Recent analyses comparing oxygen isotope values of phosphate from the teeth of marine reptiles to those of coeval fish estimated mosasaur body temperature to be in the range of 35° ± 2°C to 39° ± 2°C. In addition to these findings, other researchers recently examined oxygen isotope composition in bioapatite within coeval turtle and fish fossils from Kansas and Mississippi indicating that paleoenvironmental zones of the Western Interior Seaway were latitudinal and likely a result of both temperature and salinity variation throughout the Late Cretaceous.

Presented here are the results of an isotopic analysis of phosphate within core skeletal elements (cervical, dorsal and caudal vertebrae) of the North American mosasaurs, *Platecarpus, Tylosaurus*, and *Clidastes* from western Kansas. The purpose of this study is to estimate the core body temperatures of these mosasaur specimens and compare them to ocean water temperature calculated from coeval fish from the same area. These results show core body temperature of mosasaurs to be substantially higher than that of ocean water. High, stable core body temperature values indicate endothermic regulation and establish baseline body temperature estimates for mosasaurs found in Kansas. With these temperature estimates, it will now be possible to pursue a larger scale investigation correlating body temperature of mosasaurs to water temperatures within the Western Interior Seaway of North America on a latitudinal gradient.

Symposium 3 (Friday, November 1, 2013, 9:45 AM)

THE MORRISON FORMATION U/PB DATING PROJECT: USING HIGH-PRECISION, CHEMICAL ABRASION (CA-TIMS), SINGLE ZIRCON, ASHFALL DATES FOR CHRONOSTRATIGRAPHIC CORRELATIONS

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The Upper Jurassic Morrison Formation of the Western Interior of North America is one of the most prolific fossil-bearing rock units in the world, and it has been studied in detail across its vast depositional area. Long-distance correlations of the formation have been difficult, however, due to the inherent variability of terrestrial systems, the lack of biostratigraphically useful fossils, and the lack of definitive marker horizons in this rock unit. Radiometric dating has the potential to help overcome these issues and to aid in correlations across the depositional area.

This project focuses on dating individual vertebrate fossil quarries in the Morrison Formation in order to place them into temporal context. The resulting ages can then be used to create a radiometrically based stratigraphic framework for the formation as a whole. Many researchers have already contributed matrix from their quarries as well as funding to support the dating of their individual sites.

As a result of this ongoing project, new U/Pb ages from geographically diverse vertebrate fossil localities in the Morrison Formation have been produced. These ages, along with legacy 40Ar/39Ar ages (recently recalculated due to the recalibration of the Fish Canyon Tuff sanidine standard to the astronomical timescale), are allowing better long-distance correlations than previously were available. In addition, techniques such as chemical abrasion (CA-TIMS) and ultra-low Pb lab blanks are allowing the University of Wyoming Geochronology Lab to date single, small, ashfall zircons with greater precision and accuracy. These crystals often have such a low level of radiogenic lead that only ultra-low blank methods can produce robust data.

Several ages from geographically widespread fossil localities in the Morrison Formation are now available, and they are being used to test previously published correlations of fossil-bearing localities. These new data support the concept that long-distance correlations of the Morrison Formation based on lithostratigraphy, including a change in the dominant clay mineralogy, should be used with caution when radiometric dates are not available.

Technical Session XV (Saturday, November 2, 2013, 10:45 AM)

EARLY EVOLUTIONARY RADIATION IN BALEEN WHALES (CETACEA: MYSTICETI) FROM THE OLIGOCENE OF NEW ZEALAND

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Early stages of evolutionary radiations often show numerous cladogenetic speciations, rapid ecological occupancy, and high morphological disparity. In filter-feeding or baleen whales (Cetacea: Mysticeti), their earliest history in Oligocene times is particularly problematic because of the rarity of fossils. Recently, several studies have considered the early radiation and later diversification of mysticetes, but many aspects of history are poorly understood. Here, we consider the early evolutionary scenario of baleen whales based on the complex anatomical features of the earbones (tympanic bulla and periotic), elements that preserve well because of their dense structure. A character matrix (59 morphological characters) from earbones was constructed and analysed in both cladistic and phenetic ways. Taxa included 9 undescribed toothless late Oligocene mysticetes (Geology Museum, University of Otago) from the Kokoamu Greensand and Otekaike Limestone (28 - 23 mya) of New Zealand, plus *Balaena mysticetus*, *Balaenoptera bonaerensis*, *Caperea marginata*, *Eomysticetus whitmorei*, *Eschrichtius robustus*, *Eubalaena* spp., *Herpetocetus* spp., *Mammalodon colliveri*, *Megaptera novaeangliae*, and an archaeocete (*Zygorhiza kochii*; outgroup). TNT (Tree analysis using New Technology) and PAST (PAlaeontological STatistics) were used to analyse and measure the morphological disparity in the NZ Oligocene taxa cladistically and phenetically, respectively. Cladistic and phenetic results both show considerable morphological disparity, with cladistic branch lengths ranging from 6 to 10 (branch lengths for modern mysticetes families ranging from 3 to 8) and distance in phenetic cluster analysis spanning from 4.56 to 7.306 (distance for modern mysticete families spanning from 5.837 to 9.963) in NZ Oligocene taxa. The disparity arises partly because of some marked plesiomorphies: the presence of accessory ossicle and fovea epitubaria on the anterior process of the periotic, position of Eustachian outlet ventral to the mid-dorsoventral height of tympanic bulla, the presence of a cavity inside the ventral part of sigmoid process, and the presence of an elliptical foramen. Results are consistent with the notion that the early morphological radiation of baleen whales was linked to evolutionary and ecological experimentation during the Oligocene.

Technical Session VII (Thursday, October 31, 2013, 3:00 PM)

ANATOMY OF SAURISCHIAN HIP JOINT SOFT TISSUES AND ITS SIGNIFICANCE IN BODY SIZE EVOLUTION

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Reconstructing joint anatomy and function is critical to understanding posture, locomotor behavior, ecology, and evolution of extinct vertebrates. Major changes occurred in hip joint morphology during archosaur evolution, resulting in a spectrum of postures. However, the lack of joint soft tissues in fossil taxa, as well as limitations of two-dimensional analyses, makes inferences of joint function difficult. Previous studies have shown that archosaur hip joint subchondral surfaces vary widely in joint congruence. Incongruent hip joints of gigantic dinosaurs suggest the presence of large volumes of soft tissue. Furthermore, the proximal femur and acetabulum exhibit corresponding osteological correlates for soft tissue attachments, which inform hip articulation during stance and locomotion. This study describes the relationship between hip joint dimensions and anatomical characters associated with body size evolution in extinct archosaurs. Using photogrammetry techniques, length, height, depth, and circumference of the proximal femur and the acetabulum of over 40 archosaur taxa were analyzed for relationships with body mass using phylogenetically corrected correlation. Among saurischians, gigantic theropods (i.e., *Tyrannosaurus*) and sauropods (i.e., *Apatosaurus*) convergently evolved highly incongruent hip joints, medially deflected femoral heads, reduced supraacetabular crests, and cranially facing antitrochanters. However, widespread homoplasy in epiphyseal characters of archosaurs complicates reconstruction of evolutionary transformations. In particular, the rugose proximal femoral subchondral surface of sauropods is similar to that of phytosaurs, lepidosaurs, and stem-suchians. On the other hand, theropods exhibit smooth, lightly striated femoral subchondral surfaces, suggesting increased reliance on acetabular soft tissue to maintain articular surface congruence. These data suggest that the archosaur hip underwent major evolutionary transformations in soft tissue morphology, which impact our hypotheses of character homology and joint function.

Romer Prize Session (Thursday, October 31, 2013, 12:00 PM)

A SPECIMEN-BASED PHYLOGENETIC ANALYSIS OF DIPLODOCIDAE (DINOSAURIA, SAUROPODA)

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Since the late 1800s, numerous diplodocid species were and continue to be described from the Jurassic of the USA, Tanzania, Europe, and possibly Asia. More than 30 different species have been proposed, some now regarded as invalid. Recent phylogenetic analyses of Diplodocoidea resolved intergeneric relationships, but by using *Apatosaurus* and *Diplodocus* as terminal taxa, they relied on earlier identifications of single specimens, which are not all beyond doubt. In order to test the validity of these previous referrals, a specimen-based phylogenetic analysis was conducted. This approach was previously done for *Apatosaurus*, but is here applied for the first time for the entire clade of Diplodocidae.

The present phylogeny includes all diplodocid holotypes (including the recently described *Kaatedocus siberi*), as well as the more complete non-type specimens that provide overlap of skeletal elements between fragmentary holotypes (e.g. *Barosaurus* American Museum of Natural History [AMNH] 6341). The data-matrix counts more than 40 ingroup specimens, and nearly 30, mostly species level, outgroup taxa, ranging from more basal Diplodocoidea (e.g. *Dicraeosaurus*) to titanosauriforms (e.g. *Brachiosaurus*), and early eusauropods (e. g. *Shunosaurus*). The character list amounts to nearly 500 characters, which makes the analysis one of the most detailed studies of sauropod phylogeny performed to date.

The resulting cladogram yields the classical arrangement of diplodocid relationships, but also detects cryptic taxa previously included in well-known genera, which are generically different (e.g. '*Diplodocus*' *hayi*). Counting the number of autapomorphies for different diplodocids allows for a relatively objective way to decide if genus-level separation is warranted. It thereby shows that diplodocine diversity has been underestimated, and that the sauropod fauna of the Morrison Formation (Western USA) in particular was even more diversified than previously thought. Based on individual specimens, the study furthermore shows that skulls previously referred to *Diplodocus* might actually belong to different diplodocine genera, as none of the included diplodocid skulls consistently groups with the *Diplodocus* types, which all consist of exclusively postcranial material. Such a specimen-based phylogenetic analysis thus proves to be a valuable tool to validate historic species and specimen identifications in sauropods, and in paleontology as a whole.

Technical Session II (Wednesday, October 30, 2013, 8:00 AM)

PROFILING THE DUROPHAGE: CONVERGENT SKULL SHAPE EVOLUTION BETWEEN BONE AND BAMBOO SPECIALISTS

TSENG, Zhijie Jack, American Museum of Natural History, New York, NY, United States; MARTÍN-SERRA, Alberto, Universidad de Málaga, Málaga, Spain; FIGUEIRIDO, Borja, Universidad de Málaga, Málaga, Spain

Consumption of hard and tough organic tissues represents biomechanically demanding tasks that are often associated with unique morphological modifications to the masticatory apparatus. The high muscle forces involved in performing such tasks are