and crocodil-
form elements (two species, including bones and teeth of a very large form) remains, and numerous unidentified tetrapod elements. Dinosaurs are currently represented by fragmentary remains of a ?Titanosauriform sauropt and the partial skeleton of a theropod. The therop-
rod, the most complete record of a Libyan dinosaur to date, was found at the top of the Cabao Formation near the town of Nalut, ~40 km east of the Tunisian border. It consists of vertebrae and a pedal element. This specimen, which appears to be a previously unrecorded taxon as evidenced by several autapomorphies, possesses femoral and tibial characters very similar to Masiakasaurus and is thus perhaps a large-bodied sauropod. If correctly identified, this find extends the African record of Abelisauridae into the Neocomian.

Wednesday 9:30
BIOGEOGRAPHIC RESPONSE OF LIZARDS TO THE PALEOCENE/EOCENE THERMAL MAXIMUM: EVIDENCE FROM THE BIGHORN BASIN, WYOMING, U.S.A.
SMITH, Kristie, Yale Univ., New Haven, CT

Intensive study of the Paleocene/Eocene boundary over the past 15 years has revealed a global Thermal Maximum (the PETM), widespread floral and faunal biogeographic shifts, and reorganization of terrestrial communities. In North America, the boundary marks

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the first appearances of several mammalian higher taxa. The response of reptilian groups is generally less well understood, yet the close relationship of fossil reptilian taxa to groups still living in North America may permit an understanding of intracontinental biogeographic patterns in response to rapid climate change.

The earliest Eocene (Was) Castle Gardens local fauna in the Bighorn Basin provides considerable insight on the response of lizard communities to the PETM. Fourteen species are documented from jaw fragments and significant cranial material: two iguanids, two xantusiids (night lizards), a “higher” amphisbaenian, six anguimorphs, an anguimorph of uncertain affinities, and two varanoids. Among the anguimids are the earliest species certainly referable to Gerrhonotinae (alligator lizards) and a new glyptosaurusine morphologically intermediate between the primitive “melanosaur” and later glyptosauras.

Diploglossine anguids (galliwasp), represented by fragmentary material at Castle Gardens, are presently confined to Central and South America and the Caribbean. Likewise, the genus Lepidophytone, to which one of the xantusiids is related, currently resides only in Central America (the specimens from Castle Gardens constitute the only record of the lineage in the Rocky Mountain interior). That both first occur in Rocky Mountain region during the cretaceous period suggests migration from the south in response to earliest Eocene warming and is consistent with previously described biogeographic patterns in plants.

**Saturday 4:00**

**WEIGHTED BROOKS PARSIMONY AND TIME-SLICING IN BIOGEOGRAPHIC ANALYSIS**

SMITH, Nathan, Univ. of Chicago-CEB/FMNH, Chicago, IL; MAKOVICKY, Peter, The Field Museum of Natural History, Chicago, IL

Temporal information is crucial for accurate inference of biogeographic patterns from organismal phylogenies. Recently proposed time-slicing methods seek to infer biogeographic patterns during a chosen time period by limiting the analysis to taxa that were present in that particular time-slice. Although generally effective at assessing temporal congruence while minimizing deleterious effects of biogeographic overprinting, these methods ignore informative biogeographic data from taxa that postdate the time slice, but whose presence is implied by phylogeny.

Here, we present an alternative time-slicing approach, modified from the biogeographic method Brooks Parsimony Analysis (BPA), which takes such information into account. A taxon-area cladogram is coded into a data matrix as in traditional BPA. Clade history is then divided into a series of time-slices suited to the biogeographic question and organismal group at hand. Biogeographic patterns for each time-slice are inferred through parsimony analysis of the matrix, with a weighting function applied to syntaxa based on their temporal distribution relative to a select time-slice. Syntaxa pre-dating the chosen time-slice are omitted, whereas remaining syntaxa are progressively down-weighted with decreasing age relative to a base weight given to the time slice under analysis.

The method was applied to the crocodyliform dataset of Turner (2004), using stage-level time-slices. Analyzed with traditional BPA or tree reconciliation analysis, this dataset suggests a close biogeographic relationship between South America and Indo-Madagascar to the exclusion of Africa during the Cretaceous.

However, time-sliced BPA reveals that this pattern of area relationships is primarily a post-Aptian signal, with analyses for earlier time-slices recovering a closer biogeographic relationship between South America and Africa. These results are robust to both the type (linear vs. exponential), and degree of weighting implemented. Thus, an important advantage of the time-sliced BPA method is its ability to track changes in biogeographic patterns through time, a primary goal of the “chronobiogeographical” paradigm.

**3D Imaging Symposium, Friday 8:30**

**LASER SCANNING AUTOMATION AND STANDARDIZATION**

SMITH, Nicholas, STRAIT, Suzanne, Marshall Univ., Huntington, WV

While 3D data from laser scanners have been employed in a number of morphometric studies, no standardized processes have been developed to regulate model accuracy. Using previous methods, 3D data manipulation is cumbersome, and left largely to the discretion of the user. The goal of this study was to automate and standardize one laser scanning technique for the mass-production of models suitable for both morphometric analyses and publication.

The laser scanner used in this study was a LDI Inc. RPS 120 probe, mounted on an ISEL Automation gantry unit. Coordinate point cloud data from this instrument were acquired as multiple 2D profiles of the object similar in concept to the slices of CT data. Specimens were first coated with a thin layer of ammonium chloride to diffuse the laser light. To adequately represent the surface, five scans per specimen were collected, and imported into Geomagic Studio 6.0, for manual registration. Once merged, noise reductions were performed, and the point cloud was wrapped with a polygonal mesh.

To streamline the process, the development of software macros with predefined parameters automated 7 operations of image processing including: global registration, select disconnected, select outlines, uniform sample, merge, wrap, refine. Now following registration, the remaining procedures can be performed with a single command, minimizing sources of human error. The linear and volumetric accuracy of this technique, an extensive error study was performed. A screw with a known thread-pitch of 250 microns, and a certified scale bar were scanned as control objects. Using a trio of 3D analysis programs (AutoCAD Mechanical Desktop, Geomagic Studio, 3D-Doctor), the system was found to be accurate within +/- 0.001 mm in the x-y plane, and volumetric analyses differed from the original by 0.7%-2.8%.

While the use of 3D data affords the ability to examine questions once unattainable, it is imperative that standards are applied to maintain morphological accuracy. Automation minimizes subjectivity and limits variation in model generation yielding comparable data from one researcher to the next.

**Wednesday 4:45**

**EARLIEST BATS FROM INDIA**

SMITH, Thirery, Royal Belgian Institute of Natural Sciences, Brussels, Belgium; RANA, Rajendra, JNIB Garhwal Univ., Srinagar, India; SAHNI, Ashok, Panjab Univ., Chandigarh, India; ROSE, Kenneth, Johns Hopkins Univ. School of Medicine, Baltimore, MD

The oldest known bats are recorded from the early Eocene of North America, Europe, Africa, and Australia. Recently, bats have also been reported from the early Eocene of India in the Vastan Lignite Mine east of Surat, Gujarat. Associated foraminifera of this locality indicate a middle Ypresian age, confirming that these are the first early Eocene bats from India and the oldest bats known from Asia. No confirmed bats have been found in the earliest Eocene anywhere in the world.

The bats are the most abundant and diversified mammals of Vastan Mine, which may locally represent a mangrove environment. Bats are represented by teeth and jaws, and also by isolated postcrania such as typical limb bones. At least four species are present. The largest species has the size and morphology comparable to the European Archaeoemyops patagonicus from Patagonia (France) but differs by having higher p3 and canine. The most frequent species is a medium-sized bat close to Eucyonopterus menui from Patagonia but differs by having more developed metacarpals and p4 and a non-reduced p3. This species presents particularly primitive characters also visible in nyctitheriid insectivores. Another medium species, somewhat smaller than the previous one, is characterized by a more nictalote condition with the hypoconid near the back of the entoconid but without a crest between the hypoconid and entoconid. A fourth species, very rare, is extremely small.

The new important micromammal material from Vastan indicates that the purported nyctitheriid insectivore Cambaya and didelphid marsupial Jaegeria recently described from Vastan actually belong to the most frequent medium bat species. Resemblances to European taxa in particular suggest earlier Eocene biotic contact between India and Eurasia.

**Saturday 8:40**

**A REDESRIPTION OF THE ANATOMY OF TRISTICHOPTERUS, WITH COMMENTS ON THE VALIDITY OF EUSTHENOPTERON AND THE MONOPHYLY OF THE TRISTICHOPTERIDAE**

SNITTING, Daniel, BRAZEAU, Martin, Uppsala Univ., Uppsala, Sweden

Tristichopterus alatus, from the Middle Devonian (Givetian) of Scotland, was originally described by Egerton in 1861, and has been considered to be the most basal member of the Tristichopteridae, a probably monophyletic group of tetrapodomorph fishes. Historically, Tristichopterus has been described very much in the shadow of the well-studied taxon Eusthenopteron, mainly known from the work of Erik Jarvik. Descriptions of Tristichopterus have often been very brief, partly because of the similarity to Eusthenopteron, and partly because of the lack of good Tristichopterus material. The morphological and biogeographical relationships between the two taxa are great interest, not least since its original description by Whiteaves, the validity of Eusthenopteron has been questioned. This discussion has continued up until the present, and no consensus has been reached on whether Tristichopterus is a senior synonym of Eusthenopteron. Considering the widespread use of Eusthenopteron in the literature, and the general familiarity of the name, this is more than a trivial taxonomic issue.

Data from a large number of new well-preserved specimens of Tristichopterus is presented here, shedding light on both the taxonomy and interrelationships of basal tristichopterid. Two of the specimens have also been CT-scanned at the Univ. of Texas, Austin, giving a composite picture of the neurocranium. Other new structures that are described for the first time include the palate, the hyomandibula and the endoskeleton of the pelvic fin.

**Poster Session I**

**POSTCRANIAL ANATOMY OF EARLY CENOZOIC CARNIVORAMORPHA (“MIACOIDS”), AND THEIR USE IN RESOLVING TAXONOMIC AND PHYLOGENETIC AMBIGUITY**

SPAULDING, Michelle, FLYNN, John, American Museum of Natural History, New York, NY

Recent phylogenetic analyses of the Carnivoramorpha have identified the “Miacidae” as a paraphyletic stem lineage leading to the crown group Carnivora. “Miacids” are represented in collections by a moderate amount of postcranial material. This material typically receives little attention, however, with studies focusing instead on the variation among the much greater amounts of dental material available. Here we present the first detailed cranial and postcranial description of “Miacis” uintensis (italics reflect almost certain paralogy of this genus). This AMNH specimen, collected for the AMNH from the Bridger Basin over 100 years ago, is particularly interesting because of confusion surrounding its taxonomic assignment and phylogenetic position. Opinion varies as to if “M.” uintensis belongs in “Miacis” or if it is more fitting to resurrect the genus Prodaphaenus and include this taxon within it. A taxonomic revision of “miacids” is needed, with the many species assigned to “Miacis”
requiring the most emphasis; this study is a step towards resolving the positions of the indi-
vidual species historically placed in the “miacid” “waste basket” at the base of the 
Carnivora. Also discussed is an array of other skeletons from both historical and more 
recently recovered collections. Many prior studies of “miacid” postcranial anatomy have 
taken an exemplar approach, often making sweeping generalized comparisons between 
“miacids” and Viverravidae or crown-group Carnivora. Here the detailed and more individ-
ualized comparisons of several “miacids” begin to detail the amount of postcranial variation 
within the stem lineage, and elucidates its potential for more precisely resolving the diver-
sification pattern of early Cenozoic Carnivoromorpha. Future comprehensive analyses will 
build on these results by incorporating our observations on these specimens and detailed 
description of other new postcranial specimens (e.g., Tapocyon, Odoctes, etc.).

Student Poster Session

PHYLLOGENETIC POSITION OF XENOSMILUS HODSONAE

STEVENS, Nancy, Ohio Univ., Athens, OH; NGASALA, Sifa, Univ. of Dar es Salaam, Dar 
es Salaam, Tanzania; GOTTFRIED, Michael, Michigan State Univ., East Lansing, MI; 
O’CONNOR, Patrick, Ohio Univ., Athens, OH; ROBERTS, Eric, Univ. of the 
Witwatersrand, Johannesburg, South Africa

The phylogenetic affinities of macroscelidians have been the source of considerable debate. 
These small mammals have been described as “living fossils”, with an evolutionary history 
variably linked with anagalis, condylarthra, and tethytheria. Modern sengis are restricted to 
continental Africa, and molecular studies have placed them in a somewhat unconventional 
grouping of African mammals (Allotheria), an arrangement that lacks strong morphologi-
cal support. fossils of the Eocene Macroscelides from the Paleogene of northern Africa, and are represented by Herodotus and Metodobotes from Oligocene strata 
in the Fayum Depression of Egypt, Chambius from the early Eocene Chambi Massif of 
Tunisia, and more recently by the Eocene Nemenchatherium from Bir el Atar, Algeria. Until 
recently, the macroscelidian record has been interrupted by a hiatus in fossiliferous locali-
ties until the Miocene and later faunas of Kenya, Namibia, and South Africa. Based in 
southern Tanzania, the Rukwa RiB Basin Project is beginning to fill in some of the crit-
ical gaps in the African fossil record. In particular, recent work has revealed a diverse 
vertebrate fauna of mid-late Oligocene age, preserving invertebrates, fish, anurans, 
crocodylians, and a diversity of mammals. Here we describe two new elephant shrews 
from the Unit II of the Red Sandstone Group. In both, upper and lower molars are intermediate in 
morphology between described Paleocene and Neogene forms. Specimens resemble 
herodotines in preserving upper molars that are wider than long, with substantially less hypo-
sodont cheek teeth than in, for example, Myohyrax. The larger of the two taxa is in 
size to Metodobates, and is represented by a single quadrangular upper molar. The smaller 
taxa, based on a partial maxilla, preserves an M3 that is triangular in outline but relative-
ly more reduced than that observed in Chambius. A calcaneus referable to Macroscelididae 
has also been recovered and is similar in size to extant Petrodromus, preserving strikingly 
modern facet morphology. Taken together, these finds document a rare window into 
macroscelidian evolutionary history at the close of the Paleogene.

Poster Session III

NEW VERTEBRATES FROM THE PALEOGENE OF EASTERN TEXAS AND THEIR IMPORTANCE FOR STRATIGRAPHY AND CORRELATION

STIDHAM, Thomas, College Station, TX

Although early Paleogene vertebrates have been known since the 19th century in eastern 
Texas, major questions about the biota, biotic change, and the age of the formations have 
yet to be addressed. A combination of published data and new field and lab work has 
expanded the known fossil record of the Paleogene of eastern Texas and has begun to place 
the Texas stratigraphic column into a regional and global context.Previously, the Paleocene-
Eocene Boundary has been suggested to lie below the Calvert Sandstone. The Calvert 
Sandstone is a rich source of vertebrate taxa, including those in Fig. 1, indicating an early 
Eocene age of the formation. Some workers have considered the unconformably underlying Calvert 
Bluff Formation as Paleocene. A recently discovered vertebrate fauna from a storm bed 
low in the Calvert Bluff Formation contains a diversity of sharks, rays, fish, and crocodilians. 
One of the rays, Burdnania, is not currently known from the Paleocene in North America 
and occurs in the early Eocene Bashi Formation of Mongolia. Based on these data, the 
Paleocene-Eocene Boundary appears to occur either very low in the Calvert Bluff 
Formation or in the conformably underlying Simshoro Sand. Further refinement of Eocene 
stratigraphic correlations has been aided by examination of marine and terrestrial vertebrate 
fossils. Recent work has uncovered the first fossil vertebrates from several Eocene forma-
tions in eastern Texas, including the Calvert Bluff Formation, Reklaw Formation, Queen 
City Sand, and Weches Formation. The majority of these fossils are sharks and rays, but do 
include terrestrial taxa. Additional work in the middle Eocene Cook Mountain Formation 
has produced a variety of marine and terrestrial vertebrates including a diversity of sharks, 
rays, and fish and specimens of turtles, lizards, snakes, crocodilians, mammals, and birds. 
These taxa likely are equivalent with other faunas from the Bridgerian NALMA and under-
lie the Uinta NALMA mammals of the Yegua Formation.
PALEOVIEW3D: AN INTERACTIVE DATABASE OF MAMMALS FROM THE PALEOCENE/EOCENE BOUNDARY

STRAT, Suzanne, SMITH, Nicholas, Marshall Univ., Huntington, WV

The most dramatic temperature change of the Cenozoic occurred during the late Paleocene/early Eocene. This global warming had an extensive impact on ecosystems world-wide, affecting both marine and terrestrial organisms. Study of the late Paleocene/early Eocene fossil record is essential to understanding the consequences of climatic change on biota and the origins of modern clades. Key to this work is ready access to the fossil evidence of these events, and internet accessible high resolution digital models are one of the most effective means to make this data available to the widest body of researchers.

PALEOVIEW3D is a web-based interactive database of late Paleocene and early Eocene North American fossil mammals. The Paleoview3D database currently includes interactive 3D models of over 100 specimens. When completed, this number will exceed 300 specimens, representing 300 species. Data for these surface models were acquired with a laser scanner and converted into surface models that can be viewed in either 2D or 3D, magnified and rotated by the user. These models are more than images; researchers can use them to gather quantitative data. Simple measurements (i.e., linear distance, circumference, and area) of models can be made directly on the web-site with simple point and click features. Users can also download models as data files so that more sophisticated 3D measurements can be made utilizing CAD, GIS, or 3D measurement software. Paleoview3D also includes a substantial user’s guide, about both model development and how to use a variety of software programs which are available to view and analyze the downloadable data.

The ability to create high-resolution 3D models is restricted due to significant investments in equipment and personnel training. With this website any scientist, teacher, or student can view the images or download data to be analyzed in a variety of software programs. By making these 3D data so easily accessible, Paleoview3D’s goal is to stimulate quantitative research in morphology and systematics and lead to a more informed understanding of faunal turnover and adaptation during a past period of substantial global warming.

A PRELIMINARY REVIEW OF CIMOLESTID SYSTEMATICS WITH COMMENTS ON THE GENUS PROCRERUS

STRAUSS, Justin, San Diego, CA

Cimolestids, Late Cretaceous mammals known primarily from western North America, are suspected to include the origin of Carnivora as well as other placental clades. This hypothesized relationship is based on their position biostratigraphically, within Late Cretaceous (70-64 mya) sediments, as well as on the carnassial-like occlusion of their dentition. Current systematic relationships of cimolestids are based almost entirely on tooth morphology, and remain largely unresolved. One cimolestid in particular, Procerberus, is of special interest because of its uncertain placement in relation to a number of other taxa. Once considered basal to the leptictids, Procerberus is currently regarded as a member of the family Palaeoryctidae, along with cimolestids, based on tooth morphology. Recent studies suggest some species of Procerberus may actually be ancestral to Taeniodonta. While much speculation has been done; and complete descriptions, necessary to make accurate systematic placements have not been published.

It has been hypothesized that Procerberus is a descendant of Cimolestes based on the placement of accessory cusps on both the premolars and the molars. Preliminary morphological analyses weakly support this conclusion, which may call for a systematic revision of Cimolestes, as the clade would be paraphyletic in this instance. However, the molariformization of the premolars in Procerberus is also seen in leptictids, which has been used to suggest a relationship. The paracone and metacone of the premolars of Procerberus are of nearly equal size, which is almost identical to the state of these cusps in the leptictid Gymnosictops. In the premolars of Cimolestes, the metacone is significantly smaller than the paracone. A more thorough analysis of a greater number of morphological characters is being conducted to bring greater resolution to these systematic relationships. It is expected to show greater support for the hypothesis that Procerberus is a close relative and possible descendant of Cimolestes, with little direct relation to leptictids.

THE EVOLUTIONARY ORIGINS AND FUNCTIONAL SIGNIFICANCE OF THE CHARACTERS OF CRUROTARSA ARCHOSAURS

SULLIVAN, Corwin, Harvard Univ., Cambridge, MA

Numerous structural changes occurred in the hind limb during the Eocene. In basal archosaurs, such as protorosuchids, the astragalus and calcaneum were attached to the crus, and ankle movement occurred at poorly consolidated mesotarsal and infratarsal joints. The calcaneum bore a posteriorly directed process analogous to that of extant varanid lizards. Rotoscopic animations based on X-ray footage of Varanus exanthematicus show that this process acts as a heel, increasing the moment arm of M. peroneus longus about the ankle, and this was probably also true in basal archosaurs. In crocodylians and other advanced crurotarsan archosaurs, however, the calcaneal process is posterior, and associated with the gastrocnemius. The calcaneum is integrated into the pes, and most ankle movement occurs between the calcaneum and calcaneus. Rotoscopic study of Alligator mississippiensis shows that the distal hind limb remains nearly parasagittal during movement, although knee rotation allows the femur to maintain a position of partial abduction. The combination of a parasagittal crus and a partly abducted femur may have characterized many extinct crurotarsans, although in some the entire limb was parasagittal.

The ability to create 3D models is restricted due to significant investments in equipment and personnel training. With this website any scientist, teacher, or student can view the images or download data to be analyzed in a variety of software programs. By making these 3D data so easily accessible, Paleoview3D’s goal is to stimulate quantitative research in morphology and systematics and lead to a more informed understanding of faunal turnover and adaptation during a past period of substantial global warming.

THE EFFECTS OF CONSOLIDANTS ON FOSSILS WITH RESPECT TO FUTURE CHEMICAL ANALYSIS

STRICKLAND, Katrina, North Carolina State Univ., Raleigh

With the advent of increasingly specific and sensitive analytical methods, new techniques for understanding extinct organisms are quickly being incorporated into the field of palaeontology. However, field collection and preparation of fossils have failed to evolve at the same rate, and the field practices of today are much the same as they have always been, with little attention attributed to a fossil’s subsurface chemical and structural preservation. In order to fully preserve all molecular and chemical information stored within fossil bone matrices, it is critical that these long-established methods for fossil collection and stabilization be re-examined in the context of future analytical procedures. The porous nature of fossil bone has been ignored while selecting fossil consolidants, and vascular channels and pore spaces from well preserved fossils contain the potential for uptake of chemicals through capillary action. Presented are the results of a study designed to determine the depth of penetration of common field-applied consolidants, and examine the potential of chemical interactions between externally applied chemical preservatives and organic matrices of fossil material.

Poster Session III

VEBRETEA FAUNAS OF THE WIND RIVER AND BRIDGER FORMATIONS, WYOMING (EARLY TO MIDDLE EOCENE): STRATIGRAPHIC CONTEXT AND FUTURE EVOLUTIONARY STUDIES

STUCKY, Richard, HARDY, Tom, Denver Museum of Nature & Science, Denver, CO; VAN REGENMORTER, John, Grand Valley State Univ., Allendale, MI

The vertebrate faunas of the Wind River and Bridger Formations of Wyoming serve as the standards for the transition in western North America from the early to middle Eocene. This period of time encompasses the interval of peak warming during the Cenozoic. Field research since the 1970s has resulted in substantial samples of vertebrate fossils, particularly those of mammals, from many different stratigraphic horizons. Differences in depositional environment, geographic location, and stratigraphic position provide a framework for future studies of species and faunal evolution. This poster will show the stratigraphic context and species diversity of these fossil assemblages. Faunas from the Wind River Formation across the early-middle Eocene boundary (Liaobinian to Gardnerbuttean) have higher mammalian species diversity than do those from the Bridger Formation. The Wind River Fauna also have more evenly distributed species abundance whereas those from the Bridger Formation are often dominated by a few taxa.

Saturday 3:00
ANATOMY AND RELATIONSHIPS OF THE TRIASSIC PARAREPTILE SCLEROSAURS

SUES, Hans-Dieter, National Museum of Natural History, Washington, DC; REISZ, Robert, Univ. of Toronto at Mississauga, Mississauga, ON, Canada

Based on excellent, newly prepared casts of the two known species, we have reassessed the skeletal structure and phylogenetic relationships of Sclerosaurus armatus, an enigmatic parareptile from the Middle and Upper Buntsandstein (Early to Early Middle Triassic) of Baden (Germany) and northern Switzerland. This taxon has been variously assigned to Procolophonidae, Pareiasauria, stem-group of Pareiasauria, or its own family-level taxon. Sclerosaurus is distinguished from other known parareptiles by a number of autapomorphies including: enormous, posterolaterally projecting spikes on pedicles presumably formed by the supratemporalis, teeth with bluntly conical crowns except for posterior dentary teeth, which have mesiodistally aligned, slightly labiolingually flattened, and somewhat overlapping crowns, and a narrow median band of dorsal dermal armor with two or three rows of sculpted osteoderms on either side. Phylogenetic analysis supports placement of Sclerosaurus in Procolophonidae, close to Leptoleposaurinae, rather than in or as a proximate sister-taxa to Pareiasauria. It is the largest procolophonid known to date.

Romer Prize Session, Thursday 12:00
THE EVOLUTIONARY ORIGINS AND FUNCTIONAL SIGNIFICANCE OF THE CHARACTERS OF CRUROTARSA ARCHOSAURS
presently 29 lost or mystery DPP quarries (1914-1954) have been redocumented and the whereabouts of 18 field campsites (from 28 1910-1956 expeditions) located. Nearly 25% of all the 1954 and older DPP quarries have been found through this project. Relocation of camps is important as the pre-1921 crews, lacking motor vehicles, camped close to their quarries. Knowing where crews camped can lead to the discovery of a lost quarry, or at least suggest a smaller search area. Relocated quarries increase the scientific value of the specimens and especially its critical stratigraphic context. A case report, dealing with the discovery and eventual identification of a scientifically and historically important WWI Centrosaurus quarry will be presented.

Poster Session III
ENVIRONMENTAL CONTROLS ON LATEST TRIASSIC NONMARINE TETRAPOD TURNOVER
TANNER, Lawrence, Le Moyne College, Syracuse, NY; LUCAS, Spencer, New Mexico Museum of Natural History, Albuquerque, NM

Rather than one or two major tetrapod extinctions during the Late Triassic, as previously interpreted, the fossil record suggests that tetrapod turnover progressed in stages. The Norian and Rhaetian were characterized by decreasing diversity, primarily in central Pangaea, as widespread continental ice sheets forced elevated sea-levels and drastically and adversely impacted communities that were dependent on aquatic environments or the disappearing Dicroidium flora. Consequently, the non-aquatic tetrapods fauna expanded the hypothesized relationship of Krasnoyarichthys indicate the possibility of a catastrophic tetrapod extinction at the Triassic-Jurassic boundary, the loss of many non-dinosaurian archosaurs, particularly primitive crocodylomorphs, is noted during and up to the end of the Rhaetian. This turnover coincides with environmental degradation caused by the prolonged CAMP eruptions, which began during the Rhaetian and lasted several million years. Stomatial frequency data from fossil plants are consistent with the widespread effects of outgassed SO2, suggesting that atmospheric cooling by volcanic aerosols was an important consequence of the eruptions. Interestingly, in addition to dinosaurs, Upper Triassic tetrapods that continue to the Jurassic include documented endotherms such as pterosaurs, advanced cynodonts and mammals. We propose, therefore, that instead of super greenhouse warming, as generally accepted, end-Triassic tetrapod turnover was driven by an extended interval of volcanic aerosol-driven global cooling that favored survival of tetrapods with enhanced metabolisms, regardless of body size.

Friday 11:15
TESTING PALEOECOLOGICAL ASSUMPTIONS USING TAPHONOMIC DAMAGE PATTERNS OF SMALL-MAMMAL BONE ASSEMBLAGES AT HOME-STEAD CAVE, UTAH
TERRY, Rebecca, Univ. of Chicago, Chicago, IL

Shifts in the composition and structure of small-mammal communities have long been recognized as important sources of information on past environmental change as well as the ecological consequences of such change, particularly over the Holocene. Raptors are major contributors to the Holocene small-mammal subfossil record; creating death assemblages of their prey in localized masses of bone-rich pellets. These stratified pellet accumulations represent valuable archives; recording shifts in faunal composition over time-scales critical to conservation efforts (100’s-1000’s of years). Although shifts in small-mammal community composition through Holocene transitions are typically assumed to have been environmentally driven, similar shifts can be generated by changes in the raptor taxa responsible for concentrating the remains. Correct interpretation of the impact of Holocene environmental change on small-mammal communities thus requires a solid understanding of the taphonomy of small-mammal death assemblages.

Here I test the assumption of constant raptor identity through the Holocene at Homestead Cave. Using ordination and discriminant function techniques, I show that assemblage-level skeletal damage patterns in modern pellet death assemblages can be used reliably to distinguish assemblages created by owls from those created by diurnal raptors and mammalian carnivores. The persistence of these skeletal damage patterns into stratified deposits in arid settings supports the use of sub-fossil damage patterns for raptor identification. By applying this multivariate approach to the stratified Holocene mammal record from Homestead Cave, I am able to examine the temporal concordance between shifts in assemblage-level damage patterns and shifts in the composition and structure of the local small-mammal community to test the assumption of constant raptor identity over the formation history of this record. Despite an observed diurnal to nocturnal switch in prey dominance, results suggest occupation of the cave by owls throughout the Holocene, indicating climatically-driven environmental change as the most likely driver of this trend.
Observation of taphonomic details preserved on bone assemblages gives access to the paleo-
obiological information lost during fossilization and of the paleoethology of the bone col-
lector. An argali (Ovis ammon antiqua) assemblage from the Middle Pleistocene cave of the
Cana de L’Arage (Tautavel, southern France) is studied in terms of taphonomy. The level
analyzed is 550,000 years old. Previous observations leave no doubt that carnivores are
responsible for this accumulation and non-selectively transported argali carcasses into the
cave. The type of bones in articulation and the gnawing marks are characteristic of carni-
vores. Analytical study of this accumulation reveals hunting rather than scavenging as pro-
curement mode of carcasses. This is consistent with the association of carnivores from these
levels, where the hyena is absent, represented by ursids, and strict carnivores such as felids
(lion cave, leopard with ancia-like features) and canids (wolf), whose body size and food
habits are compatible with argali as game. The hypothesis tested consists in defining the
species involved in this process. A similar association can be observed today in the
Himalayan Mountains. In addition, the topography of the site (plateau, cliffs), as well as the
climatic conditions (cold and dry) contemporaneous to the deposit of these levels favored
such an association. This unique assemblage provides relevant elements for interspecific
competition between carnivores, in southern Europe, during the lower middle Pleistocene.

Poster Session III

DARWINCOPE, A PALEONTOLOGICAL EXTENSION FOR THE DARWIN-
CORE 2 DISTRIBUTED DATABASE SCHEMA

THEODOR, Jessica, Univ. of Calgary, Calgary, AB, Canada

DarwinCore (DarwinCore Paleontology Extension) is a proposed draft extension of the
DarwinCore 2 XML schema (http://darwincore.caalacademy.org), to provide the specialized
data for geologic time and lithology needed to search fossil collections. The DarwinCore
schema forms the basis of the DIGIR distributed database protocol (http://www.digir.net).
DIGIR is used by a number of data portals, such as MANIS (mammals), ORNIS (birds),
HerpNet (amphibians and reptiles) and Fishnet (fishes) to retrieve collection records from
multiple museum collections.

DarwinCoPE was developed at an NSF-sponsored Paleontology Collections Databases
meeting held at the Illinois State Museum in May 2005, as a draft for a community stan-
dard. It is very similar to the schema used by the Pale Portal project, and is compatible with
the proposed European schema, ABCDEF, used in GeoCASE (http://projects.naturkunde-
museum-berlin.de/syntheseys_activity.d/). DarwinCoPE has been proposed to the
Taxonomic Databases Working Group (http://www.tdwg.org) as a draft standard extension
to DarwinCore 2. As a standard extension to DarwinCore 2 DarwinCoPE would allow col-
lections databases developers a standard interface that would allow collections managers to
make their collections data more easily and widely available over the web.

DarwinCoPE includes fields for geologic time units, biotstratigraphic zonations, and
lithostratigraphic units, which, when combined with field from DarwinCore 2.0 and the
Geospatial and Curatorial extensions, should allow more widespread adoption of the DIGIR
protocol for creating distributed databases among paleontological collections.

Saturday 3:30

MY THERIOPD IS BIGGER THAN YOURS OR NOT: ESTIMATING THERO-
POD BODY SIZE FROM SKULL LENGTH

THERRIEN, Francois, HENDERSON, Donald, Royal Tyrrell Museum of Palaeontology,
Drumheller, AB, Canada

Most large theropods are known from incomplete skeletal remains, often only by a skull,
which gives free course to the imagination when it comes to estimate the body length and
body mass of the “largest terrestrial predators.” Unfortunately, most body size estimate
methods require a degree of mathematical prowess that prevents widespread application.
To develop a simpler method to estimate body size, the scaling relationship between skull
length, body length, and body mass was investigated using 14 strictly carnivorous, non-
avianal theropod taxa ranging in size from the 1-m Sinosauros copris prima to the 12-m
Tyranosaurus rex. Body length was obtained from the literature for complete to nearly-
complete specimens and body mass was obtained through 3D mathematical slicing of those
same specimens to ensure accurate body length-body mass associations. Least-square
regressions on logarithmic plots reveal a tight correlation between skull length and body
mass (R² = 0.98, %SEE = 11.6%, %PE = 9.3%) and skull length and body mass (R² = 0.99,
%SEE = 34.4%, %PE = 22.1%). The skull length/body length regression (SK-BL) is nega-
tively allometric (slope < 1), which indicates that skulls become longer relative to body
length with increasing body size. In contrast, the skull length/body mass regression (SK-
BM) is positively allometric (slope > 3), indicating that body mass increases faster than
skull length with increasing body size. These conclusions confirm that the common prac-
tice of scaling isometrically smaller relatives of a given taxon to obtain body length and
to body mass estimates is not valid.

To test the validity of SK-BL, it was applied to taxa of known body length that were not
previously used in the regression. Although the body length of abelisaurids was underesti-
matated, indicating that these theropods have short heads relative to body size, SK-BL pre-
dicts body lengths very close to published values for more “typical” theropods (e.g.,
Sinraptor 7.15 m, Velociraptor 2.12 m), which confirms its validity. Body size estimates
for Carcharodontosaurus, Gigantosaurus, and Spinosaurus, approaching 13 m and 14
tonnes, suggest that they may have surpassed Tyrannosaurus in size.

Vertebrate Development Symposium, Wednesday 11:45

DEVELOPMENTAL CONSTRAINTS ON EVOLUTION: THE CETACEAN BODY-
PLAN

THEWISSEN, J.G.M., COOPER, Lisa, Northeastern Ohio Universities College of Medicine,
Rustown, OH

The rapidly growing field of Evolutionary Developmental Biology is elucidating the mech-
anic link between gene control of development, embryology, and adult morphology. It
has been shown that some dramatic morphological differences in adult morphology are
underlain by a mechanism that includes relatively minor changes in gene control of devel-
opment in early embryology: a possible mechanism for macroevolution. Such changes in
gene expression may be pleiotropic: they influence the adult morphology of many, dis-
parate body parts.

The cetacean body plan includes a number of features that are unusual among mammals:
modern cetaceans are edentulous or polydont, hyperphalangeal, lack hind limbs and (near-
ly all) hair, and have a fluke and dorsal fin. Study of cetacean embryos can thus be used to
test both the hypotheses of the role of control genes in macroevolution and that of the
pleiotropic effects of these control genes.

Interestingly, teeth, baleen, forelimbs, hind limbs, hair, dorsal fin and fluke all form at
the interface between ectodermal epithelium and underlying mesodermal mesenchyme.
Interactions between these tissues during organ formation are controlled by a genetic took-
it that includes many of the same genes in spite of the very different end organs formed.

Studying the development of these organs forms a robust test of the developmental control
gene hypothesis, and, combining the results of these studies, the pleiotropy hypothesis can
also be tested. The fossil record provides a necessary control on the timing of origin of
some of these organs.

Thursday 1:30

ACTINOPTERYGN FISHES ACROSS THE PERMO/TRIASSIC BOUNDARY

TINTORI, Andrea, LOMBARDI, Cristina, UNIMI, Milano, Italy

Though Early Triassic actinopterygian fishes are rather well represented all over the coast-
al seas around Pangaea, very few records are known around the P/Tr boundary. Most of
the Early Triassic faunas is Olenekian in age and shows a more or less homogenous composi-
tion, based on about a dozen actinopterygian genera. Basalmost Triassic fish faunas are still
unknown, but specimens with different stage of preservation are recorded from northern
Italy (Dolomites) and western Australia. In the Dolomites, both above and below the P/Tr
boundary, isalope remains (tooth bearing plates) were found: they had been wrongly
ascribed to the semionotid Paralepididus, a Late Triassic genus, but they can be better inter-
preted as pharyngeal teeth of Bobasatrunia, the only genus so far known both below and
above the P/Tr boundary. In Australia several scattered specimens of the same genus had
been found in a drill core (just above the P/Tr boundary). It must be stressed, however, that
stout teeth are much easier to be preserved. Bobasatrunia, a deep-bodied, laterally com-
pressed form, is generally well represented in Wapiti Lake (BC, Canada) Madagascar and
Greenland Olenekian fish faunas, but it is apparently absent from the Guizhou Province
(southern China) coeval ones. Body shape and dentition point to an uneven bottom dweller
feeding on rather hard shelled benthic prey. Concerning size, inferred length for the
Dolomites specimens is at least 25 cm, but this genus could reach 1 m. Just above the P/Tr
boundary from the same Dolomites area comes an almost complete specimen, not revised
yet, denominated as Archacephonopsis leonardi, showing again quite stout teeth, even if it
could not be considered as strictly durophagous. The presence of fishes with similar denti-

tion seems to contrast with the poor bottom environment characterizing the P/Tr bound-
ary, when most of benthic organisms almost disappeared. Also, it must be pointed out that a
widespread durophagy in actinopterygians was achieved only in the Norian, thus more than
25 m.y. after the P/Tr crisis.

Poster Session III

THIRTY-THREE YEARS AFTER VINCENT MAGLIO: A NEW LOOK AT THE
ORIGIN AND EVOLUTION OF THE ELEPHANTIDAE

TODD, Nancy, Manhattanville College, Purchase, NY

In 1973, Vincent Maglio published a seminal monograph on the evolution of the
Elephantidae. In Maglio’s phylogeny, 3 lineages of elephants, Loxodonta, Elephas and
Mammuthus, evolved from Primelephas in Africa, approximately 6 Ma. Loxodonta never
left Africa, with all species going extinct except for the modern African elephant.

The Elephas lineage also ultimately goes extinct in Africa, but at least 1 migration event
occurred in the early Pliocene, out of Africa to Eurasia, where it diversified and underwent
a major adaptive radiation, leaving only 1 species alive at the end of the Pleistocene
(Elephas maximus). Mammuthus also goes extinct in Africa –2 Ma, but also migrated out
in the early Pliocene. Beden (1979) further revised the African species only, delineating subspecies of
Elephas recki and Loxodonta adaurora, and suggesting Stegotetrabelodon as a possible
ancestor of Loxodonta. With addition of new specimens and species, and revisions of

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and early African are virtually indistinguishable in dental spans the late to set the stage for subsequent diversification into two clades. One clade in the to having similar molar size, low and lineage is polyphyletic, breaking into 3 intriguing clades, which as the most ancestral. The two clades seem to have diverged migrated into Africa.

In this study, we examined the relationship between enamel microwear and diet in modern caviomorphs with the goal of interpreting the diet of the early Miocene rodent Neoreomyos. A comparative dataset of nine microwear variables was compiled for 12 modern caviomorph taxa (87 specimens total). This dataset was used to construct a discriminant model with three broad dietary categories: fruit/seed, grass/leaf, and fruit/leaf consumers. The discriminant model resulted in 100% correct dietary classification of modern caviomorphs based on enamel microwear characteristics; gouges, large pits, and scratches were found to be most useful in characterizing diets. The model classified Neoreomyos (N=6) as a fruit/leaf consumer, but with a low probability. The microwear profile of Neoreomyos is characterized by low frequencies of gouges, large pits, and puncture pits, and low scratch counts, suggestive of soft fruit feeding. Unlike other “daenophrutes,” which are known to consume seeds and fruits with tough pericarps, Neoreomyos does not exhibit microwear consistent with hard fruit feeding. It also does not exhibit numerous scratches indicative of grazing.

Rodents are common in most Tertiary South American faunas and detailed paleobiological reconstructions of these animals are necessary for precise paleoecological analyses. Our initial investigations suggest that enamel microwear is a sound method for inferring diet among caviomorphs and that wider application of this method will significantly clarify trophic relationships among extinct South American herbivores.

Wednesday 3:30 ORIGIN AND COMPLETENESS OF THE PENGUIN FOSSIL RECORD TULCIE, Nina, Austin, TX

Penguins (Aves, Spheniscidae) have what is arguably the best fossil record of any extant bird lineage. The current oldest known specimen dates from the late Early Paleocene (about 62mya) and the 40 or so remaining fossil species are known from nearly every geologic stage after this. The preservation potential of penguins is excellent, considering their lack of skeletal pneumaticity, near-shore aquatic environment, and nesting behavior (where most extant species group in huge colonies during the majority of the year). The abundance and distribution of fossil remains are large, occurring as thousands of bones in some locations and covering the entire geographic distribution of extant taxa. This, however, is the first quantitative analysis of the quality of the penguin fossil record and of the estimated timing of origin of the Spheniscidae based on fossil data.

The three most common tests of relative completeness of a fossil record (Relative Completeness Index (RCI), Stratigraphical Consistency Index (SCI), and Gap Excess Ratio (GER)) are summarized here to the record of penguins, allowing evaluation of the correlation of the penguin tree to its stratigraphic occurrence, and of the proportion of ghost lineages that are unrepresented in this record. Also, confidence intervals are calculated from the penguin record to propose a divergence time for the clade; this divergence lies well before the Cretaceous/Tertiary extinction. Recent molecular estimates for the origin of the crown-Spheniscidae lie in the Eocene, suggesting that penguin stem-groups originated prior to the C/T boundary and diversified during the Paleocene, prior to crown-penguin evolution. The relative completeness of the penguin record supports the use of these data in future comparative studies and strengthens the contention that the fossil avian record is not actually as poor as previously thought.

Poster Session III ENAMEL MICROWEAR OF MODERN CAVIOMORPH RODENTS AND DIETARY INTERPRETATION FOR THE SANTA CRUZIAN RODENT NEROTEMYS TOWNSEND, Kathryn, CROFT, Darin, Case Western Reserve Univ., Cleveland, OH

Modern caviomorph rodents are a spectacular example of adaptive radiation; they are unlike most other rodents in many respects and various species have been compared to deer, hyraxes, pygmy hippopotamuses, and rabbits. Despite this diversity, no study has examined morphological correlates of diet in the group as a whole. This lack of functional dietary information has precluded rigorous interpretations of caviomorph paleodiet, and thus the diets of extinct taxa are virtually unknown.

In this study, we examined the relationships between enamel microwear and diet in modern caviomorphs with the goal of interpreting the diet of the early Miocene rodent Neoreomyos. A comparative dataset of nine microwear variables was compiled for 12 modern caviomorph taxa (87 specimens total). This dataset was used to construct a discriminant model with three broad dietary categories: fruit/seed, grass/leaf, and fruit/leaf consumers. The discriminant model resulted in 100% correct dietary classification of modern caviomorphs based on enamel microwear characteristics; gouges, large pits, and scratches were found to be most useful in characterizing diets. The model classified Neoreomyos (N=6) as a fruit/leaf consumer, but with a low probability. The microwear profile of Neoreomyos is characterized by low frequencies of gouges, large pits, and puncture pits, and low scratch counts, suggestive of soft fruit feeding. Unlike other “daenophrutes,” which are known to consume seeds and fruits with tough pericarps, Neoreomyos does not exhibit microwear consistent with hard fruit feeding. It also does not exhibit numerous scratches indicative of grazing.

Rodents are common in most Tertiary South American faunas and detailed paleobiological reconstructions of these animals are necessary for precise paleoecological analyses. Our initial investigations suggest that enamel microwear is a sound method for inferring diet among caviomorphs and that wider application of this method will significantly clarify trophic relationships among extinct South American herbivores.

Poster Session II PALEOBIOGEOGRAPHY OF THE GENUS HYAENICTITHERIUM KRETSZIOI (CARNIVORA, HYAENIDAE) AND THE FIRST RECORD OF H. HYAENOIDES ZDANSKY IN INNER MONGOLIA TSENG, Jack, Univ. of Southern California, Los Angeles, CA; WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA

The genus Hyaenictitherium represents a transitional form between the mixed feeding icthitheres and the more specialized hyaenines, exemplified by the spotted hyena. The morphological trend towards more robust premolars and overall increase in body size of Hyaenictitherium set the stage for subsequent diversification into two clades. One clade includes the bone-cracking taxa; the other includes the highly cursorial, hunting dog-like chasmaportherine affinities. Here we review the spatial and temporal distribution of species of Hyaenictitherium. In addition, we report an important new record of H. hyaenoides in the Baogeda Ula Formation of Inner Mongolia, representing the eastern-most known occurrence of the genus. The new record also represents one of the few eastern Asian localities associated with capping basalt, which in conjunction with the small mammal fauna constrains the age of Baogeda Ula at 8-7 Ma. The occurrence of Hyaenictitherium spans the late Miocene to the latest Pliocene, with highest number of localities during the later late Miocene. The genus is found in Eurasia from Spain in the west to China in the east and in Africa from Morocco in the north to South Africa. In Eurasia, the genus was widespread by MN9 (NM8) in the mid-lates. It was not until ~7 Ma (MN12/13) that species of Hyaenictitherium were found in the northern and southern latitudes of Eurasia, and into Africa. Furthermore, we propose two distinct clades within the genus, one composed of the more ancestral H. intuberculatum and H. minimum clade, and the other composed of the rest of the genus, with H. wongi as the most ancestral. The two clades seem to have diverged by the first occurrence of the genus in MN9, before Hyaenictitherium migrated into Africa. Therefore, the clades probably migrated to Africa independently. Spatial morphological trends support an easterly migration route into Africa. The genus persisted until the latest Miocene in Europe, and early Pliocene in Asia. The last record of the genus is reported by H. b. barbarum in the late Pliocene of Morocco.
The Kobe Group had traditionally been correlated to the Miocene based on plant, molluscan, and benthic foraminiferal fossils. However, recent studies of radiometric ages and marine invertebrate fossils have suggested an Upper Paleocene correlation for the group. The three fossil mammals reported from the Yokawa Formation of the Kobe Group are Bothriodon advena-like, Hyrachyus-like, and Zaisanamynodon-like mammals. B. advena and Zaisanamynodon are indicative of the late Eocene; on the other hand, Hyrachyus is indicative of the early to middle Eocene. Therefore, based on mammalian fossils, the Yokawa Formation of the Kobe Group is most probably correlated to the uppermost middle Eocene or lowermost upper Eocene (around the Bartonian-Priabonian boundary: ca. 37 Ma). This correlation is consistent with the correlation of the Kobe Group based on recent studies of radiometric ages and marine invertebrate fossils, and denies the traditional Miocene correlation.

Poster Session I
INFORMATION OF MUSCLE AND LIGAMENT ANATOMY IN THE CERVICAL REGION OF DIPLODOCID SAUROPODS USING THE EXTANT PHYLOGENETIC IC BRACKET
TSUJI, Linda, MUELLER, Johannes, Humboldt-Universität zu Berlin, Museum für Naturkunde, Berlin, Germany
Parasaurus geinitzi von Mayer, 1857 from the Late Permian Kupferschiefer deposits of is believed to be a derived pareiasaur closely related to Parasaurus geinitzi. This specimen of sacral ribs combined with the swollen neural arches of the dorsal vertebrae allow the reconstruction of soft tissue anatomy. We used this approach to infer the anatomy of the axial musculature and spinal ligaments in the cervical region of diplodocid sauropods. The origins and insertions of homologous cervical muscles are topologically very similar between extant crocodilians and birds, enabling a safe inference on positions of such attachments in sauropod skeletons. In diplodocids such as Diplodocus and Apatosaurus, attachments of tendons of m. spinalis, m. longissimus, and m. ilieocostalis can be recognized as prominent scars. In extant archosaurs, the anterolateral aspect of the prezygapophysis is the shared origin of m. longissimus and m. tendinoarticularis, or their homologs. In diplodocids, this area is marked by a prominent process, which is especially robust and projects anteriorly in Barosaurus, suggesting that these muscles may have been well-developed in these sauropods. A positional shift of the osteological correlate for the attachment of the m. semispinalis tendon is observed near the cervico-dorsal boundary in a specimen of Diplodocus, suggesting that this tendon probably changed its attachment near the cervico-dorsal boundary in diplodocids as it does in extant archosaurs.

As previously described, a well-developed prominence is present in the notch between metapophyses of each cervical vertebra in these dinosaurs, marking an attachment site of a ligament. In Diplodocus and Apatosaurus, this prominence tends to project postero dorsally, likely indicating the direction in which a branch of a long ligament would have inserted there as previously hypothesized. In Barosaurus, however, the attachment site is marked with strong, longitudinal striations in the notch or on the medial surface of the metapophysis, suggesting that the spinal ligament of this dinosaur may have had a configuration that is different from those in other diplodocids.

Poster Session II
A REEXAMINATION OF PARASAURUS GEINITZI (AMNIOTA: PARAREPTIL-IA); THE FIRST PAREIASAUR
TSUJI, Linda, MUELLER, Johannes, Humboldt-Universität zu Berlin, Museum für Naturkunde, Berlin, Germany
Parasaurus geinitzi von Mayer, 1857 from the Late Permian Kupferschiefer deposits of Germany was the first pareiasaur ever named. Whereas all other pareiasaurs have been named and studied since that time, these first specimens have not been reexamined, making this taxon problematic in terms of both identification and systematics. Other fragmentary material has subsequently been assigned to the species including a partial skull, on the basis of which Parasaurus is believed to be derived pareiasaur closely related to Elginia, the only other Western European taxon. This skull was assigned to Parasaurus because it is the lone pareiasaur found in the Kupferschiefer localities. However, there is no common anatomical material linking the type with the cranium.

An examination of this type material of the first time since its initial description has interesting implications for the taxonomy of the group. The presence of four to five sacral ribs combined with the swollen neural arches of the dorsal vertebrae allow the recognition of the postcranial remains as pareiasaurian, however examination of the lectotype specimen of Parasaurus reveals no autapomorphic features that can positively identify this material as a distinct taxon.

The skull of Parasaurus is very small for a pareiasaur, and was assigned to the Pareisaauridae primarily on the presence of distinctive multicusped teeth. The teeth are labio-lingually compressed, fan shaped, and possess approximately 7-9 cusps. Many of the cranial sutures are difficult to interpret due to the unfavorable condition of the specimen, but other than the characteristic teeth, there is little to definitively classify this animal as pareiasaurian. The odd placement of the large tabular on the postero lateral corner of the skull table and the unornamented ventral edge of the quadratojugal could also support identification as a pareiasaurid thiposaurid, which are also known to have multicusped teeth. Little detailed information is available concerning this enigmatic group, however, and more taxonomic and anatomical study is necessary to fully explore this possibility.

Poster Session I
ON THE OCCURRENCE OF FIBROLAMELLAR BONE IN ALLIGATOR TULLHEIM-DERATZIAN, Allison, Vassar College, Poughkeepsie, NY
The histology of modern crocodylians is typically characterized by zonal bone, in which regions of active growth (zones) alternate with regions of slowed growth (anuli) and lines of arrested growth (LAGs). Zones generally consist of a slow-growing lamellar or paral- lal-labeled (pseudolamellar) bone tissue. There are few references to the presence of rapidly growing woven or fibrolamellar bone (FLB) in modern crocodylians. The examples given are most often captive animals raised under artificially ideal environmental conditions (high ambient temperature, excellent nutrition, etc.) The implication is that only under artificial conditions are individuals able to sustain the high growth rates associated with the formation of FLB, and that in the wild crocodylians grow at a slower "normal" rate. Moreover, it is generally maintained that FLB can be formed only by juveniles or early in ontogeny when growth is most rapid.

Histological examination of long bones of wild American alligators from central Florida revealed weakly defined growth zones and extensive FLB formation in some individuals, including adults. The occurrence of FLB in these animals suggests that the high growth rates needed for formation of this bone tissue are not confined solely to juveniles and captive alligators, as has been widely supposed in the literature. It is possible that occurrences of FLB are more common in modern crocodylians than has heretofore been appreciated. This has significant implications for understanding growth in modern crocodylians, as well as for studies of growth patterns in fossil archosaur taxa, since the latter often draw heavily on modern crocodylian mode.

Poster Session II
RESOLVING DROMAEOSAURID PHYLOGENY: NEW INFORMATION AND ADDITIONS TO THE TREE
TURNER, Alan, American Museum of Natural History, New York, NY; POL, Diego, Conicet, Museo Paleontológico Egidio Feruglio, Trelew, Argentina; MORELL, Mark, American Museum of Natural History, New York, NY; HWANG, Sunny, New York College of Osteopathic Medicine, Old Westbury, NY
In the last few years, the number of described dromaeosaurids has increased from six to more than 18 putative taxa. Resolving the interrelationships among these theropods has proven problematic. The first known dromaeosaurids (Deinonychus, Velociraptor, Dromaeosaurus) are morphologically similar. The recently discovered small-bodied, avian-like taxon Microraptor, Sinornithosaurus, and Butcheraptor, along with putative dromaeosaurids previously thought to be avialans (Unenlagia and Rahonavis), greatly increase the range of morphological variation within the Dromaeosauridae and alter what may be reconstructed as the basal conditions for dromaeosaurids.

Here we describe three new dromaeosaurid taxa. These taxa were collected from the Upper Cretaceous Djadochtata Formation in Ukhaa Tolgoi and Tagruuin Shireh as well as the Lower Cretaceous Oiids deposits in Baykhangor Mongolia by joint Mongolian Academy of Sciences-American Museum of Natural History expeditions. Respectively, these taxa comprise a well preserved skull and cervical series; a partial cranium and well preserved postcranium; and a partial rostrum and mandible. This material, coupled with CT imagery of the Ukhaa Tolgoi skull expands our understanding of dromaeosaur anatomy and morphological variation. These specimens offer new information to explore the phylogenetic relationships within the Dromaeosauridae and provide an opportunity to expand both taxonomic and character sampling within a broad sample of coelurosaurian dinosaurs. Preliminary phylogenetic analysis indicates the presence of at least three distinct dromaeosaurid clades. The Ukhaa Tolgoi specimen is found closely related to the contemporaneous Velociraptor mongoliensis, while the other two taxa occupy more basal positions.

Preparators Symposium, Thursday 8:15
RELLOCATION OF NEW FOSSIL DEPOSITS AT THE RANCHOLABREAN TYPE LOCALITY, LOS ANGELES, CALIFORNIA
TURNER, Robin, ArchaeoPaleo Resource Mgmt Inc Venice, CA; HARRIS, John, SHAW, Christopher, George C. Page Museum, Los Angeles, CA
The Mexican land grant of Rancho La Brea received its name from the asphalt seeps in its southwest corner that became the type locality for the late Pleistocene Rancholabrean Land Mammal Age. The remnants of the Rancho La Brea tar pits, including the ongoing Pit 91 excavation, may be viewed in the now extensively landscaped Hancock Park in the Miracle Mile district of Los Angeles but opportunities to find and exploit new fossil deposits at this locality occur only rarely. The last two major deposits discovered in Hancock Park were those found during the construction of the Page Museum in 1975 and of the Japanese Pavilion of Art for the Los Angeles County Museum of Art (LACMA) in 1986. Construction of LACMA's new underground parking structure adjacent to the west edge of Hancock Park, beginning in February 2005 and monitored by ArchaeoPaleo Resource Management staff, uncovered at least five fossiliferous asphaltic accumulations at varying depths below ground surface. The construction schedule did not permit detailed in situ excavation of these localities and inclement weather plus the size of the deposits precluded them being jacketed in segments as took place with the Page Museum salvage operation. Representative samples of plant and insect remains were obtained from the periphery of each deposit. Then each bone bed was delineated, wrapped in plastic, and encased in the kind of wooden container used by landscapers for relocating large trees. Voids between
the edge of the deposit and the enclosing box were filled with expanded polyurethane foam. Each deposit was then relocated by crane to a corner of the excavation site that was not affected by the ongoing construction. Relocation of the entire deposit permitted more thorough investigation of its stratigraphy and taphonomy than would have been possible had the deposit been salvaged in situ.

Poster Session I
THE DIET OF SAUROPOD DINOSAURS—CARBON ISOTOPE COMPOSITIONS OF FOSSIL BONES AND POTENTIAL FOOD PLANTS
TÜTKEN, Thomas, Institut für Geowissenschaften, Universität Tübingen, Tübingen, Germany; HUMMEL, Jürgen, Institut für Tiersystematik, Universität Bonn, Bonn, Germany; SANDER, Martin, Institut für Paläontologie, Universität Bonn, Bonn, Germany Sauropod dinosaurs were the largest living land vertebrates. As megaherbivores they played an important role in terrestrial Jurassic ecosystems with a gymnosperm-pteridophyte flora. Differences in sauropod skeletal and dental morphology, tooth wear, neck length and biomechanics indicate different feeding strategies. The bone carbon isotope composition (δ13C) of sympatric sauropod taxa (Apataosaurus, Diplodocus, Barosaurus, Brachiosaurus, Camarasaurus), mostly from the Upper Jurassic Morrison Formation and Tendaguru beds, was analysed to investigate their niche partitioning and feeding behaviour. δ13C values from leaf samples of modern gymnosperms (e.g., araucaria, ginkgo, cycads) and ferns were analysed to infer potential sauropod food plants. Apatite δ13C values of bones and teeth are related to that of the animals’ diet. The diet-skeletal apatite offset is known for large herbivorous mammals (~14‰) and birds (~16‰); however, it might be different for dinosaurs. δ13C values of the sauropod bones range from −5.5 to −10.9‰. Differences between average bone δ13C values of some sauropod taxa might indicate the ingestion of isotopically distinct food plants. However, bone is liable for diagenetic alteration, which must be monitored. If the bone δ13C values are not significantly altered and the bird diet-apatite offset is valid for non-avian sauropod dinosaurs, δ13C values of −21.5 to −26.9‰ can be calculated. These values are similar to those measured for gymnosperm and fern leaves (δ13C = −21.9 to −36.4‰, n = 180), which cover a range typical for terrestrial C3 plants. Plant δ13C values vary due to photosynthetic pathway, tissue-type, plant species, δ13CART values and/or environmental factors. Niche partitioning and preferred feeding of sauropods on cycads (~26‰), conifers (~27‰), and/or ferns (~29.5‰) with different mean δ13C values can explain differences in their bone δ13C values. In general sauropods fed exclusively on terrestrial C3 plants, most likely conifers such as araucaria with high nutritional value, though feeding on CAM plants can not be excluded. However, the consumption of plants with high δ13C values such as C4 or marine plants seems unlikely.

Neoceti Symposium, Saturday 8:00
BIOGEOGRAPHIC AND TEMPORAL ORIGIN OF NEOCETI
UBEN, Mark, Cranbrook Institute of Science, Bloomfield Hills, AK Basilsaurid archaeocetes are known from all continents except Antarctica (reported specimens from Antarctica are probably mysticetes), and Australia (basilsaurids are known from New Zealand). Fossils of basilsaurids are found in shallow marine deposits, and are abundant in Zeuglodon Valley, Egypt, the Gulf Coast of the USA, and in the newly discovered Archaeocete Valley in Peru. Archaeocetes were thought to have gone extinct at the end of the Eocene, but recent discoveries from New Zealand show that they persist until the late Oligocene. The earliest representative of the Neoceti is Llanocetus from the Eocene/Oligocene boundary in the La Meseta Formation, Seymour Island, Antarctica. What is known of this animal is similar to basilsaurids. Other mysticetes have been noted from the early Oligocene, but they are poorly known or their ages are poorly constrained. Mysticetes diversify in the late Oligocene, when both toothed and toothless forms are known from several continents in both hemispheres. There are several reports of early Oligocene odontocetes, but they are poorly known or their ages are poorly constrained. Late Oligocene odontocetes are known from several continents in both hemispheres. Areas that have produced abundant fossils include the Pacific Northwest of North America, Japan, New Zealand, southeastern Australia, and South Carolina. The archaeocete currently thought to be most closely related to Neoceti is Chrosyctetus from South Carolina. Llanocetus is the most basal mysticete known and archaeodeltichs, Xenorhabus, and Agyrophius are near the base of the odontocete clade. Given that Chrosyctetus is from North America, Llanocetus is from Antarctica, and the basal odontocetes are from North America, the most parsimonious reconstruction of the time and place of origin of Neoceti is in the latest Eocene of North America. Archaeocetes from the late Oligocene of New Zealand may represent a refugium for archaeocetes given the duration and intensity of collecting that has occurred in the Oligocene of North America.  

Poster Session I
ESTIMATION OF DIETARY AND HABITAT PREFERENCES OF DESMOSTYLUS AND PALEOPARADOXIA BASED ON CARBON AND OXYGEN STABLE ISOTOPE AND TRACE ELEMENT ANALYSES
UNO, Hikaru, National Institute for Environmental Studies, Japan, Tsukuba, Japan; YONE-DA, Minoru, Univ. of Tokyo, Graduate School of Frontier Sciences, Kashiwa, Japan; TARU, Hajime, Kanagawa Prefectural Museum of Natural History, Odawara, Japan; KOHNO, Naoki, National Science Museum, Japan, Shinjuku, Japan. Desmostylus and Paleoparadoxia often occur at the shore of the North Pacific Ocean in the late middle Miocene. We measured the carbon and oxygen isotope compositions (δ13C and δ18O) and the ratios of trace elements (Sr/Ca and Ba/Ca) of the Desmostylus and Paleoparadoxia teeth, which are excavated from a same locality in Hokkaido, Japan. The carbon and oxygen isotopes of mammal body correlate with the diet and ambient water, respectively, and the trace element ratios (Sr/Ca and Ba/Ca) reflect a relative position in trophic level. The carbon and oxygen isotopes of Desmostylus are significantly different from those of Paleoparadoxia. The trace element ratios (Sr/Ca and Ba/Ca) show a difference between the two taxa, the ratio of Desmostylus is apparently lower than that of Paleoparadoxia. These results may reveal that Desmostylus and Paleoparadoxia share a nearly same habitat under an effect of freshwater on the basis of the value and variation of δ18O, but that they have distinct dietary preferences; Desmostylus may have a tendency to be an omnivore in comparison with Paleoparadoxia based on the values of the δ13C and ratios of trace element. These data cannot clearly decide their diets but limit some combinations of nutrient sources corresponding to the isotope and trace element information (e.g. mollusks and plants). Identification their diet in the environment of the late middle Miocene is required as a future work.

Friday 10:45
DINOSAUR BIOGEOGRAPHY AND THE BREAK-UP OF GONDWANA: A RE-APPRaisal USING CLAdISTIC BIOGEOGRAPHIC METHODS
UPCHURCH, Paul, Univ. College London, London, United Kingdom. New data on Gondwanan dinosaurs has prompted debate about the role of continental fragmentation in determining Cretaceous distributions. Three main hypotheses have been proposed: 1) the “traditional model” in which Gondwana was first divided into western (Africa-South America) and Eastern (Antarctica-India-Madagascar-Australia) portions; 2) the “Africa-first model” in which Africa separated from the rest of Gondwana in the middle Cretaceous, while S. America remained in contact with East Gondwana until the Late Cretaceous; and 3) the “pan-Gondwana model” in which the southern continents remained in contact via three landbridges until at least the Late Cretaceous. Models 1 and 2 predict different vicariance patterns, while model 3 suggests that distributions were largely determined by dispersal and extinction. Paradigmatically, both palaeogeography and biogeography have been cited as supporting evidence by advocates of all three models. However, the majority of these studies are “narratives” based on a relatively literal evaluation of the fossil record and palaeogeography. The more rigorous analytical methods of cladistic biogeography are superior because they attempt to distinguish between true distribution “signals” and the background “noise” created by sampling biases, phylogenetic error etc. Such approaches have only rarely been applied to dinosaurs. Application of cladistic biogeography to Gondwanan dinosaurs reveals signals for the Early and Late Cretaceous and provides strong support for the role of Gondwanan fragmentation in creating vicariance patterns. The Early Cretaceous was dominated by the separation of Gondwana into western and eastern portions, whereas by the Late Cretaceous the signal is consistent with the Africa-first model. This two-stage model explains the complexity of Gondwanan distributions in the Cretaceous and illustrates the recently acknowledged biogeographic principle that area relationships may be “reticulate” rather than purely hierarchical.

Thursday 2:45
CRYPTIC EXTINCTION OF A UNIQUE PLEISTOCENE WOLF ECOMORPH
VAN VALKENBURGH, Blair, UCLA, Los Angeles, CA; LEONARD, Jennifer, VILA, Carles, Uppsala Univ., Uppsala, Sweden; WAYNE, Robert, UCLA, Los Angeles, CA; ALLARD, Heather, the last Pleistocene (late Pleistocene) removed many large herbivore and carnivore species, there were some survivors, such as the gray wolf (Canus lupus). Whether the survivors sailed through the extinction event easily or suffered near-extinction is not known and difficult to assess with fossil data. However the presence of DNA in the bones of mammals preserved within Pleistocene permafrost deposits now allows documentation of genetic history over the past 40,000 years. To examine the effects of the late Pleistocene on a surviving taxon, we compared the genetic and morphologic diversity of gray wolves from the Alaskan Pleistocene to that of extant North American wolves. Remarkably, the late Pleistocene wolves of Alaska appear to have been a unique genetic clade of unusual morphology. Fifteen mtDNA haplotypes were recovered from a sample of 21 permafrost wolves (radiocarbon dated at 12,600 to > 47,170 ybp), none of which were shared with, or closely related to any modern wolf. Multivariate analyses of 11 measures of craniodental shape indicate that these ancient wolves had broader palates, larger teeth, and more modern canine shape than any modern wolf. Together, these data suggest that the permafrost wolves were adapted for robust bone consumption and intense carcass utilization. Thus, despite surviv-
ing as a species, the gray wolf suffered in the late Pleistocene due to the loss of a uniquely adapted, genetically distinct ecomorph. It has been suggested that greater specialization (e.g. large body size, hypercarnivory) leads to greater extinction vulnerability among species, and this may be equally true within species, as exemplified by these ancient wolves.

Poster Session II
SAUROPOD TRACKWAYS FROM THE MIDDLE JURASSIC OF YUNNAN, CHINA
VARRECCHIO, David, Earth Sciences Dept., Bozeman, MT; YANG, ChuanWei, ZHONG, ShuMin, Museum of the Chuxiong Autonomous Prefecture of the Yi Nationality, Chuxiong, Yunnan, China; HUANG, Timothy, DinoDragon International Research Foundation, Asian Operation, Taipei, Taiwan, ROC; KNELL, Michael, Earth Sciences Dept., Bozeman, MT A recently discovered footprint locality occurs in the Chuanjie Formation of the central Chuxiong Prefecture of Yunnan, China. The Chuanjie Formation is equivalent to the basal section of the forelanden Upper Lufeng Formation or Upper Lufeng System and has a potentially early Middle Jurassic age. The trackway horizon sits within a 2 m plus sequence of dull red silstones and mudstones. These are thinly bedded from < 1 cm to 5 cm and show multiple alternating layers of mud cracks and ripple marks. The track-bearing unit is a thin (~5 cm), dull red muddy silstone and exhibits both ripples and mud cracks. The horizon covers 105 m² and contains six distinct trackways as well as an additional band of densely packed and overprinted tracks representing at least two additional trackways. Each of the narrow-gauge trackways consists of alternating manus/pes couplets. Manus tracks are crescent shaped, but their appearance changes with stride length and overprinting by the pes track. Pes tracks are sub-triangular to oval with a laterally pointing apex. A few show four small impressions of anteriorly directed unguals. Strides measure from just less than 1 to 1.7 m and roughly correlate to pes size (length). Within single trackways, same-side manus and pes tracks remain distinct and non-overlapping with short stride lengths. But as stride lengthsens, pes tracks begin to overprint the posterior margin of the manus track. The quadripped postures, semi-digitigrade pes, and digitigrade manus phalanges indicate a sauropod origin for these tracks. Only one sauropod taxon, Chuanjiesaurus, of unknown affinities is currently known from the formation; its manus and pes are represented by only a single ungual phalanx. The narrow gauge and forward pointing digits of these tracks suggest a more primitive sauropod with a morphologic grade and pes are represented by only a single ungual phalanx. The narrow gauge and forward pointing digits of these tracks suggest a more primitive sauropod with a morphologic grade and pes are represented by only a single ungual phalanx.

Friday 8:00
ANALYSIS OF DINOSAUR DIVERSITY AND PROVINCIALITY IN LATE CRETACEOUS NORTH AMERICA
VAREK, Matthew, LARSKON, Hans, McGill Univ, Redpath Museum, Montreal, QB, Canada
Previous studies on diversity across North America in the Late Cretaceous have often ignored modern methods of diversity estimation, such as non-parametric incidence estimates. However, these methods have been shown using modern datasets to give precise and accurate estimates from patchy sampling. As well, comparison of dinosaur assemblages and delimitation into faunal provinces has often been restricted to comparisons of presence or absence of species, ignoring for effects of abundance and sampling intensity. However, there is a strong relationship between shared species between two collections and the size of those collections; as sample size increases, so does the number of shared species. By analyzing some datasets of Late Cretaceous dinosaur collections, we were able to obtain differing results before and after we corrected for sampling intensity and species abundance. Taking into account all these effects of sampling method and data analysis, we may be getting a false view in some respects to our understanding of dinosaur ecology and provinciality. By using what neoeology has already learned, we can avoid major possible pitfalls in paleoecological research. Previous studies on diversity across North America in the Late Cretaceous have often ignored modern methods of diversity estimation, such as non-parametric incidence estimates. However, these methods have been shown using modern datasets to give precise and accurate estimates from patchy sampling. As well, comparison of dinosaur assemblages and delimitation into faunal provinces has often been restricted to comparisons of presence or absence of species, ignoring for effects of abundance and sampling intensity. However, there is a strong relationship between shared species between two collections and the size of those collections; as sample size increases, so does the number of shared species. By analyzing some datasets of Late Cretaceous dinosaur collections, we were able to obtain differing results before and after we corrected for sampling intensity and species abundance. Taking into account all these effects of sampling method and data analysis, we may be getting a false view in some respects to our understanding of dinosaur ecology and provinciality. By using what neoeology has already learned, we can avoid major possible pitfalls in paleoecological research.

Poster Session I
DINOSAUR EGGS AND CLUTCHES FROM PINYES LOCALITY (SOUTHERN CHINA)
VILA, Bernat, Sabadell (Barcelona), Spain; GARRIDO, Alberto, Museo Carmen Funes, Plaza Huinuc, Argentina; GALOBART, Angel, Institut de Paleontologia M. Crusafont de Sabadell, Sabadell (Barcelona), Spain; BRAVO, Ana Maria, Unidad de Paleontologia, Dpto. BiologÌa, Universidad AutÌnoma de Madrid, Spain; JACKSON, Frankie, Montana State Univ., Bozeman, MT Recent review of the literature reveals that significant differences may exist between Late Cretaceous megalaolithid egg localities from Europe and India, compared with the Auca Mahuevo site in Argentina. To test this possibility, we compare and contrast a new megalaolithid locality in Catalonia (NE Iberian Peninsula) with the Argentine locality. Four distinct egg layers at the Late Cretaceous Pinyes site near Coll de Nargó, Spain occur within extensively developed, vertically-stacked paleosols. Ten clutches containing 114 eggs were excavated and mapped. Trimble Total Station data allowed reconstruction of the clutch geometry in three dimensions. Various eggshell morphologic aspects were recorded. Clutches contain a maximum of 15 eggs, 20 to 24 cm in diameter. Elliptical egg shape results from compaction due to tectonic stress. The Catalan eggs are larger and the clutches contain significantly fewer eggs than the 30-40 eggs reported from Auca Mahuevo. Shell thickness of the Catalan eggs is greater, and pore density and gas conductance are 20 and 12 times higher, respectively, than those at Auca Mahuevo. Plan view and cross sectional mapping supplements 3D reconstruction of egg positions and allows more accurate interpretation of egg and clutch distribution. While similarities exist in clutch architecture, the high gas conductance in eggs of the Pinyes locality suggests an incubation environment that differed from that of Auca Mahuevo. Although both localities occur in pedogenically modified, fine-grain overbank deposits, the paleosol features at Auca Mahuevo indicate significant differences in climatic regime.

Poster Session I
WEICHSELIAN PHOCA GROENLANDICA IN THE NORTH SEA (MAMMALIA; PINNIPEDIA)
VISSCHER, Tjitse, Univ. of Utrecht, Utrecht, Netherlands; RUEUMER, Jelle, Nat.Hist.Mus. Rotterdam, Rotterdam, Netherlands
A large collection of bones of harp seal (Phoca groenlandica) has been dredged by fishing vessels from the North Sea and The Netherlands. The bones are 14C-dated to the pre-LGM Middle Weichselian (50,000—35,000 B.P.). Nowadays, this pin- nipped species inhabits only the Arctic Oceans. Among fossil phocid bones, especially humerus and femur are identifiable to the level species and thus useful for study. Interestingly, at first sight they seemed smaller than recent P. groenlandica bones. If the correlation between bone size and total body length would be significant, the body size of Weichselian harp seal might have been smaller than that of recent specimens.

We measured all available humeri (n = 256) and femora (n = 137). Distinction has been made between different life stages; we only used bones of adult animals and compared them to measurements of recent harp seal bones. As a result, it was confirmed that the bones of Weichselian harp seal are significantly smaller than those of their recent conspecifics. The correlation between bone size and total body size was calculated from measurements in recent specimens with known body lengths. It was totally insignificant (R-square = 0.0023 and 0.0531 for femur and humerus, respectively). As a consequence, precise estimation or reconstruction of the total body sizes of the fossil animals was impossible. Although we assumed that there was a significant size difference between recent and Weichselian harp seals, this hypothesis can therefore not be proved or disproved.

Small bone size (and possibly smaller body size) may be due to various reasons, such as a lower sea-level during the late Pleistocene, influencing sea currents and the amount of nutrient supply. The amount of food available for harp seal in the North Sea may have been limited at several stages during the Pleistocene. However, the influence of climate (Bergmann’s rule) or of genetic drift (in an isolated population) cannot be ruled out.

Saturday 2:45
RECONSTRUCTING THE PALEOECOLOGY OF THE SANTACRUZIAN FAUNA (EARLY-MIDDLE MIocene; PATAGONIA; ARGENTINA) FROM FORM AND FUNCTION, ARAMIDILLO AND PRIMATE EXAMPLES
VIZCAÌNO, Sergio, BARGO, Susana, Museo de La Plata, La Plata, Argentina; KAY, Richard, Duke Univ., Durham, NC
The Santa Cruzian (early-middle Miocene) fauna is taxonomically rich, including Marsupialia, Xenarthra, various ungulate orders, Rodentia, and Primates. This year, we dis- covered two new fossil localities from the coastal exposures of the Santa Cruz Formation between 51° and 52° south, notable in their species diversity and unusually complete skele- tal material. They provide a temporally constrained collection that documents skulls and skeletons of many species. Such recoveries are essential for reconstructing the community using ecomorphology. A number of key niche parameters may be inferred from living analogs, including body mass, locomotion and substrate use, diet, and activity pattern. Preliminary results for armadillos exemplify this approach. armadillo’s body masses are inferred from the limb dimensions based on scaling in living taxa. Locomotion, especially the relative importance of cursoriality or digging behavior, is determined from limb propor- tions and muscular lever arms. Dietary interpretations are based on the jaw mechanics, the morphology of the jaw and tooth shape and wear. Santacruzan armadillos were as diverse, or more so, than the most rich armadillo communities today. Species body masses fall within the range of medium-sized living ones. They occupied a narrower locomotor range, there being no obligate burrowers, nor extremely cursorial forms. The dietary range was broader than today’s armadillos: within the context of generalized omnivory are distinct specializa- tions for carnivory and herbivory. Thus, dietary specialization was a larger determinant of niche partitioning in the santacruzan armadillos than it is today. The primate community...
consists of a single Cebus-sized monkey, Homunculus. New cranial, dental and postcranial remains reveal an arboreal quadruped with some leaping ability that had a diet of fruit and leaves. Except for the small sample of footprints, any evidence of the life habits of this animal that lived at >50° South latitude. Orbit- and the optic-canal size indicate diurnality and acute vision. The brain endocast shows a large visual cortex and small olfactory bulb despite the comparatively well-developed scroll bones in the nose.

Poster Session I

THE KANSAS BOE AND EVOLUTION—A TALE OF ADAPTATION, REVOLUTIONS, AND THE FITNESS OF KANSAS SCIENCE CURRICULA

VLAMIS, Ted, Wichita, KS

Challenges to the inclusion of evolution in K-12 curricula continue to be made in a wide variety of states in the USA. One arena in which this debate has repeatedly occurred during the past several years has been the Kansas State Board of Education, with some outcomes favoring anti-evolution forces and some to pro-evolution forces. Because different election results have driven these different outcomes, analysis of the reasons for these results can be instructive for those from other states facing similar challenges as well as for Kansans.

In 2005 the Kansas State Board of Education enacted Science standards hostile to the teaching of evolution on a 6-4 vote. Subsequent actions by the BOE taken on identical 6-4 votes have made it clear that opposition to evolution is only a part of the ideology motivating the current majority of the BOE.

In the August 7, 2006 primary 4 of the 6 BOE members who voted in favor of the Science standards hostile to evolution will face primary opposition. The results of this primary election and the November 7 general election are likely to determine the fate of evolution in K-12 curricula for many years to come in Kansas, and will serve as a bellwether for other states.

This presentation will analyze the results of the primary and will compare these results with previous BOE elections in order to identify successful strategies. It will look at the place of the pro-evolution anti-evolution issue in the primary and at how this issue can become part of a broader agenda. It is hoped that these lessons can be used in other states facing similar issues.

Poster Session II

REDECOVERY OF WILBUR KNIGHT’S 1898 MEGALNEUSAURUS REX SITE. NEW MATERIAL FROM AN OLD PIT

WAHL, William, Wyoming Dinosaur Center, Bighorn Basin Foundation, Thermopolis, WY; ROSS, Mike, Bighorn Basin Foundation, Casper, WY; MASSARE, Judy, SUNY College at Brockport, Brockport, NY

We report the redecovery of Wilbur Knight’s original 1898 excavation site of the large Jurassic plesiosaur Megalneusaurs rex. Known only from the type specimen, present material includes both large humeri and corresponding articulated epipodials (2m limb length) but originally included vertebral and pelvic elements as well.

The site was found using old maps identifying the original shallow oil basin described by Knight. The triangular excavation pit, not much larger than the specimen itself is in the Wind River Basin near the original western border of Natrona County. No spoil piles were nearby but partial rib scapulae and parts of an epipodial were discovered on the surface surrounding the site. The preservation matches that of the mounted articulated paddy at the Geological Museum, Univ. of Wyoming. Additionally, the sandy, green-stained glauconitic matrix matches material mixed into the original plaster filler used by Knight to reconstruct the pliosaur limb.

We can now verify that Megalneusaurs rex was from the upper Redwater Shale Member of the Sundance Formation, within about 10m of the Windy Hill Sandstone, near the base of the Morrison Formation. The sandy matrix suggests that Megalneusaurs rex frequented shallower portions of the Sundance Sea during the regressive phase of deposition. Sections of the sandy matrix contained dense amounts of thousands of coleoid cephalopod tentacle hooklets, which may have been gastric contents of the pliosaur. This site redecovery returns focus to the largest member of the Sundance marine reptile fauna.

Poster Session III

POSTCRANIA OF BRISTOL’S RED PANDA. PRISTINAILURUS BRISTOLI FROM THE LATE MIOCENE OF THE SOUTHERN APPALACHIANS

WALLACE, Steven, SCHUBERT, Blaine, East Tennessee State Univ., Johnson City, TN

The original description of Bristol’s red panda, Pristinailurus bristolii from the late Miocene-Early Pliocene Gray Fossil Site of eastern Tennessee included an upper first molar (Holotype = ETMHN-360) and an additional referred canine (ETMHN-359). Continuing excavations at the site have yielded another canine and numerous postcranial elements affording a closer look at this unique carnivora. Tentatively identified elements include: an associated partial left front limb (distal humerus, nearly complete ulna, proximal radius, unciform, cuneiform, MC4, MC5, two proximal phalanges, one medial phalanx, and several sesamoids); an ulna; an associated tibia and calcaneus; several isolated artagals; isolated caudal vertebrae; and a metatarsal. Overall morphology of the elements is strikingly similar to that of the living red panda (Ailurus fulgens), however major limb elements average around 20-25% larger. Smaller elements are only slightly larger.

At least one major difference between the Gray taxon and the living form is worth noting. The medial phalanx from the associated front limb from Gray is significantly longer with a large, raised distal articular surface compared to the living form (or other equal-sized carnivora). Living pandas have very large claws (for their body size), which are semi-retractile and flexed at the distal articular surface, which is quite different from that of the living Ailurus. The Gray medial phalanx is nearly identical to that of the living Ailurus, suggesting that P. bristolii also possessed semi-retractable claws, which were even more exaggerated in size and at the end of longer digits. Increased body size alone could not explain the difference in digit and claw dimensions, therefore an alternative explanation is required. Perhaps the less derived dentition of P. bristolii necessitated a more omnivorous (to even carnivorous) diet than in Ailurus. The highly curved and cat-like claws of Ailurus are ideal for climbing; however, it seems possible that P. bristolii used its digit/claw morphology in a more cat-like fashion, perhaps to capture and/or bring down small prey.

Wednesday 5:45

A NEW VERTEBRATE FAUNA IN LATE PLOECONE OF KUNLUN MOUNTAIN PASS, NORTHERN TIBETAN PLATEAU AND ITS PALEOENVIRONMENTAL IMPLICATIONS

WANG, Xiaoming, Natural History Museum of Los Angeles County, Los Angeles, CA; QIU, Zhuding, Li, Qiang, Institute of Vertebrate Paleontology and Paleoanthropology, Beijing, China; WANG, Yang, Florida State Univ., Tallahassee, FL; TSENG, Jack, Univ. of Southern California, Los Angeles, CA

Vertebrate fossils are exceedingly difficult to find on the high Tibetan Plateau due to a combination of factors such as low diversity and low productivity of paleocommunities, lack of suitable depositional environments, and lack of access to fossil localities. We report a late Pliocene fauna in the Kunlun Mountain Pass area. At an elevation of 4,786 m above the sea, it is the highest late Cenozoic vertebrate assemblage in the world so far known. Preliminary explorations during two field seasons have yielded a small collection of large and small mammals in a fluviolacustrine deposit in the lower member of the Qiangtang Formation, and the new fauna is paleomagnetically dated between 2.1-2.4 Ma.

Small mammals consist of cf. Metasamys sp., Chardinomys sp., Mimomys sp., Soricidae indet., Cricetidae indet., and Ochotona sp. Of these, Chardinomys and Mimomys are known from the Pliocene of North China. Morphologically the Kunlun Chardinomys and Mimomys represent advanced forms of these genera, indicating a late Pliocene age and consistent with the magnetic results. The small mammal fauna also boasts possibly the last occurrence of Metasamys in Asia, a clade extending roden previously thought to be extinct in the late Miocene of Pakistan.

Large mammals are represented by a rhino, a hippo, one or two boids, Chasmaphoractes sp., and Plesiosiglo sp. Overall, the fauna is north China or central Asia in character, with the possible exception of Metasamys. Although it currently consists of fragmentary material, the fossil assemblage presents an exceptional window of opportunity to peek into the past biota and environment of the high plateau. Preliminary analysis on the 13C isotopes on herbivore enamels yielded a range of -5.4 to -9.0 per mil. In our limited sample, fossil teeth are consistently enriched in the heavy 13C compared to modern herbivore teeth, suggesting that C4 grasses were an important component of local ecosystems in the late Pliocene.

Poster Session II

GEOLOGICAL AND GEOGRAPHICAL DISTRIBUTION OF BIRD-LIKE THEROPOD. AVIMIMUS IN MONGOLIA

WATABE, Mahito, SUZUKI, Shigeru, Center for Paleontological Research, Okayama, Japan; TSOGTBAATAR, Khishigjav, Mongolia Paleontological Center, Ulaanbaatar, Mongolia

Avimimus is a bird-like theropod with specialized forelimb structure found from the upper Cretaceous bed in the Gobi desert, Mongolia. A holotype specimen of the genus was reported by Soviet—Mongolian joint paleontological expedition in 1980’s. The locality of its discovery was assigned to a late Cretaceous (Djodkhta age) locality called Udun Sayar. Fossiliferous beds in the locality with mainly eolian origin yielded protoceraptod (Ceratopsia) and pinacosaurus (Ankylosauria) in addition to multituberculate mammals and lizards.

Hayashibara Museum of Natural Sciences and Mongolia Paleontological Center Joint Paleontological Expedition found additional specimens of Avimimus from localities in southern Gobi region such as Shar Tsav and Yagaan Khovil. Shar Tsav yielded theropod footprints and trackways comparable in size with the animal, and Maastrichtian gastropod: Mesolaniostes. Yagaan Khovil is located close to Udun Sayar and Dzamin Khord where a theropod genus Oviraptor was found. Bone fossils of a large theropod and an ornithopod, footprints of a large ornithopod, dinosaur eggshells (oviraptorid and elongatoolithid forms), and thick-shelled large turtle were also found from the locality. Fossiliferous beds in these two localities are of fluvial origin and their fossil assemblages indicate that they are correlated with the Nemegt Suite. Avimimus fossils (mainly vertebrae and metapodials) were also found by the joint expedition from the Nemegt Suite of Bugin Tsav, western Gobi region where Tarbosaurus, Saurolophus, and Nemigoria (Oviraptoro- sauria) were found.

In spite of intensive prospecting works by the expedition party, no bones of Avimimus were found from Udun Sayar which had been considered as the locality where the holotype of the genus was found. On the other hand, from Yagaan Khovil located close to Udun Sayar a several skeleton of the animal consisting of vertebrae, fore- and hindlimbs and sternum were abundantly found.
It is probable that the locality where the holotype of the genus was not Udan Sayr but Yagaan Khovii, and a name of the locality was mistakenly assigned. Fossils of *Avimimus* are limited in occurrence to the Nernert Geit (Maastrichtian), and its fossils have not been found from the Djukhtka (Campanian) beds.

Student Poster Session

**PNEUMATICITY, NECK LENGTH, AND BODY SIZE IN SAUROPODS**

WEDEL, Mathew, Berkeley, CA

Long necks are synapomorphic for sauropods, and additional neck elongation occurred independently in different sauropod clades. Increases to 15 or more cervical vertebrae occurred at least four times, in mamenchisaurids, diplodocids, Euhelopos, and Rapetosaurus. Necks longer than 10 meters also evolved at least four times, in mamenchisaurids, diplodocids, brachiosaurids, and giant titanosaurs like *Puertasaurus*. The longest-necked sauropod for which a rigorous estimate is possible is *Supersaurus*, which had a neck at least 14 meters long. The sauropods with the longest necks, such as *Supersaurus*, Sauroposeidon, and *Puertasaurus*, are also among the largest known terrestrial vertebrates.

Pneumatic vertebrae facilitated neck elongation in sauropods. The lightest sauropod vertebrae were 89% air by volume and had a specific gravity (SG) of 0.22. By comparison, cervical vertebrae of the giraffe have an SG of 1.3, and are scarcely lighter than other postcranial elements (SGs up to 1.7). The cervical column of *Brachiosaurus* is 8.5 meters long but the vertebrae would have totaled less than 600 kilograms—about the same mass as the animal’s paired humeri, which are each only two meters long.

The relationships between body size, neck length, and pneumaticity can be evaluated statistically using phylogenetically independent contrasts. I used the PDAP module in Mesquite v1.06 to test the correlations among femur length (FL), trunk length (TL), absolute neck length (ANL), proportional neck length (PNL; neck length/dorsal length), cervical count (CC), and air space proportion (ASP) in 14 sauropodomorphs. ASP and the size-independent measures of neck length (PNL and CC) form a pool of mutually-correlated variables (at p<0.05), as do the variables related to absolute size (FL, ANL, and DL). However, only two significant correlations link the two pools: ANL is correlated with ASP and PNL. Neck elongation in sauropods is tied to pneumaticity but largely independent from size-related variables.

**Posters Session III**

**LATE CRETACEOUS DUCKBILL MANDIBLES AND DUCKBILL DINOSAUR CHIN SKIN SCALES: CHEEKS, CHEWING KINETICS, AND SKIN**

WEGWEISER, Marilyn, Draper Museum of Natural History, Cody, WY; BREITHAUBT, Brent, Univ. of Wyoming, Laramie, WY; WAHL, William, Wyoming Dinosaur Center, Thermopolis, WY; BREITHAUBT, Brent, Univ. of Wyoming Geological Museum, Laramie, WY; HARTMAN, Scott, Wyoming Dinosaur Center, Thermopolis, WY

Duckbill dinosaur chin skin (DCS) has been discovered in direct association with the underside of a hadrosaurine mandible from the “This Side of Hell Wyoming” (TSOH) quarry in the Lance Formation. This is the first report of dinosaur chin skin associated with a mandible from Late Cretaceous Lance Formation sediments in northwestern Wyoming. Surface morphology of dinosaur chin skin found beneath the jaw of a large duckbill dinosaur is now related to an exact location on the dinosaur mandible. The DCS remains, and associated elements, are preserved within regionally laterally continuous very fine-grained sandstone beds of the Upper Cretaceous, Maastrichtian Lance Formation. The quarry is located on Bureau of Land Management administrated lands. Quarry excavation has been ongoing, for 6 years to carefully observe and record taphonomic features associated with the skeletal elements. Duckbill DCS is characterized by a pavement pattern of non-overlapping, closely spaced and tightly packed polygonal scales having a morphological pattern akin to a radiating sunburst design, allowing a detailed look at the surificial appearance of this Late Cretaceous dinosaur. The mandible itself exhibits a gentle sigmoid curve along the long axis, so that jaw width narrows quickly from the predentary to the tooth row. An associated predentary preserves traces of the keratinous rhamphotheca. The rhamphotheca forms vertical ridges on the predentary. Because the thickened ridges would have worn more slowly, the rhamphotheca may have formed an ever-growing serrated structure on the lower jaw that could be used to crop plants prior to oral processing by the dental batteries.

**Student Poster Session**

**A FOSSIL HORSE SPECIMEN FROM NORTHERN OREGON (HEMPHILLIAN) WITH UNCOMMON PATHOLOGIES AND PRESERVATION OF RARE FEATURES**

WEILER, Matthew, South Dakota School of Mines & Technology, Rapid City, SD

The Alkali Canyon Formation of the Dalles Group, northern Oregon (Hemphillian) has produced several unique specimens, one being a nearly complete skeleton of an adult *Pseudhipparion* sp. cf. *P. granti* with many uncommon pathologies and rare features preserved with exceptional detail. The preservation within the specimen includes fossilized sternal cartilages and a complete hyoid apparatus. The sternal cartilages are smaller in width than their corresponding ribs and are more tubular. The cartilages appear to be strongly attached, as they cover the entire distal end of the corresponding ribs. The hyoid apparatus in the specimen is composed of seven distinct bones with a weak degree of fusion at the points of articulation between the individual elements. The pathologies in this *Pseudhipparion* specimen include a distinct injury to the right dentary, associated disease and malocclusion of the dentary, as well as appears to be a broken rib. CT scans of the dentary indicate that a continuous sub-vertical fracture bissects the dentary just posterior to the p3. This malocclusion produced a significant offset of the p3 leading to abnormal wear of the p3 and the corresponding P2 and P3. As a result of the fracture, the normal growth was altered and a disease may have resulted. Evidence from the CT scans include noticeable alterations of the roots in the area surrounding the fracture, most likely caused from the trauma and possibly by disease.

Wednesday 2:30

**EVOLUTION OF SYNDACLYTY IN THE MARSUPIAL FOOT: A MORPHOMETRIC AND DEVELOPMENTAL REASSESSMENT**

WEIBECKER, Vera, Univ. of New South Wales, Sydney, Australia; NILSSON, Maria, Univ. of Lund, Lund, Sweden

Syndactyly (fusion of digits II and III) in the foot of marsupials has long been recognized as a highly significant character in marsupial phylogeny. It has attracted much attention regarding its precise character, origin, and functional implications, on which no consensus has yet been reached. The aim of this study was to revise available information on syndactyly from the literature and supplement it with developmental and morphometric data from a broad range of syndactylous species. Visual examination of museum specimens, clear staining of feet of pouched young specimens, and morphometric measurements of length and width of metatarsals, proximal and intermediate digits in 29 syndactylous species were conducted. Analysis of covariance and correlation matrices showed that measurements of syndactylous digits are more correlated than either to digits IV and V, or digits IV and V with each other. This suggests integration between digits II and III. Developmental data support this, showing that syndactyly manifests itself in the earliest stages of digital chondrification. Diversity of relative size and development in syndactylous digits is high across the marsupials tested, ranging from extremely thin and nearly fused (e.g. in kangaroos) to sturdy and well developed (e.g. in wombats), suggesting that syndactyly has not constrained pedal proportions, but there is a convergent emphasis of digit V among the hopping/bounding kangaroos and Peramelemorphidae (Bandicoots), which is unique within Mammalia. The convergent concurrence of reduced syndactylous toes and a hopping/bounding locomotion in these two clades suggests that syndactyly may facilitate the evolution of hopping. The possible presence of syndactyly in some South American marsupials suggests a deep origin of syndactyly within marsupials, or alternatively a general tendency towards it. It is therefore possible that contrary to the traditional view, syndactyly of Peramelemorpha and Diprotodontia is a plesiomorphic character for a larger grouping of marsupials.

Saturday 1:45

**ENDOSTEALLY DERIVED TISSUES IN DINOSAURS AND THE EVOLUTION OF MEDULLARY BONE**

WERNING, William, Univ. of Oklahoma, Norman, OK; LEE, Andrew, Univ. of California, Berkeley, Berkeley, CA; BYBEE, Paul, Utah Valley State College, Orem, UT

Medullary bone is an endosteally derived tissue found naturally only in extant birds, where it acts as a labile calcium reserve for eggshell production. This tissue was described recently in *Tyranosaurus rex*, and it was proposed that medullary bone evolved early in the theropod lineage. Here we report two new observations of this tissue in other dinosaurian taxa, the Late Cretaceous *Supersaurus* (JL) and the Late Jurassic *Supersaurus* (JL) and the ornithopod *Tenontosaurus tilletti* (OMNH 34784, Early Cretaceous, North America). Both specimens exhibit endosteal tissues that are morphologically homologous to the medullary bone described in *T. rex* and extant ratites, with rapidly-deposited cancellous bone internal to endosteal lamellae. Although the tissues are morphologically homologous, the functional homology of medullary bone in extant taxa and similar tissues in any fossil taxon is untestable. As expected, some differences in morphology also exist among the three known examples of dinosauromorph medullary bone, including the organization of cancellous tissue and evidence of remodeling, but these are most likely the result of phylogenetic disparity among the taxa. These new specimens offer insight into the process of medullary bone tissue deposition in dinosaurs, and suggest that the ability to produce medullary bone evolved at least as early as the Saurischian-Ornithischian divergence in basal Dinosauria.

Wednesday 9:15

**UNUSUAL FOSSIL RODENT FAUNAS FROM SOUTH CENTRAL CHILE**

WERTHEIM, Jill, HERRIOT, Trystan, Univ. of California, Santa Barbara, Santa Barbara, CA; CROFT, Darin, Case Western Reserve Univ., Cleveland, OH; FLYNN, John, American Museum of Natural History, New York, NY; GANS, Phillip, Univ. of California, Santa Barbara, Santa Barbara, CA

Laguna del Laja, Chile (LdL) is one of few places that preserves stratigraphically superposed fossil mammal faunas in South America; taxa that occur elsewhere in at least four South American Land Mammal Ages (SALMAs) are represented. The volcanogenic nature of the strata at LdL permits high-precision 40Ar/39Ar analysis; 17 dates (~20-9 Ma) are distributed throughout most of the ~1.8 km thick section, significantly improving age control particularly for the early to middle Miocene segment of the SALMA sequence. All twenty rodent taxa from LdL (37.3°S 71.2°W) represent new species, but temporal ranges for relevant genera elsewhere span much of the early late Miocene. The lowest levels of the Cura-Mallin Fm. exposed at LdL produce taxa differing modestly from Patagonian contemporaries. 2*Neoreomys* n. sp. from LdL resembles the rare 3*Colhuacuquensis Neoreomys* sp. from El Pajarito, Chubut, while Santacrucian *Protacaremys*
n. sp. from LdL compare closely to but are distinct from specimens reported from the Aguja Fm. Diplodocus specimens may be conspecific, and if so, should be referred to n. sp. and
IN MEXICO have been found in Chihuahua, MX. Near Ojinaga, the Late ammonites, and sp. is similar in age to sp. and may have lived during the early Early Jurassic mammal-bearing assemblages from the Kayenta Formation Silty sandstones, and hematitic marls dominate the lowermost Morrison Formation, providing information about the non-dinosaur components of the planktonic paleontological tools such as morphology or phylogeny, but often they cannot. Stable carbon and oxygen isotope ratios provide an empirical way to study aquatic and marine ecosystems and their habitats. For estuarine animals, stable isotopes provide a unique opportunity to estimate proportions of diet and drinking water provided by oceanic versus terrestrial sources. Marine and estuarine mammal ecology has been previously studied using a stable isotope approach, but systematic data for marine and estuarine reptiles does not exist. The carbon and oxygen data from tooth enamel carbonate indicate that modern reptiles (including crocodylians) from freshwater habitats differ significantly from animals from marine or estuarine habitats. Habitats and diets may be differentiated based on δ13C and δ18O values from tooth enamel carbonate as well as the δ18O value variability when multiple individuals of the same species are measured. Hsiology and could potentially provide information useful in the phylogenetic debates concerning crown clade crocodylians.

Poster Session III

FIRST OCCURRENCES OF DEINOSUCHUS IN MEXICO

WESTGATE, James, Lamar Univ., Beaumont, TX; BROWN, R., Instituto Nacional Antropologia Hist, Chihuahua, TX, Mexico; PITTMAN, Jeffrey, Lamar Univ., Beaumont, TX; COPE, Dana, College of Charleston, Charleston, SC; KALB, Jon, Texas Natural Science Center, Austin, TX

Poster Session I

THE PALEOECOLOGY AND TAPHONOMY OF THE EARLIEST MAMMALS AND THEIR CONTEMPORARIES: A MULTI-CONTINENT STUDY

WHATLEY, Robin, BEHRENSMEYER, Anna, Smithsonian Institution, Washington, DC

It is widely assumed that the success of the earliest mammals was grounded in ecological niches distinct from those of the large-bodied archosaurs. Despite the considerable amount that we know about the anatomy, biogeography, and phylogenetic relationships of the earliest mammals and their closest relatives, the advanced cynodonts, relatively little is known about the adaptive characteristics of these early terrestrial vertebrates. The earliest mammals and their closest relatives, the advanced cynodonts, are characterized by a small size, a specialized dentition, and a derived skeletal morphology, which is thought to reflect their adaptations to terrestrial life. In this study, we used a combination of paleoecological and paleontological approaches to investigate the ecological and taphonomic diversity of the earliest mammals and their contemporaries. We focused on the analysis of dental morphology and microanatomy, as well as the study of fossil deposits and taphonomic signatures. Our results suggest that the earliest mammals and their relatives had a diverse ecological niche, ranging from terrestrial to arboreal environments. This study contributes to our understanding of the diversification of early mammals and their role in the assembly of terrestrial ecosystems.

Saturday 3:00

ONTOGENETIC GROWTH IN THE SKULL OF DIPLODOCUS

WHITLOCK, John, Univ. of Michigan, Ann Arbor, MI

Diplodocids were among the largest terrestrial animals to have ever lived on Earth. The study of ontogenetic changes in the skull is crucial for understanding the growth and development of these giant sauropods. In this study, we examined a series of Diplodocid skulls from different stages of growth, including newborns, juveniles, and adults. Our results show that the skull morphology changes significantly from birth to adulthood, with important implications for the growth rate and life history of Diplodocids. This study contributes to our understanding of the evolution of sauropod ecology and behavior.
extent of the formation. Screen washing of matrix from a new dinosaur quarry in a lower Morrison Fm. locality in the northern Bighorn Basin of Wyoming, near Shell, has produced microvertebrate remains. This quarry is stratigraphically lower than previously described microvertebrate localities in this area.

The dinosaur quarry is in a stacked channel deposit seven meters above the marine Sundance Formation. The microvertebrates recovered so far are from the upper channel facies, consisting of a medium-grained sandstone with calcite cement. Preliminary sampling has demonstrated a relatively high yield of fossils per quantity of processed matrix. To date, the remains of herbivores, a partial hepatic skull, an atoposorous crocodile tooth, and a lower right molar from Amblotherium debilis have been recovered. Amblotherium debilis has been reported previously from the Morrison Fm. sediments of Como Bluff in southeastern Wyoming.

Thursday 2:15
3D ANALYSIS AND RECONSTRUCTION OF A PTEROSAUR WING SKELETON WILKINSON, Matthew, Univ. of Cambridge, Cambridge, United Kingdom

The potential for gaining a deeper understanding of pterosaur locomotion has greatly increased in recent years, thanks to the discovery of several near-complete, three-dimensionally preserved fossil skeletons in the Santana Formation (Lower Cretaceous) of Brazil, most of which have been assigned to the Ornithochiridae (Pterodactyloidea). Every principal limb joint is preserved in excellent detail in at least one of these specimens, offering an unprecedented opportunity to accurately reconstruct the pterosaur wing and elucidate its range of motion in 3D. While no single complete skeleton exists, a morphometric analysis of the material indicates that, within the Ornithochiridae, skeletal proportions remain roughly constant over a wide size range. The skeletal dimensions of a composite ornithochirid could therefore be calculated with a high degree of confidence. These morphometric data were used to construct a virtual 3D model of a fleshed-out ornithochirid skeleton. Joint movement was analysed by marking and articulating casts of the fossil bones, making due allowance for articular cartilage. Articulating elements were photographed at their limits of movement, the photographs were digitized, and the coordinates of the markers found. Rigid body equations were applied to the coordinate pairs to find the position and orientation of each joint axis and the range of motion about each axis. The axes were then mapped onto the virtual model. Application of rotation matrices to the 3D surface could then be used to generate any possible configuration of the wing skeleton. The analysis confirms that the pteroid—a bone unique to the pterosaurs that articulated at the wrist and supported a membranous forewing—was directed forwards in flight, not towards the body as indicated in several flattened articulated specimens. While the pteroid could be swung away from a forward-pointing position, at maximum flexion it pointed ventro-medially, not medially, and the resulting forewing shape would not have been effective for flight. The pteroid was therefore not a mere passive element, but enabled the forewing to act as a high-lift device, airbrace, and versatile control surface.

Poster Session I
NEW UNTAN PRIMATES FROM TEXAS AND THEIR IMPLICATION FOR NORTH AMERICAN PATTERNS OF DIVERSITY IN THE EOCENE WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM; WEIL, Anne, Oklahoma State Univ. Center for Health Sciences, Tulsa, OK; BECENTI, William, Thomas, New Mexico Museum of Natural History, Albuquerque, NM; WILLIAMS, Lavina, Univ. of New Mexico, Albuquerque, NM

The definition of the Llandoverian Land-Mammal “Age” is problematic, largely because of difficulties in designating a first occurrence datum to mark its onset. However, three mammal taxa, Batodon, Glasbius, and Exsonodon, that uniquely occur in the Llandoverian have been identified from the Alamo Wash local fauna. Two specimens can be confidently referred to Glasbius. NMMNH P-46380 is a right m2 or m3. P-46381 is a right m4. It is possible that both specimens are from a single individual. Both teeth are larger than those of G. intricus tus from the Lance Formation of Wyoming. They are approximately the size of G. twitchelli from the Hell Creek Formation of Montana, and are tentatively referred to that species. The m4 is much smaller than the m2 or m3. The m2 or 3 and m4 both have a labial cingulid with a cuspid anterolabial to the hypoconid. The presence of Glasbius in the Namaahibo Member gives additional support for a Llandoverian age for the Alamo Wash local fauna.

Poster Session III
RENEWED PALEONTOLOGICAL INVESTIGATIONS INTO THE MIOCENE VETEREBRATE FAUNA OF SOUTHERN ECUADOR WILLIAMS, Susan, Athens, OH; RYBCZYNSKI, Natalia, Canadian Museum of Nature, Ottawa, ON, Canada; RAMÓN, Jose-Luis, ALBUJA V., Luis, Escuela Politécnica Nacional, Quito, Ecuador

Until the mid-1980s, the pre-Pleistocene vertebrate fossil record of Ecuador was remarkably sparse. In 1922, Anthony reported the discovery of a Pleistocene caverniform rodent Drytomomys aquacatorialis from the Nában region in southern Ecuador. Fifty-five years later, fragmentary upper third molar of a toxodontid was reported from the Cuenca region. Starting in 1985 and continuing for almost a decade, several intermontane sedimentary basins of southern Ecuador were prospected with some success. These efforts substantially increased the Miocene vertebrate fossil record from this region and uncovered a diverse plant flora as well. While continued efforts by paleobotanists have greatly expanded the plant fossil record, vertebrate paleontological research in the region has virtually halted. Recently, we conducted a one-week reconnaissance to determine the viability of renewing fieldwork in the intermontane basins of southern Ecuador. We relocated some of the Miocene localities in the Cuenca and Nában basins. These localities are of particular interest because they are of known ages. Although a definitive bone layer in the Cuenca basin has yet to be established, fragmentary toxodontid dental enamel and other unidentifiable bone fragments were recovered by surface prospecting. At Nában, additional toxodontid dental material was collected from Miocene sediments. Besides enamel for stable isotope analysis, fossilized brood balls from scarabaeid beetles were also collected and appear promising for phylothesis analysis to permit paleoecological reconstruction of the local herbivores. Continued fieldwork and systematic paleontology in southern Ecuador holds promise for the discovery of vertebrate fossils. The dietary composition and evolution of equatorial faunas from South America can address hypotheses about community structure and response to local climate change, in particular Andean uplift.

Poster Session I
FIRST OCCURRENCE OF GLASBIUS (MAMMALIA, METATHERIA) NEW MEXICO AND A LANCIAN AGE (LATE CRETACEOUS) FOR THE NAHAHOBITO MEMBER, KIRTLAND FORMATION WILLIAMSON, Thomas, New Mexico Museum of Natural History, Albuquerque, NM; WEIL, Anne, Oklahoma State Univ. Center for Health Sciences, Tulsa, OK; BECENTI, William, Thomas, New Mexico Museum of Natural History, Albuquerque, NM; WILLIAMS, Lavina, Univ. of New Mexico, Albuquerque, NM

The first occurrence of the genus Glasbius in New Mexico is from the Alamo Wash local fauna, the westernmost occurrence yet known. The m4 is much smaller than the m2 or m3. The m2 or 3 and m4 both have a labial cingulid with a cuspid anterolabial to the hypoconid. The presence of Glasbius in the Namaahibo Member gives additional support for a Llandoverian age for the Alamo Wash local fauna.

3D Imaging Symposium, Friday 9:45
DIETARY PREFERENCES OF MULTITUBERCULATES: PRELIMINARY INFERENCES FROM DENTAL MORPHOLOGICAL COMPLEXITY PATTERNS IN MUROID RODENTS WILSON, Gregory, Denver Museum of Nature & Science, Denver, CO; EVANS, Alistair, JERNVALL, Jukka, FORTELIUS, Mikael, Univ. of Helsinki, Helsinki, Finland

Mammalian tooth shape can be used to reconstruct dietary preferences in fossil taxa and track patterns of morphological evolution through time. However, quantifying tooth shape has been hampered by several methodological limitations. Methods, like geometric morphometrics, that rely upon shared homologous landmarks restrict the taxonomic and morphologic scope of comparisons. They also neglect the shape information that is not captured by shared homologous landmarks. A new method that addresses these limitations. It uses Geographic Information Systems software to analyze slope orientation of three-dimensional tooth surface data. We used the number of distinct orientation patches on a tooth surface as a measure of tooth surface complexity. In a sample of living murid rodents and carnivorans with known dietary preferences, “orientation patch complexity” differentiates between feeding ecologies independent of phylogeny, increasing from faunivores to omnivores to herbi- vores.
We used the modern dataset and this new method to estimate dietary preferences in a sample of Late Cretaceous and Paleocene multituberculates. Multituberculates are a group of long-extinct mammals that have been particularly challenging for dental functional morphologists because their molars are highly complex and lack homologous features with therian molars. GIS analyses capture this complexity and allow for direct comparisons with the morphologically similar sample of modern murid rodents. Some previous studies have suggested that multituberculates were herbivorous, whereas other recent studies have suggested they were omnivorous. Our preliminary results provide a range of orientation patch complexity values that suggest that multituberculate diets ranged from more herbivorous taxa, like the Late Cretaceous Rhodomedus, to more omnivorous taxa, like the Cretaceous and Paleocene Mesodont.

Wednesday 11:15

LATEST CRETACEOUS REPTILES FROM THE HASHEMITE KINGDOM OF JORDAN

WILSON, Jeffrey, Univ. of Michigan, Ann Arbor, MI; MUSTAFA, Hakam, Yarmouk Univ., Irbid, Jordan; ZALMOUT, Iyad, Univ. of Michigan, Ann Arbor, MI

The paleobiogeographic relationships between Africa and neighboring landmasses during the Cretaceous remain a major question, due to differing paleoclimatic reconstructions and the uneven distribution of fossiliferous sediments on southern landmasses. South America is the only region of Gondwana with good representation of vertebrates from both Lower and Upper Cretaceous sediments. Vertebrates of Africa and Australia are best known from Cenomanian and older horizons, whereas those of India, Antarctica, and Madagascar are best known from latest Cretaceous sediments. These latter share a common latest Cretaceous fauna that has not yet been documented on Africa, a pattern that has been interpreted to reflect Early Cretaceous paleobiographic isolation of Africa from the rest of Gondwana.

Africa and Arabia maintained a broad geographic connection until rifting of the African and Arabian Plates and opening of the Red Sea ~34 Ma and the relatively recent collision between the Arabian Peninsula and Eurasia ~10 Ma. Jordan forms the northwestern part of the Arabian Peninsula, which was rimmed by seas that received erosional products from the continent throughout the Phanerozoic. Recent field exploration in Cretaceous deposits in southern Jordan has uncovered major new Santonian and Maastrichtian localities that preserve diagnostic fossil reptiles. Santonian fossils include the recently described bathorey did side-necked turtle Karkaemys arabicus, which is closely related to Zolahabah bella from the Maastrichtian of Egypt. Maastrichtian fossils include the first diagnostic dinosaur from the Arabian Peninsula and partially articulated cranial and postcranial remains of the ashdarchid pterosaur Arambourguiniana philadelphiae (wingspan 6-7 m). The dinosaur is a titanosaur sauropod that is characterized by extreme camellate pneumatity, a posteriorly inclined neural spine, absence of hypsonepho-hypantrum articulations, and features linking it to the Early Cretaceous Malawisaurus dixeyi from central Africa. These preliminary discoveries suggest that the Cretaceous of Jordan contains diagnostic vertebrate fossils that provide insights into African paleobiogeography.

Wednesday 11:45

COMPARATIVE TAPHONOMY AND PALEOECOLOGICAL RECONSTRUCTION OF TWO MICROVERTEBRATE ACCUMULATIONS FROM THE HELL CREEK FORMATION (MAASTRICHTIAN), EASTERN MONTANA

WILSON, Laura, Museum of the Rockies, Bozeman, MT

Microvertebrate accumulations are often used for paleoecological reconstructions, but taphonomic characteristics of specimens included in assemblages are rarely considered prior to population analysis. Taphonomic and taxonomic structures from one fine-grained and one coarse-grained facies bearing non-isotaphonomic assemblages of the Maastrichtian Hell Creek Formation were compared. Specimens were quarried to collect high-resolution distribution data permitting positioning of each specimen in three-dimensional space. Taphonomic signatures of an assemblage and subsequent relative abundance of taxa are directly correlated to the hydraulic indicators (i.e., grain size, sedimentary structures) of the depositional facies. Statistical analyses show size, shape, abrasion, and taxonomic compositions vary significantly between assemblages. Despite potential differences in time-averaging, comparison of hydraulically equivalent elements (e.g., ornithischian teeth or caudate vertebrae) between the two deposits does not show sub-populations of the assemblages to be significantly different. Results demonstrate that portions of the assemblages can be analyzed for population structure, most notably relative abundance of hydraulically equivalent skeletal elements from morphologically similar organisms, regardless of accumulation in non-isotaphonomic deposits. Only after detailed taphonomic analyses and comparison of taphonomically similar elements can the population structure represented within an assemblage be assessed.

Preparators Symposium, Thursday 11:00

COLLECTION AND HANDLING PROTOCOL FOR MOLECULAR AND CHEMICAL ANALYSES OF WELL PRESERVED FOSSIL SPECIMENS

WITTMeyer, Jennifer, SCHWEIZER, Mary, North Carolina State Univ., Raleigh, NC

The chemical and molecular characterization of soft tissues and cells preserved in fossil bone presents many technical challenges, not the least of which is detecting artifact induced by collection and handling procedures. Here we discuss a series of experiments designed to determine the extent of interference caused by these common practices and protocols. Results showed that some analytical analyses, such as FTIR, are disproportionately affected by, for example, the application of standard field consolidants, while the results of other methods are not affected by these same procedures.

We present an overview of analytical methods most appropriate for fossil analyses, and suggest standard protocols for collection and handling fossil specimens for future chemical and molecular characterization. In particular, we emphasize the role of the field crew assigned to the original recovery of fossil remains, and the preparators who are first to observe exceptionally preserved fossils that may hold promise for future analyses. Although we do not propose the elimination of common field practices, such as application of consolidants to stabilize fossil remains, we encourage collectors and preparators to consider the effect these handling methods have upon analytical analyses of fossil tissues, and to set aside untreated representative specimens. For this reason, we propose a simple method, and describe components of a kit, for field collection of well-preserved fossil specimens potentially appropriate for future molecular analyses.

Saturday 2:45

DEDUCTIVE VIRTUAL SYNTHESIS OF A SAUROPOD SKULL

WITZEL, Ulrich, GOSSLING, Rainer, Ruhr-Univ. Bochum, Bochum, Germany

The measurement of strains in real skulls is an inductive method that yields information about the stresses occurring in the a priori existing shape. In contrast, the approach taken here to determine the relationship between skull function and skull shape applies Wolff’s law through a deductive technique of structure synthesis. This paper describes the application of this method in the exact virtual synthesis of a sauropod skull, e.g., Camarasaurus.

An unspecified homogeneous solid is first constructed, giving the stresses ample volume to spread between points of force application and constraint. The FE-software ANSYS 10 is used to form 10-noded tetrahedral finite elements with a maximum of 129,000 nodes. The initial conditions are the functional spaces for the eye openings, muscle forces, and placement of the dental arcade, including assumed bite forces. Enforcing equilibrium of forces, the primary 3D stress flows in each load case are summarized by a physiological superposition, which accumulates the highest value of stress in each finite element. If the stress free parts are eliminated and the summarized stress flows are maintained, a reduced model appears, which is very similar to the real skull. This reduction of shape can be repeated iteratively and leads to a more exact form. The final FE-model is presented by using the CAD-software CATIA V5.

Changes in the form of the dental arcade, its position relative to the braincase, the origins of muscles, or the height of the skull lead to models that clearly resemble morphological differences between genera. The deductive virtual synthesis of a skull of Camarasaurus using the finite-element structure synthesis (FESS) demonstrates the direct correlation between functional loading and the biological structure and shape and can be used to test hypotheses regarding the relationship between structure and function during skull evolution.

Saturday 11:15

EVOLUTION OF THE SCALATION PATTERN IN TEMNOSPONDYLYS

WITZMANN, Florian, Berlin, Germany

The presence of ossified dermal scales is a plesiomorphic feature of basal tetrapods. In most Paleozoic temnospondyls, thin round-oval scales covering the flanks and the back of the trunk can be distinguished from ventral, elongate gastric scales arranged en chevron that protected the belly during crawling on the bottom. The investigation of an extensive growth series of the Permo-Carboniferous temnospondyl Scleroscelphalus reveals that the morphology of the gastric scales in small larvae corresponds to the round-oval scales of the rest of the body. During further ontogeny, the gastric scales differentiate and reach a spindular morphology. The tapering end of each spindular gastric scale fits into a dorsal groove on the medial adjacent scale. This arrangement allowed telescoping of the scales and thus provided a high degree of flexibility during flexion of the body. In the ontogenetically most advanced specimens of Scleroscelphalus, the gastric scales are distinctly thinner and attain a rhomboid outline by accelerated growth in the posterior direction. The articulation between neighbouring gastric scales by well-defined facets has reduced the flexibility between them. Outgroup comparison shows that the stem-tetrapod Greererpeton and many archosauromorphs possess corresponding rhomboid gastric scales. In most temnospondyls, however, the gastric scales do not attain the adult rhomboid condition but retain the juvenile spindular or even the larval round-oval shape, which can be interpreted as paedomorphic traits. This suggests that the different types of gastric scales in temnospondyls as well as the scales of the back and the flanks can be traced back to the same Anlage of round-oval scales that differentiated early in ontogeny. In the Mesozoic, a complete reduction of dermal sculation occurred independently in distinct diapsid morphotypes, captosaurids, and trematosaurid temnospondyls. This reduction was probably caused by several factors that are different for each group, like cutaneous respiration especially in small forms, the demand for greater mobility, and the decreased importance of belly protection in fully aquatic temnospondyls.
Ectocion, a "condylarth" lineage spanning the Paleocene/Eocene boundary

WOOD, Aaron, ZELDITCH, Miriam, GINGERICH, Philip, Univ. of Michigan, Ann Arbor, MI
Past studies of evolutionary mode in fossil mammalian lineages have often been limited to univariate traits (e.g. molar crown area). It is reasonable to assume that tooth shape, a multivariate trait, reflects more of the functional portion of the tooth, the part that is more likely to respond to selective pressures. Previously, we studied the tooth margin shape and cusp configuration in the lower dentition of Ectocion, a phenacodontid "condylarth" from the Paleocene/Eocene (P/E), using geometric morphometric techniques. Our results indicated stasis in tooth margin shape and cusp configuration over the sampled time interval spanning the P/E boundary. Admittedly, these aspects of tooth shape in Ectocion, the most herbivorous of phenacodontids, may not contain the true shape differences resulting from selective pressures on the full masticatory abilities of the lower dentition.

Here we present the results of a new geometric morphometric study of the shearing crest shape of the lower dentition (p4, m1, m3) of Ectocion oshonumianus and E. parvus. Teeth with little to no wear were sampled over a 1.5 million year interval. Principal cusps were used as landmarks, and semi-landmarks were digitized along the highest edge of the shearing crests. Principal components analyses showed no separation between time intervals at all temporal resolutions. Multivariate tests characterize the crest time series as consisting of counteracting changes with less change (i.e. stasis) than expected under a random walk. Permutation F-tests show that the shape variation within each bioclone is not significantly different than variation for the entire sampled interval, providing further proof of stasis.

Currently, these methods are being extended to the Eocene perissodactyl genus Hyracotherium. Chronostratigraphic data of Hyracotherium show distinct molar sizes during the early Wasatchian with the smallest species, H. sandreanu, occurring during the Paleocene/Eocene Thermal Maximum. The purpose of the new study is to study change in the functional tooth shape and tooth wear shape between the Hyracotherium chronospecies.

Wednesday 2:30

A NEW "MIDDLE" CRETACEOUS ZALAMBDALESTID MAMMAL FROM NORTHEASTERN CHINA

WOOD, C.B., Providence College, Providence, RI; ZAN, Shuqin, Geol. Mus. China, Beijing, China; CHEN, Jun, Jilin Univ. Geol. Mus, Changchun, China; ROUGIER, Guillermo, Univ. Louisville School Med., Louisville, KY; SCHAFF, Charles, Museum of Comparative Zoology, Cambridge, MA
Fossils from a new mid-Cretaceous locality near Gongzhuling City in Jilin Province, China, include two incomplete dentaries, which represent a newly described genus and species (Zhangolestes jilinensis) referable to the eutherian family Zalambdalestidae. Both dentaries possess an enlarged, procumbent first incisor combined with an interesting mosaic of both plesiomorphic and derived dental characters compared to the early zalambdalestid Kaliboeckia kaliboecke. For example, the new specimens appear to show five premolars (including an almost fully molariform ultimate premolar) combined with only three incisors and a low but single-rooted canine. The trigonids on p5 and m1 are relatively open and not as compressed as in later zalambdalestids. Kaliboeckia, from Turonian deposits in Uzbekistan, has four premolars, and other than the typical procumbent incisor its anterior dentition is different in detail (e.g., four incisors plus double-rooted canine) compared to the Chinese material. Cenomanian Bobolestes (now including Otilestes) has an almost fully molariform ultimate premolar but no sign of enlarged incisors. Other early eutherians such as Eomaia, Prokenelestes, and Montanolestes have a trenchant, non-molariform ultimate premolar. Zhangolestes may therefore extend the range of certain, presumably derived eutherian characters to an earlier time than previously known.

More work is needed on interbasinal correlation, but at present it seems unlikely that Zhangolestes could be younger than Cenomanian. The locality is in basin-margin outcrops of the Quantou Formation, which is widespread in the subsurface of Songliao Basin and which has been assigned ages ranging from Aptian to Cenomanian. Songliao Basin is tec-tonically and sedimentologically distinct from the smaller but more numerous basins in western Liaoning. The Gongzhuling locality is likely to emerge as an important source of new information on "middle" Cretaceous vertebrates as additional mammalian, dinosaurian, and other specimens already collected are described from it.

Poster Session III

A STUDY OF CAMARASAURUS' (DINOSAURIA: SAUROPODA) TORSO AND ITS BIOMECHANICAL IMPLICATIONS

WOOD, Jacqueline, Univ. of New Orleans, New Orleans, LA
This project examined the torso shape through artificiating casts of both dorsal vertebrae and ribs and its biomechanical implications of the well-known sauropod Camarasaurus. The project resulted in a new curve in the dorsal vertebrae series, a torso which is more narrow and volumetrically smaller than previous models, the first attempt in reconstructing intercostal musculature, and a scapulocoracoid angle of 20-30° based upon scapular facets. New knowledge for the reconstruction was gained through dissection of Alligator mississippiensis, Iguana iguana, and Gallus domesticus. The dorsal vertebrae were articulated based on the position of the zygapophyses and centrum spacing. The dorsal ribs were articulated onto the vertebrae based upon the tuberculum/diaphysis, capitulum/parapophysis articulations, and the flat lateral edge of the ribhead. The results are not consistent with published models, however they are consistent with the information obtained in dissections.

Saturday 9:30

USING LIMB CIRCUMFERENCE AND BODY MASS TO ESTIMATE SAUROPOD DINOSAUR GROWTH RATES

WOODWARD, Holly, Montana State Univ., Bozeman, MT; LEHMAN, Thomas, Texas Tech Univ., Lubbock, TX
Sauropod dinosaurs were the largest terrestrial animals and their growth rates remain a subject of debate. Based on counting growth lines in histologic sections and relating bone length to body mass, it has recently been estimated that Apatosaurus attained its adult body mass of about 25,000 kg as little as 15 years, with a maximum growth rate of 5,466 kg/yr. This rate exceeds that projected for a precocial bird or eutherian mammal of comparable estimated body mass. Using an alternative method of estimating limb circumference and body mass for each growth line, and fitting the resulting age/mass data to the von Bertalanffy growth equation, a revised growth curve suggests that Apatosaurus adult mass was reached by 70 years with a maximum growth rate of 520 kg/yr. This alternative method for growth rate determination was also applied to histological studies of two titanosaurid sauropods. At about half the mass of Apatosaurus, Janenschia took between 20 and 30 years to attain its adult size (~14,029 kg). This result is supported by independent evidence of estimated bone apposition rates. Despite having an adult body mass greater than Apatosaurus, the titanosaurid Alamosaurus attained a mass of about 32,663 kg within 4 years and a maximum growth rate of 1,090 kg/yr. Titanosaurs may have been the fastest growing of all sauropods. Even so, the growth rate estimates produced using the von Bertalanffy equation for all three sauropods fall within the interval between those project- ed for reptiles and those for birds or mammals of equivalent projected body mass. These results are comparable to those found for smaller dinosaurs, and suggest that sauropods grew at rates similar to other dinosaurs in spite of their great size.

Wednesday 2:45

EARLIEST KNOWN BIRD TRACKS FROM THE CEDAR MOUNTAIN FORMATION, UTAH

WRIGHT, Joanna, Univ. of Colorado, Denver, Denver, CO; KIRKLAND, James, Utah Geological Survey, Salt Lake City; FOSTER, John, Museum of Western Colorado, Grand Junction, CO; DEBILLEUX, Donald, Utah Geological Survey, Salt Lake City, CO; GAS- TON, Robert, Gaston Design, Fruitia, CO
The earliest known bird, Archaeopteryx, is known from the Upper Jurassic deposits of Solnhofen in Germany but all other fossil bird remains are Early Cretaceous or younger. Similarly, the oldest known fossil bird tracks are Early Cretaceous in age, with the possible exception of some bird-like tracks reported from the Triassic of South America.

The Cedar Mountain Formation of western Colorado and eastern Utah is renowned for producing diverse Early Cretaceous terrestrial fossils, and several tracksites have also been reported. However, these are the first bird tracks reported from the Cedar Mountain Formation. The tracks are preserved in the Yellow Cat Member, which is probably Barremian in age.

Two tracks were discovered in summer 2005 by JRF and RG on a fallen sandstone block. Further investigation of the site turned up two further blocks, found by JIK and JILW respectively. A ripple-marked fourth slab preserves two small theropod tracks. All the tracks are preserved in concave epirelief on a thin medium-grained sandstone layer at the top of a meter thick erosional-based coarser sandstone with a rippled top surface, which may be of crevasse splay origin. This lithology is very distinctive and it was therefore possible to definitively locate it in the measured cliff section, although no tracks were found in situ. The tracks are 35-45mm in length and have pace lengths of 130-150mm. Some preserve faint phalangeal pads and small claw marks but there are no traces of interdigital webbing. Several preserve a hallux impression. The distal diameter of digits II-IV is 105-115 degrees. The tracks are tooed-in about 15 degrees. Approximately 50 tracks are preserved on the three slabs and there are several short trackways. We believe these to be the earliest known bird tracks in the world.

Saturday 3:45

A REVIEW OF THE EVIDENCE FOR A HUMAN ROLE IN THE EXTINCTION OF AUSTRALIAN MEGAFAUNA AND AN ALTERNATIVE INTERPRETATION

WROE, Stephen, Univ. of New South Wales, Sydney, Australia; FIELD, Judith, Univ. of Sydney, Sydney, Australia
Arguments that megafaunal extinctions in Australia were anthropogenically mediated have focused on establishing terminal appearance ages. This approach has been underpinned by three principle tenets: (1) if megafauna disappeared before significant climate change, but after human colonisation, then it can be inferred that extinctions were human mediated; (2) climate change within the last glacial cycle was unremarkable relative to previous cycles; and (3) all or most Pleistocene megafauna were present when people arrived on the conti- nent. We review the evidence for human causation and note mounting evidence suggesting that the last 30,000-50,000 ka in Australia has been characterised by escalating aridity and climat- ic variability, culminating in the breach of a hydrological threshold within the last glacial cycle. Only 21 species (35%) of megafauna whose disappearance is known to have persisted after the Penultimate Glacial Maximum (c. 130
ka), a time of undoubtably severe climate change. Thus, 39 species of megafauna (65%) cannot be reliably placed within 80,000 years of firm evidence for human arrival at c. 50-43 ka. At most eight species (13%) were clearly present at this time. Four or more persist- ened until the onset of full glacial conditions at c. 30 ka. We argue for a falsifiable model of staggered extinction in which most megafaunal extinctions predated human arrival and with the influence of people as a minor superimposition on broader trends in time since middle Pleistocene times.

Friday 10:30

A NEW CERATOPSID Dinosaur (ORNITHISCHIID) FROM THE UPPER HORSESHOE CANYON FORMATION, ALBERTA, CANADA

WU, Xiao-chun, Canadian Museum of Nature, Ottawa, ON, Canada; BRINKMAN, Donald, EBERTH, David, Royal Tyrell Museum of Palaeontology, Drumheller, AB, Canada

Southern Alberta is uniquely famous for its richness of dinosaurian and other fossil verte- brates in the late Cretaceous. ceratopsians, or horned dinosaurs, are one of the best repre- sented dinosaur groups in the region and one of the last non-avian dinosaur groups to become extinct. Ceratopsians are well represented in the Lower Horseshoe Canyon Formation (Upper Campanian) and Lower Scollard Formation (Upper Maastrichtian, roughly equivalent in age to the Frenchman Formation of southern Saskatchewan and the Hell Creek and Lance Formations of USA), but are rare in the Upper Maastrichtian Upper Horseshoe Canyon Formation and its equivalent deposits in neighboring areas. A new cer- atopsian dinosaur skeleton was collected from the Upper Horseshoe Canyon Formation in the Dry Island-Buffalo Jump Provincial Park, southern Alberta in the field season of 2001. Although dinosaurs have been collected from this interval for approximately a century, this is the first associated specimen of vertebrate fossils found within the top 20 m of the Horseshoe Canyon Formation.

The new ceratopsian is diagnosable primarily on the basis of a combination of features in the premaxilla, nasal horn core, squamosal frill, and epiglial. The most striking of those features include an extremely dorsovenally broadened narial process of the premaxilla, a rostrally positioned premaxillary process extending into the intermaxillary fenestra, the presence of greatly elongate epoccipitals of the squamosal frill, a deep fossa on the rostral- ventral surface of the squamosal frill, the epiglial sharply triangular in lateral view, and the presence of a transverse and a oblique vascular trace on the rostral surface of the nasal horn core. Our preliminary study suggests that the new form is a chasmosaurus and nested with in a clad including Triceratops, Diceratops and Torosaurus, which are all from the late Maastrichtian deposits. The new ceratopsian fills the stratigraphical/chronological gap that currently exists between the late Campanian and the late Maastrichtian ceratopsian dinosaurs.

Saturday 10:45

NEW CERATOSAURS FROM THE JURASSIC SHISHUGOU FORMATION OF WESTERN CHINA

XU, Xing, Beijing, China; CLARK, James, George Washington Univ., Washington, DC

From 2001 through 2005, our excavations in the Middle-Upper Jurassic Shishugou Formation in the Junggar Basin, Xinjiang Uighur Autonomous Region, western China have yielded numerous vertebrate specimens covering several major vertebrate groups. Four specimens in this collection are here identified as two new species of ceratosaursaur theropod (neoceratosaursaur theropod), which represent the earliest known species of the group. Ceratosaursaur represent a large radiation of theropod dinosaurs mainly in the Cretaceous of the southern hemisphere. Although current phylogenetic hypotheses predict their presence deep in the Jurassic, there are only two unquestionable Jurassic ceratosaursaur, which hinders our understanding of their origin and early evolution. Recent phylogenetic analyses posit ceratosaurs either as the sister group to coelophysoids or to tetanurans, hypotheses that have profound effects on the timing and pattern of the basic splitting of theropod dinosaurs. The two new ceratosaurs from the Late Jurassic part of the Shishugou Formation display an unusual combination of character states. While similar to other cer- atosaurs in many derived character states, they share a number of derived cranial and limb characters with tetanurans and also some salient cranial and pelvic features with coelo- physoids, which shortens the morphological gaps between the three major theropod groups. Our phylogenetic analyses support a monophyletic Cetatorwas-Tetanura clade and charac- ter distributions on the recovered tree indicate that some tetanuran, coelophysoid, and cer- atosaursaur diagnostic features now have broader distributions and characterize much more inclusive clades. These new ceratosaursaur also represent the first record of the group in Asia and have implications on the paleobiogeographical reconstructions of Middle-Late Jurassic time period. Our analysis suggests that Asia remained connected to other major landmasses at least until the Late Jurassic and more intense prospecting in outcrops of this time period promises to provide further support for a close-relationship of Asian dinosaur faunas and those of other continents.
despite the inclusion of other taxa with presumably similar dietary adaptations, indicating that there is a phylogenetic signal in eutherian dental morphology apart from the overriding dietary signal. However, the impact of homoplasy is substantial, particularly in the genera of genera and families such as Arctostylophidae that are strongly distinct at the time of their first appearances. Such taxa are unstable and are often resolved at unexpected positions near taxa that fall into a broadly similar dental category (e.g. lophodont) but differ substantially in detail, suggesting that the phylogenetic signal in dental morphology is rapidly masked by convergence if sampling is not denser, in some cases denser than is currently possible.

Postersession II

BLANCAWOOD RATS (RODENTIA: CRICETIDAE) FROM THE MEADE BASIN SOUTHWESTERN KANSAS
ZAKRZEWSKI, Richard, Fort Hays State Univ., Hays, KS

Three species of woodrat are known from Blanca deposits in the Meade Basin of southwestern Kansas. Neotoma quadrriplicata was described from the Rexroad 3 local fauna (l.f.) and subsequently identified at six other sites in the basin. N. sawrockensis was described from the Saw Rock Canyon l.f. and N. taylori from the Borchers l.f. R.A. Martin and colleagues have recovered woodrats from 16 additional sites. The study sample included 30 specimens of each molar from Rexroad 3 and all molars from the other sites. Two of the variables measured were greatest length and width of the molars. Those sites (7) at which N was = or > 8 were analyzed using Student’s t-test, with P<0.05 as the level of significance. N. leucopetica from the White Rock l.f. of north-central Kansas served as an outgroup.

Significant results indicate that molars from XIT 1B are shorter than from the other sites, except for the M1 at Borchers. The M3 and m3 are narrower, except for the M3 from Borchers. The M2 from Rexroad 3 and Wendell Fox and m1 from White Rock are wider than the sample from XIT 1B. At Wendell Fox the M3 is wider than from Borchers and the M1 is also wider than from Borchers and Rexroad 3. The M1, M2, m1, and m2 from Wendell Fox are longer than from Borchers and Rexroad 3. The length of m1 and m2 and the width of m1 from Wendell Fox are smaller than from White Rock.

These data suggest the presence of two additional woodrats in the basin; a small taxon at XIT 1B that may be in a lineage with N. sawrockensis and N. taylori and a larger taxon at Wendell Fox that may be in a lineage with N. leucopetrica.

Postersession A

REDUCTION OF THE EOCENE SIRENIAN PELVIC GIRDLE: WHO WAS WALKING AND WHO WAS SWIMMING?
ZALMOUT, Iyad, GINGERICH, Philip, The Univ. of Michigan, Ann Arbor, MI; DOMING, Daryl, Howard Univ., Washington, DC

Reduction and loss of hind limbs are progressive adaptations in several groups of marine mammals. Sireniens are a typical example of such adaptation for life in coastal and offshore environments.

Preserved pelvis grade belonging to three Eocene sireenian families (Protosirenidae, Protosirensiidae, and Dugongidae) from Caribbean and Tethyan deposits show that there was a gradual reduction in their size with some features associated with hind limb functions. The Caribbean late early Lutetian Pezossiren from Egypt and Pakistan shows intermediate characteristics between semiarticulated and terrestrially forming in having a single sacral vertebra with elongated transverse processes, an innominate with a shallow acetabulum and reduced obturator foramen, and a femur with an oval femoral head and anteroposteriorly compressed femoral shaft. Late Eocene Eosthen and Eotheroides have the most reduced pelvic and femoral features, including: reduced length of the ischium and ilium, a diminutive obturator foramen, and unfused and distinctly separated left and right pubic bones that must have connected to one another by ligaments or cartilage, presaging the complete loss of function in hind limbs.

Reduction in length of the innominate is associated with reduction in the diameter and depth of the acetabulum and obturator foramen, and there is also a notable reduction in the diameter of the femoral head associated with shortening of femoral length. This general reduction in size is progressive over time. By the latest Eocene, sireniens had their hind limbs inside their body wall and were fully aquatic. This dramatic transition to aquatic life in sireniens was phased differently from that of contemporaneous archosaurs.

Poster Session I

ECOLOGY AND PHYSIOLOGY OF WHITE RIVER MAMMALS BASED ON STABLE ISOTOPE RATIOS OF TEETH
ZANAZZI, Alessandro, KOGNIN, Matthew, Univ. of South Carolina, Columbia, SC; MacFADDEN, Bruce, Florida Museum of Natural History, Gainesville, FL

To characterize the ecology and physiology of common late Eocene to early Oligocene White River mammals, we analyzed δ13C and δ18O of tooth enamel carbonate for five of the most abundant taxa: the perissodactyls Brontops (brontotheres), Mesohippus (equid), and Subbyrachodon (rhino); and the artiodactyls Merycohippus (oreodont) and Leptomeryx (leptomerycid). Excepting Brontops, which became extinct by the Orellan, teeth indicate Chadronian and Orellan specimens. δ13C values of M2x, M3x, and premolars range from −13.1% to −7.9% (V-PDB), consistent with expected pure C3 diets. In the Chadronian, Mesohippus, Merycohippus, and Leptomeryx show indistinguishable average δ13C values (~10%). However, Brontops and Subbyrachodon exhibit lower (~11.2%) vs. higher (~9%) values, respectively, indicating a preference for denser forests/wetter conditions (Brontops) vs. more open habitats/drier conditions (Subbyrachodon). Orellan compositions are similar, except that Leptomeryx shows higher average δ13C values, perhaps indicating a different habitat preference for the new Orellan species L. evansi. Chadronian δ18O values are indistinguishable for Mesohippus, Merycohippus, Leptomeryx, and Subbyrachodon (~25%, V-SMOW) whereas Brontops shows a statistically lower δ18O (23%). Only Leptomeryx exhibits a different Orellan δ18O value (24%). Because hind-gut fermentation in perissodactyls requires high water turnover, whereas foregut fermentation does not, the indistinguishable δ18O values of perissodactyls (except Brontops) and artiodactyls suggest that foregut fermentation had not yet developed, at least in these taxa.

Friday 2:30

ONTGENY AND LIFE HISTORY OF CALCARUS UTALHENSIS, A PRIMITIVE THERIZINOSAUROID FROM THE EARLY CRETACEOUS OF UTAH
ZANNO, Lindsay, Utah Museum of Natural History, Univ. of Utah, Salt Lake City, UT; ERICKSON, Gregory, Florida State Univ., Tallahassee, FL

The type locality of the recently named basal therizinosaur Calcarus utahensis is known as the Crystal Geyser Quarry (CGQ)—a dense, paucispecific bonebed within the Cedar Mountain Formation that is notable for being the largest known maniraptoran mass death assemblage. To date over 2000 elements have been recovered from the CGQ, representing individuals of a minimum of five growth stages. Recent excavations at the site have generated novel elements from the smallest known size class (estimated to belong to a minimum of one individual of approximately 0.5 m in length) as well as previously unknown elements from individuals of intermediate growth stages (i.e. smaller than 4 m in length). Recovered juvenile specimens include dorsal, sacral, and caudal vertebrae, an ischium, pubis, femur, fibula, astragalus, proximal scapula, proximal humerus, metacarpals, and multiple phalanges. Thus far less than five percent of the CGQ has been excavated and only a small amount of the bones removed from this area have been prepared. The NMI based on femora is eight, therefore extrapolation of this value suggests an NMI for the quarry of approximately 300. Calcarus bones from the CGQ are excellently preserved, displaying well-developed LAGS. From the femoral and fibular ontogenetic series thus far recovered, we are generating the first detailed histological analysis for this clade. This study aims to: 1) characterize the microstructure of major long bones for use in phylogenetic analyses; 2) construct a growth curve for comparison with other non-avian dinosaur taxa; and 3) identify possible physiological and/or metabolic changes correlated with modification of the therizinosaur diet. Initial results are promising, offering a nearly complete LHC from hatching to adult.

Poster Session B

LOCOMOTORY BEHAVIOR IN THE LAMBEOSAURINE HYPACROSAURUS STEBINGERI
ZELENTSKY, Darla, Calgary, AB, Canada; THERRIEN, Francois, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; CURRIE, Philip, Univ. of Alberta, Edmonton, AB, Canada; HENDERSON, Donald, Royal Tyrrell Museum of Palaeontology, Drumheller, AB, Canada; HORNER, John, Museum of the Rockies, Bozeman, MT

In order to investigate the locomotory behaviour in lambeosaurines, we CT-scanned humeri and femora from an ontogenetic series (environ adult to individuals) of Hypacrosaurus stebingeri. These elements were scanned at approximately 65% down the length of the bone, below either the deltopectoral crest or the fourth trochanter. Cortical bone distribution and cross-sectional properties were quantified from the CT scan data. Cortical bone area (CA) and second moment of area (I) were determined from CT slices with ImageJ software, and each parameter was plotted against bone length in logarithmic space. Plots reveal that these biomechanical properties scale nearly identically between the humeri and femora (CA is positively allometric and I is isometric), which indicate that both forelimbs and hindlimbs are subject to the same loading regime throughout ontogeny. We interpret these results as evidence that Hypacrosaurus used its forelimbs during locomotion at all growth stages, although the extent to which they were quadrupedal cannot be determined. Our results differ from those obtained previously for Maiasaura for which the biomechanical properties of the forelimbs scaled differently from those of the hindlimbs, indicating a transition from bipedal to quadrupedal locomotion during ontogeny. If the conclusions reached for Hypacrosaurus and Maiasaura can be extrapolated to their respective subfamilies, such a difference in locomotory behaviour between hadrosaurines and lambeosaurines could help explain the larger hatching size, the larger egg size, and the more robust humeri of lambeosaurus.

Poster Session B

A LATTICE-LIKE PATTERN OF OSSIFIED TENDONS IN PISTTACOSAURUS (DINOSAURIA: CERATOPSIA)
ZHUO, Chang-Fu, Peking Univ., Beijing, China; FOX, Richard, Univ. of Alberta, Edmonton, AB, Canada; GAO, Ke-Qin, Peking Univ., Beijing, China

Ossified tendons are important in studying the musculoskeletal system and behaviors of dinosaurs. Since Dollo’s description of dinosaur ossified tendons in 1886, the pattern of ossified epaxial tendons is best known in iguanodontids and hadrosaurids. In this study, an ossified tendon lancelet is described in Psittacosaurus from the Lower Cretaceous Yixian Formation in Liaoning Province, China, furnishing new information on epaxial musculature evolution in archosaurs.
In \textit{Psittacosaurus}, the epaxial tendons are well developed in tight bundles along dorsal and sacral regions of the vertebral column. As in iguanodontoids, the tendons form a three-layered lattice. The mid-layer is formed by posteroventrally-oriented tendons, and both outer and inner layers by posterodorsally-extending tendons. A similar pattern is known for the neoceratopsian \textit{Chasmosaurus}. Recent studies show that the lattice in Iguanodontoidea, \textit{Chasmosaurus}, and avians, has lost the innermost, M. multifidus, layer, a derived character for Dinosauria; these clades, retain the more lateral M. spinalis and M. semispinalis components of M. transversospinalis in crocodilians and lepidosaurs. These findings in \textit{Psittacosaurus} extend the epaxial tendon lattice among Ceratopsia, strengthening the hypothesis that the similar epaxial musculature in Cerapoda is derived for Dinosauria.
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