separated over 4 million years ago. In contrast to numerous examples of hybridization across Canidae, there is no evidence for gene flow between dire wolves and either North American gray wolves or coyotes, suggesting the dire wolf evolved in isolation from the Pleistocene ancestors of these species. Our results support an early New World origin of the dire wolf, while the ancestors of the gray wolf, coyote, and dhole evolved in Eurasia and only colonized North America relatively recently.

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Technical Session VIII (Thursday, October 10, 2019, 2:00 PM)

SENSING OR SUCKLING? THE EVOLUTION OF MAMMALIAN FACIAL MUSCLES

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Mammalian facial muscles are involved in a variety of functions, but their evolutionary origin has been popularly linked with the emergence of that quintessentially mammalian trait, suckling milk. Comparative morphological data on the neuroanatomy of stem-mammalian, mammalian, and outgroup taxa suggest an osteological correlate occurring in stem-mammals associated with the presence of a subset of facial muscles. We reason that the appearance of the infraorbital foramen and the orientation of this opening relative to the surface of the maxilla is associated with facial muscle-mobilized whisker pads, as this configuration is hypothesized to reduce mechanical stress on the infraorbital branch of cranial nerve V_2, which innervates the mystacial vibrissae, during active tactile exploration. In addition, we present ontogenetic data from extant marsupials and placental mammals. Facial muscles develop post-natally in the Short-Tailed Opossum (*Monodelphis domestica*), demonstrating that these muscles are not required for suckling in all taxa. But whether this represents an ancestral or derived condition is explored through comparing the sequence of facial muscle development across various taxa. We present these findings as support for the potentially greater role that innovations in active, direction-oriented gathering of sensory information played in the evolutionary origins and subsequent modifications of mammalian facial muscles.

Grant Information:
Yale University

Regular Poster Session III (Friday, October 11, 2019, 4:15 - 6:15 PM)

REDESCRIPTION AND REASSIGNMENT OF "*LIODON*" *MOSASAUROIDES* TO THE GENUS *EREMIASAURUS* (SQUAMATA, MOSASAURIDAE)

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The genus *Prognathodon* is a diverse group of mosasaurine mosasaurs often typified in part by robust jaws and variable tooth shape and enamel structure. However, some analyses have found that members of the genus *Prognathodon* do not consistently form a monophyletic clade, requiring a reassessment of taxa to better resolve these unclear relationships. Recently, the genus *Liodon* was declared a *nomen dubium* and members of the group reassigned to *Prognathodon*, based on similarity between tooth crown ratios along the jaw. *Liodon* has been historically problematic as all species are poorly-preserved and comprise mainly of jaw fragments and teeth, although "*Liodon*" *mosasauroides* represents one of the best-preserved specimens, consisting of the premaxilla, partial maxillae and dentaries, and teeth *in situ*. Despite this, there has been no recent detailed comparison of both the jaw elements and dentition of "*Liodon*" *mosasauroides* to other taxa. An assessment of multiple genera finds several traits that distinguish the genus from *Prognathodon* and instead suggests "*Liodon*" *mosasauroides* and the mosasaurine *Eremiasaurus heterodontus* are congeneric. A medially-oriented anterodorsal process of the maxilla and raised ridges on the dorsal surface of the premaxilla found in "*Liodon*" *mosasauroides* and *Eremiasaurus heterodontus* are absent in multiple species of *Prognathodon*. Heterodont dentition is present to varying degrees in these taxa; however, strongly interdigitating teeth and interdental pits on the lateral surface of bone between tooth positions are absent in *Prognathodon*, but present in "*Liodon*" *mosasauroides* and *Eremiasaurus heterodontus*. Interdental pitting is present on the anterior portion of the jaw in some members of *Mosasaurus*, although those taxa lack distinct heterodont dentition. Conversely, the posterior teeth of "*Liodon*" *mosasauroides* interdigitate to a greater degree than in *Eremiasaurus heterodontus*, indicating the two taxa are not synonymous. As much of the holotype of *Liodon* is missing and therefore not comparable, the referral of "*Liodon*" *mosasauroides* to *Eremiasaurus mosasauroides* is proposed. This provides partial resolution for a historically problematic genus, underscoring the difficulties in interpreting poorly-preserved specimens.

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Technical Session XIX (Saturday, October 12, 2019, 4:00 PM)

VERTEBRATE TAPHONOMY IN DISTRIBUTIVE FLUVIAL SYSTEMS

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Approximately 87% of facies across all modern sedimentary basins are deposited as part of Distributive Fluvial Systems (DFS), a class of fan-shaped landforms including alluvial fans, fluvial fans, and megafans. There is evidence that DFS are also common in the rock record. The prevalence of DFS in the terrestrial rock record has implications for the vertebrate fossil record because as DFS deposit they prograde, producing an autochthonously generated secular series of environmental changes at any one location. According to the simplest DFS model, environments will shift from poorly-drained overbank deposits with many small channels lower in section to well-drained overbank deposits with few, larger, amalgamated channels higher in section. This environmental change will affect both the distribution of organisms on the DFS and a range of taphonomic factors (e.g., transport energy, rate of burial, surficial and subsurface degradation processes).
To investigate the taphonomic consequences of the DFS model a quantitative taphonomic model was written to describe the changes in vertebrate preservation associated with the sedimentological transitions across the surface of a DFS. Using initial conditions for intermediate to large DFS (10s-100s of km length), the mean overbank transport distance of vertebrate specimens is anticipated to increase upsection in DFS settings, leading to a shift from preservation of associated specimens near to the point of carcass deposition to broadly dispersed, unassociated fossils. Similarly, the proportion of specimens surviving to burial is projected to decrease upsection and the magnitude of size bias in the assemblage will increase upsection. What limited quantitative taphonomic data are available from known or hypothesised DFS settings show some agreement with the expectations of the quantitative model. If shown to be broadly present, these results suggest that secular changes in preservation should be anticipated in vertebrate sequences, and should be accounted for when developing paleoecological hypotheses.

Regular Poster Session I (Wednesday, October 9, 2019, 4:15 - 6:15 PM)

CRYSTALLOGRAPHY OF *LOURINHANOSAURUS* EGGSHELLS (DINOSAURIA, THEROPODA, ALLOSAUROIDEA)

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Upper Jurassic outcrops of the Lourinhã Formation (late Kimmeridgian−Tithonian; Lusitanian Basin; Lourinhã, Portugal) are renowned by their diverse vertebrate fauna, including mammals, amphibians, squamates, testudines, crocodylomorphs and dinosaurs. Among the fossils recovered in thisfFormation, the record of eggs and clutches of dinosaurs and crocodylomorphs, sometimes containing embryos, is of special relevance. This record includes two of the oldest records of theropod embryos known so far, and the oldest crocodylomorph eggs.
The "Paimogo clutch" is a group of over a hundred partial eggs, some of them containing embryos, collected in the outcrops close to the Paimogo fort. Most of the eggs in the group can be attributed to the theropod *Lourinhanosaurus*. In addition, four crocodylomorph eggs were collected in close relation with the rest, including the holotype of the ootaxon *Krokolithes dinophilus*. Here we present the first detailed report of the crystallographic architecture of the *Lourinhanosaurus* eggshell using electron backscattered diffraction (EBSD). *Lourinhanosaurus* eggshells are composed of calcite and are thin –800 um. The eggshells show obliquiprismatic morphotype, with a mammillary to continuous layer ratio of 1:2. The shell units are wider than in most theropod eggshells –width to height ratio of 1:3. Pore canals are wide and oblique. They

can be classified as the ootaxon *Preprismatoolithus coloradoensis*, described in the contemporary Morrison Formation, U.S.A. .
Electron backscatter analysis shows that *Lourinhanosaurus* eggshells have a crystallographic architecture homologous to most theropod eggshells, with small crystalline domains radiating in all directions at the bases of the mammillae that transform into large columnar domains in the continuous layer. Inverse pole figure maps based on the orientation of the c-axis of the calcite crystals show a progressive reorientation of the c-axis towards the outer surface of the eggshell. At the transition point between the mammillary and continuous layers, these axes are perfectly parallel to the eggshell growth direction. Grain boundary maps show a reduced number of low angle (<5º) boundaries, with clean crystal domains separated one from the other of over 20º boundaries. The boundaries are not roughed, thus supporting the observed absence of squamatic ultrastructure. The presence of the typical theropod architecture in an allosauroid dinosaur suggests that the eggshell growth mechanism of derived theropods was achieved early in theropod evolution.

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Technical Session I (Wednesday, October 9, 2019, 11:30 AM)

THE OLDEST KNOWN PACIFIC SIRENIAN FROM THE EARLIEST OLIGOCENE, SAIKAI, NAGASAKI PREFECTURE, WESTERN JAPAN

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A new fossil sirenian from Japan was collected from shallow marine strata of the Kakinoura Formation, Nishisonogi Group, Saikai, Nagasaki, western Kyushu Island. The recovered fossil remains consist of a mid-anterior vertebra, a posterior thoracic vertebra, an isolated thoracic neural spine, an anterior caudal vertebra, and a number of ribs, all from a single individual. The geologic age of the Kakinoura Formation is earliest Oligocene (Rupelian), based on calcareous nannofossils (CP 16b and 16c subzones). The vertebrae preserve characteristic sirenian features, which in the case of the thoracic vertebrae include triangular-shaped centra, short transverse processes, and relatively large neural canals. The posterior thoracic vertebra also has a well-developed ventral keel. The single caudal vertebra has a hexagonal-shaped centrum and dorsoventrally thick transverse processes that project horizontally. The ribs have a dense bone histology without spongy tissue, and are pointed at their distal ends. The ribs vary in shape, with some being very thick and banana-shaped (features typical of sirenians), while others are rather narrow. The dimensions of the largest thoracic vertebral centrum (42.6 mm in width and 24.1 mm in height) and the largest rib (33.3 mm in diameter), ; suggest that the Saikai sirenian is one of the smallest known sirenians. It cannot be established, however, whether this individual was a juvenile or small adult.
Sirenians first evolved in the Atlantic (or western Tethys Ocean) in early Eocene time, and their sparse Paleogene record in the Pacific suggests a much later dispersed into the Pacific Ocean presumably via a seaway through Southeastern Asia. Previously, the oldest sirenian record from the western Pacific was a dugongid vertebra from late Oligocene strata in northern Kyushu. However, with identification of the Saikai sirenian, the Pacific record for this group can be extended back into the early Oligocene, suggesting a much earlier dispersal of sirenians into the Pacific. The Saikai sirenian was originally discovered in 1980, but it was only recently prepared with support from the Educational Board of Saikai City.

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Technical Session XV (Saturday, October 12, 2019, 10:30 AM)

THE FIRST NON-MAMMALIAN CYNODONTS FROMAUSTRALIA AND THE UNUSUAL NATURE OF AUSTRALIAN CRETACEOUS CONTINENTAL TETRAPOD FAUNAS

MUSSER, Anne M., Australian Museum, Sydney, Australia; LAMANNA, Matthew C., Carnegie Museum of Natural History, Pittsburgh, PA, United States of America; MARTINELLI, Agustin G., Museo Argentino Ciencias Naturales, Capital Federal, Argentina; SALISBURY, Steven W., University of Queensland, Brisbane, Australia; AHYONG, Shane, Australian Museum, Sydney, Australia; JONES, Robert, Australian Museum, Sydney, Australia

Cynodont therapsids appeared by the late Permian and gave rise to mammals in the Late Triassic. Several non-mammalian cynodont clades were diverse until the Early Jurassic, but most were extinct by the mid-Cretaceous. Although these globally distributed synapsids have an abundant fossil record in Gondwana, no representatives of this key group have yet been reported from Australia. Here we present non-mammalian cynodont remains from the early Late Cretaceous of New South Wales (NSW) and Queensland (QLD), describing or reinterpreting specimens that are here provisionally included within Haramiyida and non-mammaliaform Probainognathia, respectively. *Kollikodon ritchiei* from the Cenomanian Griman Creek Formation of NSW was first interpreted as monotreme and subsequently as a basal australosphenidan. However, distinctive characters linking *Kollikodon* to haramiyidans challenge these views, including: (1) postcanines with multicusped rows; (2) orthal jaw movement (although *Kollikodon* lacked the palinal action of haramiyidans); and (3) mediolateral divergence of upper postcanines, a possible haramiyidan synapomorphy. Furthermore, both *Kollikodon* and the haramiyidan *Haramiyavia* have a plesiomorphic lower jaw that may have retained substantive postdentary bones. Other Australian non-mammalian cynodont fossils include a fragmentary femur and an incipiently divided molar tooth root from Cenomanian–Turonian strata of the Winton Formation in QLD. The anteroposteriorly compressed femur has an unusually long lesser trochanter like that of non-mammaliaform probainognathians (such as chiniquodontids and basal prozostrodontians) from the Late Triassic of South America and Africa. Identification of the tooth root is equivocal but it likely possesses a non-mammalian cynodont feature: incipient bifurcation of postcanine roots precedes the fully divided roots of mammals and was independently acquired in several cynodont lineages. These fossils are all substantially stratigraphically younger than those of their closest known relatives, adding to the unique and unprecedented faunal mix of archaic (e.g., temnospondyls, tuataras), endemic, and relictual Gondwanan species (e.g., monotremes) found in the Mesozoic of Australasia. Australia's late-surviving non-mammalian cynodonts fill the last void in the global distribution of these animals. The blend of typically 'Triassic,' 'Jurassic,' and 'Cretaceous' taxa that coexisted in the mid-Cretaceous high-latitude environs of Australasia had no parallel elsewhere.

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Regular Poster Session II (Thursday, October 10, 2019, 4:15 - 6:15 PM)

A NEW SPECIES OF EOGRUIDAE (AVES, GRUIFORMES) FROM THE MIOCENE OF THE LINXIA BASIN, GANSU, CHINA: EVOLUTIONARY AND CLIMATIC IMPLICATIONS.

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Despite having one of the most robust fossil records within core-gruiform birds (rails, cranes and allies), the biogeographic history of Gruidae (cranes) and key drivers of diversification within this group remains largely unknown. The Eogruidae of Eurasia represent some of the earliest known crane-like fossils. Here, we present description of a new species represented by a well-preserved specimen of a foot from the late Miocene (7-6.5Ma) Liushu Formation of Linxia Basin, Gansu, China. It is the only eogruid fossil that has been found in this Formation and is the first eogruid known from northwest China. Linxia Basin is located along the margin of the northeastern Tibetan Plateau, which allows for new insight into Miocene dispersal of the Eogruidae and potential climatological and geological connections. It is also the first specimen with an associated tarsometatarsus and nearly complete phalanges, including a claw, which provides further morphological information on this taxon. Referral of the new specimen to Eogruidae is based on extreme reduction of the metatarsal II trochlea, which is most similar to the condition present in the eogruid subclade traditionally termed Ergilornithidae.

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