

**WARM SPRINGS RANCH DINOSAUR QUARRIES FROM THE UPPER MORRISON FORMATION OF NORTH CENTRAL WYOMING**

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The Warm Spring Ranch dinosaur quarries are located in Hot Springs county near the town of Thermopolis on the southern shoulder of the Big Horn Basin in north central Wyoming. The quarries date to the Upper Morrison Formation (Late Jurassic). Since 1993, approximately sixty individual sites, including three major quarries, have been discovered on approximately 700 acres of the ranch. Three major quarries, Bone Bed (BB), Beside Sauropod (BS), and Something Interesting (SI), are discussed relative to lithology, dinosaur taxa, and taphonomy. The predominant dinosaur remains found on the ranch are sauropods, including up to six fairly complete skeletons of *Camarasaurus*, *Apatosaurus*, and *Diplodocus*. Partial theropod remains (cf. *Allosaurus*) are present at one site. Although theropod shed teeth are found in several sites, no strong evidence of scavenging is recognized. Fragmentary remains of *Stegosaurus* are also found at another site. Generally, the majority of bones are found in a disarticulated state but well preserved. There is a paucity of non-dinosaurian vertebrate fossils (e.g., fish, turtles, crocodylians) on the ranch. Stratigraphically, the three quarries lie within a 10 to 12 m vertical span relative to each other. The lithology of each quarry exhibits slightly different facies, including various types of mudstone, fine to medium grain-sized sandstone, and thin lenses of carbonate nodules. The amount of plant material varies throughout each quarry and consists mainly of lignite. Abiotic and biotic factors of the quarries suggest various depositional environments ranging between fluvial and lacustrine systems in the Thermopolis area during this time.

Saturday 8:15

**WHAT PNEUMATICITY TELLS US ABOUT "PROSAUROPODS", AND VICE VERSA**

WEDEL, Mathew, UCMP, Berkeley, CA

Diverticula of the lungs and air sacs pneumatize parts of the postcranial skeleton in most birds. Birds are the only extant vertebrates with postcranial skeletal pneumaticity (PSP). PSP is also present in most other theropods, sauropods, and pterosaurs, but absent in ornithischians and most "prosauropods" (non-sauropod sauropodomorphs).

What "prosauropods" tell us about pneumaticity: 1. PSP originated in sauropodomorphs in the Late Triassic, at about the same time that it appeared in theropods. 2. The only "prosauropod" with pneumatic cavities in its vertebral centra is *Thecodontosaurus caducus*, one of the earliest and smallest sauropodomorphs. All "prosauropods" have vertebral laminae, but it is not clear whether these laminae were associated with pneumatic diverticula. 3. Pneumatic cavities are confined to the cervical vertebrae in *T. caducus*, basal sauropods, and basal theropods, and in the earliest ontogenetic stages of pneumatization in extant birds. 4. *T. caducus* was small and only pneumatized a few elements. The same is true of the earliest theropods with PSP. Pneumaticity probably did not evolve to lighten the skeleton (although it became important in that regard later in the evolution of sauropods and theropods).

What pneumaticity tells us about "prosauropods": 1. The pattern of pneumatization in *T. caducus* indicates the presence of a diverticular lung and cervical air sacs similar to those of birds. The same holds for basal sauropods, basal theropods, and pterosaurs. 2. In terms of evolutionary change, respiratory mechanisms are highly conserved, PSP is highly labile, and diverticula seem to be somewhere in between. In the case of dinosaurs without PSP, such as ornithischians and most "prosauropods", our null hypothesis should be that they had air sacs (since they are bracketed by taxa with PSP) but lacked either PSP or diverticula, not that they lacked air sacs.

Wednesday, Preparator Poster

**PREPARATION OF UNIQUELY PRESERVED VERTEBRATE FOSSILS FROM THE BIG PIG DIG QUARRY IN BADLANDS NATIONAL PARK, SOUTH DAKOTA**

WEILER, Matthew, JOHNSON, Shawna, SHELTON, Matthew, TATE, Allen, HERBEL, Carrie, South Dakota School of Mines & Technology, Rapid City, SD

Fossil preservation from the Pig Dig varies widely within a 36 square meter area. Thus the variable preservation (well-indurated to friable matrix) presents problems that are not commonly seen with other Badlands fossil beds. Pig Dig bones are collected from a damp environment that dries quickly and flakes apart. This is problematic as the matrix varies from one extreme to another throughout the quarry. Preparation using water as a solvent cannot be used on these clay-covered specimens as the smectite swells, thus making bone preservation unstable. The best tool for the loose friable clay is a pick and brush to remove matrix, followed by consolidation using thin Butvar B-76 to permeate the bone. Consolidating with thin Butvar first over the entire bone surface followed by medium Butvar within the cracks is critical. Later applications of Butvar glue can be used to repair large broken areas. However, when working with well-indurated matrix, the process changes, even though the fossils are as fragile as those within friable matrix. We recommend an aircsribing, usually a Microjack 2 or 5, to cut through matrix with minimal vibration, minimizing bone breakage. Repeated applications of thin Butvar during aircsribing aid in keeping bones intact. Many stages of bedding jackets are used with Pig Dig specimens to maintain the original position as collected. With a combination of

finesse and modern tools, these preservational differences within the same site, or even the same jacket can be overcome, so that each fossil can be prepared so that the specimen is preserved beautifully.

Poster Session B

**R. W. WHIPPLE'S SPECIMENS REFERABLE TO MEGAMOLGOPHIS AGOSTINI ROMER, 1952 (AMPHIBIA: LEPOSPONDYL)**

WELLSTEAD, Carl, WVU Tech, Montgomery, WV

In the early 1930s R. W. Whipple of Marietta College (Ohio) collected two series of lepospondylous vertebrae from the Ninevah Limestone (Greene Formation, Dunkard Group, Permian) at Limestone Hill, WV. One specimen consists of an articulated series of approximately 17 dorsal and six caudal vertebrae. The dorsal centra are large for a lepospondyl (1.6 cm long). The caudal centra, seemingly from tail's end, are smaller, approximately 0.5 cm long. The second specimen consists of two articulated, but fragmentary, caudal vertebrae whose centra are about 1.5 cm long. The vertebrae are similar to those found in lepospondyls such as *Megamolgothis* and *Brachydectes* in that the centra are hourglass-shaped, amphicoelous, and bear longitudinal carinae. Similarly, the left and right halves of the neural arches are sutured, not fused, to one another. Likewise, neural arches are sutured, not fused, to their centra. However, the large size of the vertebrae and morphological details of the carinae suggest assignment of the specimens to *Megamolgothis* (estimated body length, one meter), rather than to *Brachydectes* (maximum length, approx. 50 cm) whose vertebrae are generally smaller and bear simpler carinae. Whipple's specimens represent only the second- and third-known articulated series of vertebrae of *M. agostini* and contribute significantly to knowledge of the species in that the short caudal series bears haemal arches.

Student Poster Session

**EGGSHELLS AND BABY DINOSAURS IN THE UPPER AGUJA FORMATION OF BIG BEND NATIONAL PARK, TEXAS**

WELSH, Edward, Chadron State College, Chadron, NE

Surface collecting within the inland floodplain deposits of the upper Aguja Formation (upper Campanian to lower Maastrichtian) in Big Bend National Park, Texas has produced a rich abundance of fossil remains representing the Late Cretaceous of this area. The sites in this region are important in providing one of the southernmost terrestrial records at this time in North American natural history. Fossilized eggshells are present within these deposits, located around the Rattlesnake Mountain area. Specimens were collected in May of 2002 during a field course in the park. Another trip to the park was made in January of 2005 and more fragments were discovered and collected, more than tripling the size of the 2002 eggshell collection. This trip in 2005 also provided a yield of small teeth from hatchling and/or juvenile hadrosaurs and theropods (tyrannosaurs and cf. *Saurornitholestes*). This is the southernmost record of fossil eggshell remains in the United States, which is what makes this site unique. The occurrence of fossilized eggs, especially with associated animal material, is rare, which makes true taxonomic identification and correlation difficult. Fossil eggshell remains as well as material from young dinosaurs are present within the same sediments of the upper Aguja. No nests have been discovered in this area, which denies direct correlation. The specimens of the Big Bend Aguja sites reveal a variety of microstructures which resemble dinosauroid prismatic, dinosauroid spherulitic, and ornithoid eggshell microstructures, structures commonly seen in dinosaurs and birds.

These sites in Texas are beginning to reveal that animals were nesting in Big Bend, and it appears that these animals preferred this area as a nesting ground. The collective material gained will help provide a clearer picture into this nesting environment as well as the overall viewpoint of the local paleoecology. Along with the abundance and variety of specimens found in deposits such as this, this research must call other researchers to pay closer attention to similar microsites, because valuable material such as the eggshells found in Big Bend may be seriously overlooked.

Saturday 3:30

**ONTOGENY AND OSTEOHISTOLOGY OF THE ORNITHOPOD DINOSAUR TENONTOSAURUS TILLETI (CRETACEOUS, NORTH AMERICA)**

WERNING, Sarah, Sam Noble Oklahoma Museum of Natural History, Norman, OK

The ornithopod dinosaur *Tenontosaurus tilletti* is represented by a large number of specimens from several North American formations of Aptian-Albian age. The Antlers Formation of Oklahoma and the Cloverly Formation of Montana and Wyoming have each yielded excellent specimens representing two nearly complete ontogenetic growth series. Areas where these formations now outcrop were separated geographically by approximately twelve degrees of paleolatitude, and were deposited on different sides of the Hadley cell boundary. Paleocological data suggest differences in both aridity and seasonality between the two formations. In addition to these factors, *T. tilletti* is ideal for a comparative growth study because it is has been better sampled than most dinosaurian taxa.

I performed an ontogenetic study of this species using histological methods, and observed variation in bone histology and growth rate at the individual, population and species levels. This variation may be explained in part by differences in paleoclimate between the two populations. Additionally, the results of this study are compared to previously published growth curves and histological data for other dinosaurian taxa. Because of the systematic placement

of this basal iguanodontian, as well as the broad ontogenetic and populational sampling, this study provides improved basis for evaluating variation in other, more advanced ornithomids.

Poster Session A

### NEW RODENT FAUNAS SPANNING SEVERAL SALMAS FROM THE LAGUNA DEL LAJA REGION, ANDEAN MAIN RANGE, CENTRAL CHILE

WERTHEIM, Jill, UC Santa Barbara, Santa Barbara, CA; CROFT, Darin, Case Western Reserve Univ. School of Medicine, Cleveland, OH; FLYNN, John, American Museum of Natural History, New York, NY; WYSS, Andre, Univ. of California, Santa Barbara, Santa Barbara, CA

Most South American Land Mammal "Ages" (SALMAS) are based on well-sampled but geographically restricted faunas from the high latitudes, or less well known temporal "snapshot" localities from elsewhere on the continent. Abundant fossils have recently been recovered from a previously unsampled region, the primarily volcanic and volcanoclastic Cura-Mallin Formation (CMF) near Laguna del Laja (LdL) in the Andean Main Range of central Chile. Preliminary  $^{40}\text{Ar}/^{39}\text{Ar}$  dates spanning the unit's entire thickness at LdL and the base of the overlying Trapa-Trapa Formation (TTF) indicate ages ranging from ~21.9 Ma, potentially spanning five SALMAS. LdL thus represents one of very few examples of superposed mammal faunas in South America.

The extra-Patagonian location of LdL is reflected in the strong dissimilarity of the rodents to all known coeval species, with the exception of those from the geographically near Cañadon del Tordillo (CdT) fauna of Neuquén, Argentina (middle Miocene Colloncuran SALMA). Although some LdL rodents exhibit generic affinities to Patagonian taxa, most are new at the species level, and several likely represent new genera. The degree of distinctiveness of the LdL rodents relative to Patagonian contemporaries is notable given the proximity of LdL to the northern edge of Patagonia, undoubtedly reflecting differences in age, habitat, topographic isolation, paleoenvironment, and depositional setting. In contrast, the similarities between the LdL and CdT rodents demonstrate the strong effect of geography, potentially even stronger than age, on taxonomic composition and morphology.

The broad temporal range of the LdL deposits is reflected in associated changes in composition of the rodent fauna. Forms closely related to taxa typical of at least four different SALMAS appear sequentially; a Colhuehuapian aff. *Neoreomys* n.sp. is overlain by taxa of Santacrucian aspect (*Steiomys*, cf. *Acarechimys*, aff. *Stichomys* n. sp., cf. *Scleromys*, aff. *Eocardia* n. sp.) Taxa typical of the Colloncuran (e.g. *Prolagostomus*, *Maruchito*) occur highest in the CMF and a remarkably high-crowned ?*Alloiomys* has been recovered from the overlying TTF.

Wednesday 1:45

### ECOMORPHOLOGICAL STRUCTURE OF MODERN CARNIVORAN DIVERSITY AND THE IMPACT OF ENVIRONMENT

WESLEY-HUNT, Gina, WERDELIN, Lars, Swedish Museum of Natural History, Stockholm, Sweden

We test the hypothesis that the ecomorphological structure of carnivoran diversity is not significantly different among a set of environmental categories regardless of taxonomic make-up. Similar structure would infer that the ecological structure of modern carnivoran diversity is constant and not dependent on the environment. To test this, we compiled a database of morphological information for 217 fissioned carnivorans (91% of known species). Characters used to calculate a distance matrix describe the entire dentition and capture the variety of functional units found within the carnivoran tooth row. Diversity and environmental data from 197 localities worldwide were obtained from a database of modern mammal communities, compiled by a working group at NCEAS. Morphologic disparity was calculated among the taxa found in each of seven environmental categories: Bushland, Grassland, Temperate Forest, Tropical Forest, Wooded Grassland, and Woodland.

We found that only Temperate Forest can be distinguished from other environments by average disparity. Average and maximum disparity is lower in this category than in all others. Therefore, maximum distance between any two taxa is less, and taxa are generally more tightly packed. However, the structure of the taxonomic morphospace distribution in Temperate Forest is very similar to that in other categories; this is especially evident when individual localities are compared. To further explore the structure of morphospace we used the minimum spanning tree (MST). We found that the MST and its descriptive statistics provide a useful complement to average disparity in describing the morphologic distribution of a group. Knowledge of how modern carnivoran diversity is organized in different environments allows for a better understanding of the structure of fossil carnivoran diversity and the diversification of carnivorans into new environments and ecological roles.

Friday Fishes Symposium poster

### PRELIMINARY SURVEY FOR *CARCHARODON MEGALODON* AND OTHER FISHES FROM THE MIOCENE OF PANAMA

WESTGATE, James, Lamar Univ., Beaumont, TX; BROWN, R., Instituto Nacional de Antropología e Historia, Chihuahua, Mexico; COPE, Dana, College of Charleston, Charleston, SC; STRINGER, Gary, Univ. of Louisiana-Monroe, Monroe, LA

Recent field surveys near the Canal Zone and in the Darien Province of Panama have yielded new evidence of the Miocene ichthyological community that inhabited the region prior to

the closing of the Straits of Panama. A diverse assemblage of chondrichthyan teeth and teleost otoliths was collected from the Miocene Gatun Formation at two localities near Barriada San Pedro, between Colon and Sabanita. Specimens from these localities comprise the Cerveterian local fauna. *Carcharhinus* sp., *Hemispristis serra*, *Myliobatis* sp., *Rhinoptera* sp., and *Sphyræna* sp. are represented by teeth. An otolith assemblage is dominated by sciaenid (drums) with 53% of the total taxa and 51% of the total specimens. A sciaenid, *Equetus aff. davidandrewi*, is the dominant taxon based on otoliths, comprising almost 24% of the otoliths. Three species of ariids (marine catfish) constitute 24% of the total specimens. The otoliths represent forms that are found mainly in the present-day Caribbean Sea and Gulf of Mexico. The presence of at least one Pacific form is interpreted as a relict of the Western Tethys fauna prior to the closure of the Isthmus of Panama. The paleowater depth probably ranged from 0-25 m. The community represented by otoliths is comprised of species which prefer tropical and subtropical climatic conditions, normal marine salinity (with some indications of reduced salinities), and soft, muddy bottoms.

Two teeth of the great white shark *Carcharodon megalodon* represent the first records of this species from the Darien Province. One tooth was discovered on the Membrillo River near the village of Membrillo in outcrops of the uppermost Oligocene/lowermost Miocene Topalizo Formation. The other specimen was collected in the Tuira River drainage basin, probably from the upper Miocene Tuira Formation, Gatun Group, near the Colombian border.

Wednesday 9:00

### PHYLOGENY OF THE RHYNCHOSAURIA

WHATLEY, Robin, Smithsonian Institution, Washington, DC

Rhynchosaurs are a group of Triassic, terrestrial archosauromorphs that developed a mosaic of increasingly distinctive cranial features over their ~40 million year long history. Previous analyses of this group have treated Early, Middle, or Late Triassic taxa in isolation such that no single unified phylogeny was available. Morphologic characters based upon first-hand examination of all taxa and most specimens known worldwide inform a comprehensive phylogenetic hypothesis for the Rhynchosauria, including basal members *Mesosuchus browni* and *Howesia browni* and all species of the Late Triassic genus *Hyperodapedon*. This study provides the first well-supported phylogenetic placements of *Stenaulorhynchus stockleyi* (Manda Formation, Tanzania) and *Isalorhynchus genovefae* (basal Isalo II unit, southwestern Madagascar). *Stenaulorhynchus* is distinct from *Rhynchosaurus articeps* in possessing a number of derived postcranial features shared with other large-bodied rhynchosaurs. The relationship between '*Rhynchosaurus*' *spenceri* and '*Rhynchosaurus*' *mariente*' remains unresolved, but these two taxa together herald major changes in the skull and dentition, an evolutionary trend that is continued in later-diverging rhynchosaurs.

*Isalorhynchus* does not belong to the Late Triassic clade *Hyperodapedon* as previously proposed, but instead possesses a mosaic of plesiomorphic and derived cranial features supporting its position basal to all species of *Hyperodapedon*, including *H. huenei* + '*Scaphonyx*' *sulcognathus*. Many features shared by *Isalorhynchus* and *Hyperodapedon* are plesiomorphic for the latter. Resolution is lacking among the Late Triassic taxa *H. gordonii*, *H. huxleyi*, *H. sanjuanensis*, and other species of *Hyperodapedon*, and placement of the closely related taxa *H. huenei* and '*S.*' *sulcognathus* differs from that in previous analyses. The phylogenetic position of *Isalorhynchus* indicates that its lineage must have diverged by the earliest Late Triassic, prior to the diversification of *Hyperodapedon*.

Wednesday 11:45

### TABULATION AND SIGNIFICANCE OF LIMB PROPORTIONS OF *PANTHERA ATROX* FROM THE LATE PLEISTOCENE OF NORTH AMERICA

WHEELER, H. Todd, George C. Page Museum, Los Angeles, CA; JEFFERSON, George, Colorado Desert District Stout Research Center, Borrego Springs, CA

The long-limbed cursorial proportions of late Pleistocene *Panthera atrox* were first presented in detail by Merriam and Stock in the form of limb proportions based upon the sample of 90 some individuals from Rancho La Brea, California. That these observations apply to a contiguous species of *P. atrox* throughout the Americas, south of the Laurentide and Cordilleran Ice sheets, has not been seriously challenged, since assignment of all lions to *P. atrox*, *P. leo*, and *P. spelaea*, with allowance for the pronounced sexual dimorphism. This seemingly obvious conclusion however should have evidence.

Identification of individual large *Panthera* without soft tissue is a difficult and subjective process; but distinguishing populations of the different lion species can be accomplished by objective criteria such as limb proportions. The other population of *Panthera atrox* is from Natural Trap Cave (NTC), Wyoming, with a sample of five or six individuals. The *P. atrox* from (NTC) have the following limb ratios: radius/humerus .93, metacarpal III/humerus .36, tibia/femur .88, metatarsal III/femur .34, and humerus/femur .86; very similar proportions to the Rancho La Brea sample. The (NTC) lions are smaller, with the males being about the same in size and limb length, to the Rancho La Brea females; but similar size variations are seen in separate populations of both living and fossil *Panthera*.

The shorter limbed extant *Panthera leo* is described as having the limb proportions of a forest felid, which it is. Since it is also the top predator of the woodlands surrounding the savanna, its limb proportions reflect the compromise between habitats. *Panthera atrox* developed in North America. Here, *Smilodon* was the top predator of the woodlands and heavy cover habitats, conditions where *P. atrox* could not compete. Northern forests as preferred habitat for