resembles those of other early temnospondyls, but the short epipodials and large foot are more like those of early amniotes. Extraordinarily, the unguals are elongate and distally curved: a unique feature among early lissamphibians. These data support an emerging pattern of distal disparity versus proximal conservatism. Comparative consideration of femoral characters reveals different patterns on different portions of the tetrapod stem and conserved lineage-specific patterns in total-group amniotes and lissamphibians.
The distal-first pattern builds on previous observations documenting hindlimb disparity in the earliest limbed tetrapods, particularly in digit morphology and number. In conjunction with new hypotheses of tetrapod relationships, the emerging picture is consistent with previous early-burst hypotheses of evolutionary rate and mode. *Eugyrinus* and *Whatcheeria* expand both character space and morphospace in each of their respective lineages and raise new questions about clade-specific patterns of ecomorphological diversification in early tetrapods.

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

AUSTRALIA'S OLDEST AND HIGHEST PALEOLATITUDE CROCODYLOMORPHS FROM THE LOWER CRETACEOUS EUMERALLA FORMATION (UPPER APTIAN–LOWER ALBIAN) OF DINOSAUR COVE, VICTORIA

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The Australian Mesozoic crocodylomorph fossil record is restricted to the upper Albian–Cenomanian Griman Creek Formation of Lightning Ridge, New South Wales, and the approximately coeval Winton Formation of Isisford, Queensland. Crocodylomorphs have also been reported from the upper Aptian–lower Albian Eumeralla Formation of Dinosaur Cove, Victoria, but no specimens have been described. The Dinosaur Cove crocodylomorph material includes a quadratojugal, 28 teeth, a dorsal vertebra, a humerus and five osteoderms, and is the oldest (~113 Ma) and highest paleolatitude (~70°S) evidence of crocodylomorphs known from Australia. Most of the specimens show affinities with semi-aquatic freshwater mesoeucrocodylians. All of the shed teeth are conical, with vertical longitudinal grooves and ridges, and weakly defined mesial and distal carinae. However, one tooth shows a 'false-ziphodont' morphology, a rare condition in which denticles are formed by curving ridges over the carinae. The morphology of the quadratojugal suggests that it was part of a dorsoventrally flattened skull, similar to those of extant crocodylomorphs. The dorsal vertebra has a short neural arch, an elongate centrum and broad transverse processes, whereas the humerus is gracile; these are all hallmarks of crocodylomorphs with strong swimming capabilities. The dorsal osteoderms are rectangular, bisected by a weak midline keel, and did not interlock with, or overlap or underlap, adjacent osteoderms, whereas the nuchal osteoderms are circular, strongly keeled and did interlock. Such osteoderm features are rare in Mesozoic crocodylomorphs, but more common in Cenozoic taxa. The stark morphological differences between the known taxa indicate that Australian Mesozoic crocodylomorph diversity was higher than previously appreciated; however, the fragmentary nature of the Dinosaur Cove material precludes classification beyond Mesoeucrocodylia. The presence of crocodylomorphs and absence of temnospondyls in the Eumeralla Formation (upper Aptian–lower Albian), and the inverse situation in the Upper Strzelecki Group (upper Barremian–lower Aptian), supports previous hypotheses of a prominent paleoclimatic shift, from cooler to warmer annual average temperatures, during the late Early Cretaceous in southeast Australia. If the Victorian semi-aquatic freshwater crocodylomorphs were ectothermic, and subject to similar thermal constraints as extant species, then southeast Australia might have experienced mean annual average temperatures of >14.5°C at ~113 Ma.

Technical Session XI (Friday, October 11, 2019, 12:00 PM)

CLARIFYING CLIMATE'S ROLE IN MEGAFAUNAL EXTINCTION THROUGH NICHE MODELING

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Competing hypotheses regarding Pleistocene megafaunal extinction typically pit climate based causes against human based causes, particularly in North America. However, few climate-based arguments specify how climate change would have directly, or indirectly, impacted megafauna in a negative manner. Correlative species distribution models are increasingly used to inform our understanding of climate's impact on species. Using occurrences from the Neotoma Paleoecological Database and simulations of late Quaternary climates from the PaleoClim dataset, we test the hypothesis that North American climate became unsuitable for megafauna at the end of the Pleistocene. In total, we analyze seven time bins: the Last Glacial Maximum ("LGM", ca. 21 ka), Heinrich Stadial 1 (17.0-14.7 ka), the Bølling-Allerød (14.7-12.9 ka), Younger Dryas Stadial (12.9-11.7 ka), the early-Holocene (11.7-8.326 ka), mid-Holocene (8.326-4.2 ka), and late-Holocene (4.2-0.3 ka). We define the climate space that was available vs. occupied by eleven megafaunal species from the LGM to the early Holocene. We include extinct (*Mammuthus columbi*, *Mammut americanum*, *Hemiauchenia macrocephala*, *Camelops hesternus*, *Platygonus compressus*, *Tapirus veroensis*, *Bison antiquus*) and extant herbivores (*Antilocapra americana*, *B. bison*, *Odocoileus virginianus*) with varied diets and ecologies. We use maximum entropy species distribution modeling to estimate the total climatically suitable area in North America throughout each time bin, and calculate the percent change in area across time, for each species. If climate change was the primary driver of megafaunal extinction, we would expect suitability to decline through the extinction window and for habitable areas to contract. The extinct megafauna in our analyses fall well within the climatic designation of modern biomes, alongside extant species, during the late Pleistocene. With few exceptions, species within the same biome are similarly constrained by mean annual temperature, temperature seasonality, annual precipitation, and precipitation variability. We found that early and middle Holocene climates were suitable for the eleven species we analyzed, seven of which are extinct, and find little evidence for a direct climatic cause of the megafaunal extinction under the assumption of niche conservatism. Collectively, these models have broad relevance and implications for megafaunal extinctions in North America, potentially pointing to other drivers of megafaunal species decline.

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

THREE NEW SKULLS OF THE LATE CRETACEOUS ARMORED DINOSAUR *TALARURUS PLICATOSPINEUS* MALEEV, 1952

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Talarurus plicatospineus is an ankylosaurid dinosaur from the Upper Cretaceous Baynshiree Formation (Cenomanian-Santonian) of Mongolia. Since its first discovery from the Bayan Shiree type locality in the eastern Gobi Desert, various specimens have been recovered including partial postcranial skeletons of six individuals and many other fragmentary bones. However, cranial elements of *Talarurus* have been rare and only two partial specimens including the holotype were described in the scientific literature. Here we present three additional skulls of *Talarurus*, which are much better preserved than the previously described ones. The skulls feature unique characters such as an anteriorly protruding single large internarial caputegulum, a vertically oriented elongate loreal caputegulum with a pitted surface, an elongate lacrimal caputegulum positioned above the posterodorsal border of the maxilla, two longitudinally arranged large frontal caputegulae surrounded by smaller rhomboid caputegulae, small but elongate medial supraorbital caputegulae, a posterior supraorbital caputegulum that is four times larger than the anterior one, up to three transverse parallel grooves on the dorsal surface of the posterior supraorbital caputegulum, postocular caputegulae situated along the ventral to posterior rim of the orbit and that almost extend to the anteroventral margin of the squamosal horn, a longitudinal furrow tapering towards apex of the squamosal horn, and a middle nuchal caputegulum four to five times larger than other nuchal caputegulae. The phylogenetic position of *Talarurus* was assessed with an updated data matrix by using TNT. *Talarurus* was recovered as a sister taxon to *Akainacephalus*, which together are the sister clade to *Nodocephalosaurus*. Both *Akainacephalus* and *Nodocephalosaurus* are North American taxa, and the placement of *Talarurus* within this clade supports a faunal exchange between North America and Asia. Other North American ankylosaurids (e.g., *Ankylosaurus*, *Euoplocephalus*, *Scolosaurus*) formed another clade, which was recovered as a sister group to the derived Asian taxa (e.g., *Saichania*, *Tarchia*, *Zaraapelta*). Our study shows that there were two distinct clades of North American ankylosaurids during the Late Cretaceous.

Grant Information:
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Technical Session I (Wednesday, October 9, 2019, 9:00 AM)

EXAMINING THE EVOLUTION OF ECHOLOCATION IN ODONTOCETES (MAMMALIA: CETACEA) VIA MORPHOLOGICAL DISPARITY OF THE COCHLEA

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Odontocetes (toothed whales) are the most successful lineage of marine mammal, highly specialised apex predators and a key component of modern ocean ecosystems. The catalyst for their evolutionary success is their ability to use echolocation - a form of biological sonar - that allows them to sense their environment using high-frequency sound, which is produced in the forehead and detected by the cochlea. Recent studies have indicated that the morphology of the cochlea is an excellent proxy to distinguish hearing ability in extant and extinct taxa, allowing changes in echolocation abilities to be tracked over time. Using high-dimensional 3D geometric morphometrics (371 landmarks), we quantify shape variation in toothed whale cochleae (n = 90) and use the resulting principal component scores to calculate disparity-through-time in the clade. We found that cochlear disparity is relatively low in the Oligocene, then increases throughout the duration of the Miocene, peaking around the Miocene - Pliocene boundary, before beginning to decrease again until the present. We hypothesise that the increase in disparity coincides with the diversification of delphinoids (delphinids, phocoenids and monodontids), with several modern lineages originating contemporaneously with peak cochlear disparity. Additionally, there are statistically significant differences between platanistoid and delphinoid cochlear morphologies. Taken together these results indicate that the refinement and specialisation of echolocation abilities in delphinoids (e.g., narrow-band high frequency hearing in phocoenids) as they spread into new ecological niches, played a role in their successful replacement of platanistoids as the dominant odontocete group during the Miocene. The apparently low cochlear disparity of stem odontocetes may influenced by small sample size.

Grant Information:
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Regular Poster Session IV (Saturday, October 12, 2019, 4:15 - 6:15 PM)

TAPHONOMY AND PALEOCOMMUNITY STRUCTURE OF LD94 SITE, A MIDDLE MIOCENE FOSSIL DEPOSIT IN THE RIVERSLEIGH WORLD HERITAGE AREA, NORTHWESTERN QUEENSLAND

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Australia has a diverse and unique modern fauna, and the Riversleigh World Heritage Area provides much of our knowledge about its evolutionary history. However, there has been less study of how specific taphonomic agents have shaped fossil preservation at Riversleigh. Focusing on Riversleigh's relatively unstudied LD94 Site, this study describes the LD94 Local Fauna (LF), confirms the presence of new species, determines LD94's biostratigraphic placement and possible membership within recognised paleocommunities, and identifies potential taphonomic agents involved in fossilisation of the LD94 assemblage. This adds to the deep-time history of Australian fauna through enhanced understanding of the taphonomic processes operating at one of Riversleigh's richest fossil sites, describes a new, highly-diverse local fauna, possibly a new paleocommunity and two putative new species with future research potential.

Grant Information:
Australian Research Council DP170101420

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

NARACOORTE CAVES: INTERPRETING THE WORLD HERITAGE OF SOUTH-EASTERN SOUTH AUSTRALIA

PARKER, Evan A., The University of Adelaide, Adelaide, Australia; REED, Liz A., The University of Adelaide, Adelaide, Australia

The caves of Naracoorte in the South-East of South Australia have long been known for their extensive deposits of Quaternary vertebrate fossils. In 1858 bone material was first reported from Blanche cave by the Reverend Julian Tenison-Woods. This was followed by relatively sporadic collection of material from various caves in the region, until a major discovery was made in the Victoria Fossil Cave in 1969. Discovered by cave explorers, the Fossil Chamber yielded a vast deposit of vertebrate fossils and became the site of intensive research for several decades. In 1994 the Naracoorte Caves received UNESCO World Heritage listing as the Australian Fossil Mammal Sites (Riversleigh/Naracoorte) for their contribution in telling the story of Australia's unique prehistoric mammal faunas.
The Fossil Chamber has yielded almost 100 vertebrate species, including extinct megafauna. Geochronology of the site indicates a middle Pleistocene age for the deposits. Since the discovery of the chamber, visitors to the park have been able to view the deposits and see paleontologists at work on the site. This has provided an outstanding opportunity to interpret the paleontological record of the site to visitors, leaving a lasting impact on the general public. This is one of the key functions of the Naracoorte Caves World Heritage Area.
The current study titled 'The paleoecology of Fossil Chamber small vertebrates' will report on the understudied small vertebrate fossils from Victoria Fossil Cave. Identification of vertebrate fossil (>5kg) will be undertaken on previously excavated material and dating of the site completed with faunal species being assigned to depositional layers. A detailed paleoecological reconstruction will then be reported on.
The secondary output of the research is the concurrent development of interpretive and educational material for the Victoria Fossil Cave relevant to, and stemming from, the study. Effective interpretation is relevant, engaging and factual, thus a review of the current interpretative offerings from Victoria Fossil Cave is undertaken and reported on with special consideration given to the smaller vertebrate fauna (<5kg). The methodology of the interpretation is discussed and visitor engagement recorded.
It is hypothesised that the development of new interpretive materials to the Victoria Fossil Cave site with result in an increase in the engagement of the general public t the Naracoorte Caves National Park.

Grant Information:
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Regular Poster Session IV (Saturday, October 12, 2019, 4:15 - 6:15 PM)

REVEALING THE PALEOBIOLOGY OF AUSTRALIA'S EXTINCT MEGAFAUNA USING SYNCHROTRON X-RAY FLUORESCENCE MICROSCOPY: A CASE STUDY OF MACROPODIFORMES

PARKER, William M., Monash University, Melbourne, Australia; ADAMS, Justin W., Monash University, Melbourne, Australia; EVANS, Alistair R., Monash University, Melbourne, Australia

Throughout the life of a mammal, growth and development are accompanied by changes in diet and environment. Important life history events are often associated with transitions in the trace element composition of mammalian teeth. In extinct species that are disparate in ecology or body size to their modern relatives, analysis of trace element composition within teeth can be a powerful method to assess life history. Such disparity is typified by the marsupial radiations of Australia where the overwhelming majority of large-bodied species went extinct in the late Quaternary. Trace element analysis provides an avenue to understand how these giant megafaunal species underwent the altricial developmental pattern unique to marsupials.
As an animal's teeth develop, incremental lines in enamel and dentine track growth at a daily resolution. These lines may be used to determine an exact age in days at which an individual was depositing a specific region of mineralised dental tissue. Through correlating incremental growth lines in marsupial enamel with trace element concentrations it is possible to determine the age at which developmental and environmental transitions occurred in extinct marsupials. Our initial data collection at the XFM beamline of the Australian Synchrotron comprised sectioned teeth from three key macropodiform species. The Tammar Wallaby (*Notamacropus* (formerly *Macropus*) *eugenii*) is a model species for the study of extant marsupials and has a well-documented developmental timeline. The Eastern Grey Kangaroo (*Macropus giganteus giganteus*, ~60 kg) is a dwarfed subspecies of extinct giant Pleistocene kangaroo (*Macropus giganteus titan,* ~150 kg). In analysing these closely allied subspecies, direct comparisons may be made between trace elemental indicators of development and environment for living and extinct marsupials while simultaneously allowing us to detect any impact of diagenesis. Our data demonstrates that strontium is a key trace element in this type of analysis. Initial weaning and subsequent seasonal fluctuations appear to be reflected in the high-resolution strontium distribution mapped onto sequential teeth along the tooth row. Expanding this combined analysis of trace elements and incremental growth lines will allow us to understand marsupial development on a megafaunal scale.