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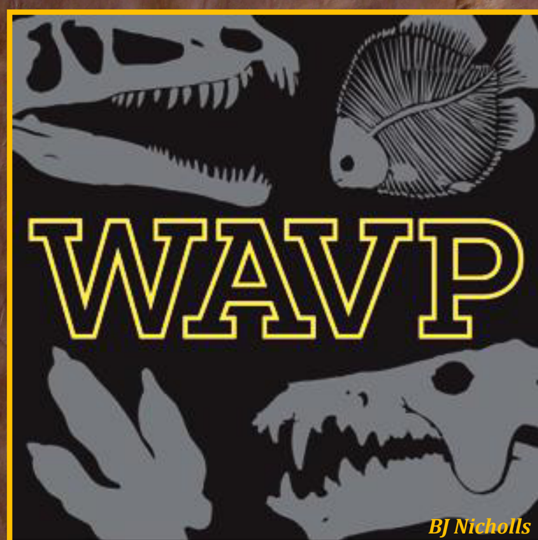
WESTERN ASSOCIATION OF VERTEBRATE PALEONTOLOGISTS ANNUAL MEETING



PROGRAM WITH ABSTRACTS

Dixie State University, St. George, Utah

FEBRUARY 16–19, 2018

Host Committee

Tracy J. Thomson, University of California-Davis
Jerry Harris, Dixie State University
Andrew R. C. Milner, St. George Dinosaur Discovery Site at Johnson Farm
Jim Kirkland, Utah State Geological Survey

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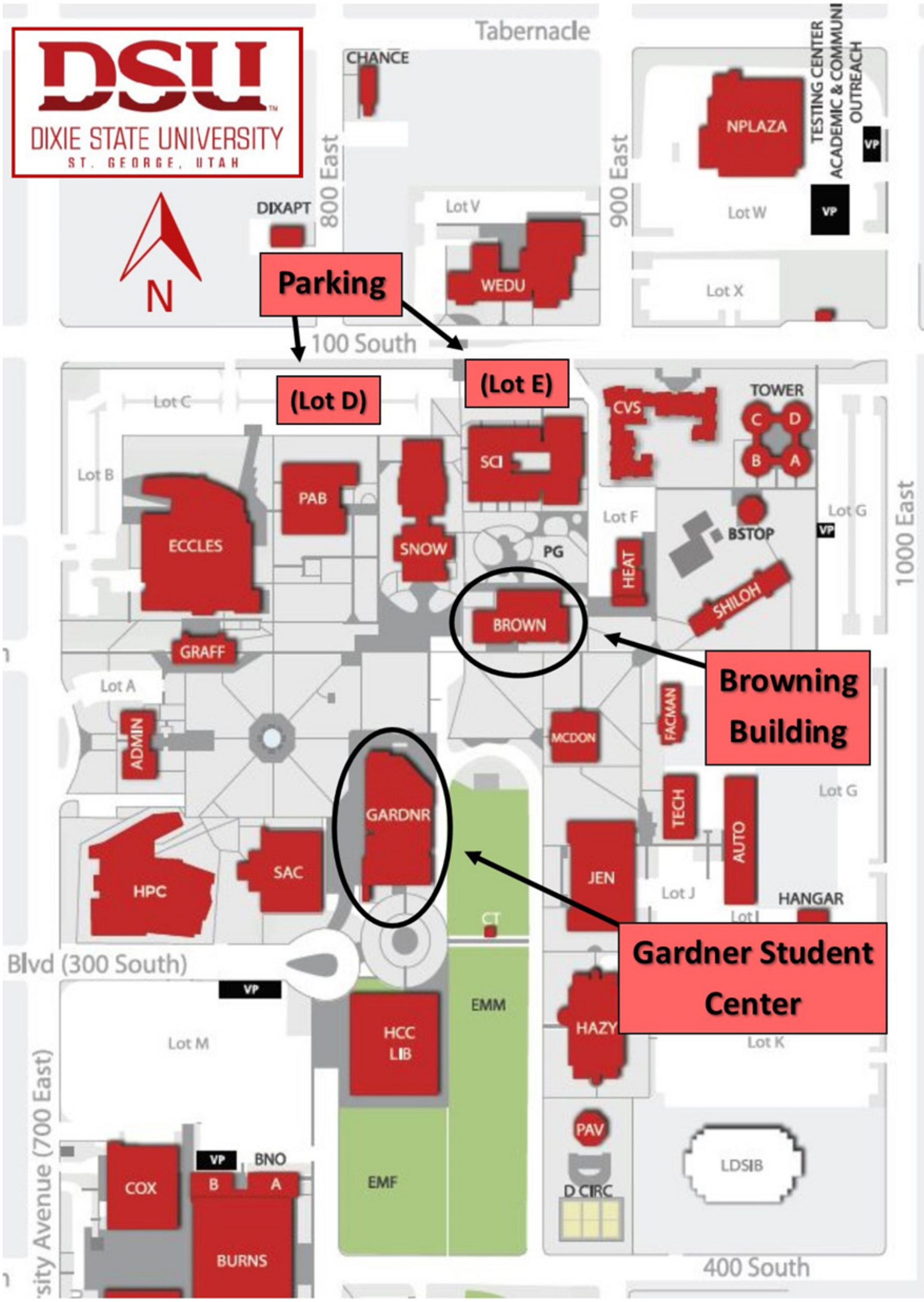
The large theropod dinosaur *Dilophosaurus* resting on the Lake Dixie beach to create a *Eubrontes* crouching trace with hand impressions. The actual crouching trace specimen can be seen at the St. George Dinosaur Discovery Site at Johnson Farm. Artwork by H. Kyoht Lutermann.

MAP OF DIXIE STATE UNIVERSITY



Schedule of Events

Friday, February 16, 2018

6:00–9:00 pm **REGISTRATION AND RECEPTION** (St. George Dinosaur Discovery Site at Johnson Farm)

Saturday, February 17, 2018

8:00–9:00 am **REGISTRATION** (Outside Dunford Auditorium (Browning Building 101), Dixie State University)

9:00 am–5:00 pm **ORAL PRESENTATIONS (**Dunford Auditorium (Browning Building 101), Dixie State University)

8:50–9:00	Thomson	**WELCOME**
9:00–9:20	Byrne	Pneumaticity and pelvic kinesis in Archosauria: Implications of physiologically unique respiratory mechanisms
9:20–9:40	Kligman	Additions to the rhynchocephalian fauna of the Chinle Formation (Late Triassic), and phylogenetic, biogeographic, and morphological implication
9:40–10:00	Beightol et al.	Quantifying temnospondyl teeth infolds to taxonomically place isolated temnospondyl teeth from the Upper Triassic Chinle Formation, Arizona
10:00–10:20	Hungerbühler et al.	Fauna of the Upper Triassic Redonda Formation of east central New Mexico
10:20–10:30		**BREAK**
10:30–10:50	Gay et al.	Looting of an Upper Triassic site in southeastern Utah
10:50–11:10	Marsh	Anatomy, systematics, and geochronology of *Dilophosaurus wtherilli*
11:10–11:30	DeBlieux et al.	The Morrison Formation in the western Blanding Basin, southeastern Utah
11:30–11:50	Kirkland & DeBlieux	Early Cretaceous salt tectonics in the Paradox Basin of eastern Utah resulted in the unique preservation of North America's two earliest Cretaceous faunas in Grand County, Utah
11:50–12:10	Thomson	Overcoming obstacles to inferring functional morphology of fossil vertebrate claws
12:10–1:30		**LUNCH**
1:30–1:50	Holroyd & Hutchison	Early Paleogene vertebrates from northern and central California
1:50–2:10	Townsend & Delgado	The skeleton of *Diplobunops* and implications for understanding variation in early artiodactyls
2:10–2:30	Bevers et al.	The camels of the Milk Creek Fauna (Late Miocene, Yavapai County, Arizona)
2:30–2:50	Thompson et al.	Equine Navicular Syndrome in the fossil record
2:50–3:10	Molnar	Seeing natural selection in the vertebrate fossil record
3:10–3:20		**BREAK**

3:20–3:40	Barnes & Flynn	A eurhinodelphinid (Cetacea; Odontoceti) from the Late Miocene Monterey Formation, San Clemente Island, Los Angeles County, southern California
3:40–4:00	Stewart & Hakel	Surgeon fish fossils as paleoclimatic indicators in California Neogene sediments
4:00–4:20	Thomson	Tetrapod swim tracks in time and space: What are they telling us and how do we deal with them?
4:20–4:30	Thomson	**2019 WAVP VENUE AND CLOSING**

4:45–6:00 pm	**POSTER SESSION** (Gardner Student Center Ballroom, Dixie State University)
Adrian et al.	Geographic, stratigraphic, and ecological distribution of turtle taxa from the Uinta Formation, Uinta Basin, UT
Bevers et al.	History of fossil research at Milk Creek, Arizona (Late Miocene) and the Yavapai College Collection
Boisvert & Thomson	A preliminary investigation into the evolution of claw specialization in vertebrates: How common is it?
Ellwood et al.	Microfossil sorting for a “mouse’s eye view” of Rancho La Brea
Flora & Davis	Methods and potential problems in building a new evolutionary tree of Antilocapridae
Graham et al.	From classes to cabinets: A curatorial workflow to engage communities in fossil collection curation
Hutchison & Bramble	A new species of *Xerobates* from the Early Pleistocene of Sonora, Mexico: Implications for the Pleistocene biogeography of gopher tortoises
Krumenacker & Ferguson	Taphonomy of and new burrows from the digging dinosaur *Oryctodromeus cubicularis*
Martinez & Farke	Trackways of *Platykopus ilycalcator* from the White Narrows Formation (Pliocene), Nevada
Mychajliw et al.	Extinction, extirpation, and (re)introduction of bears in California
Mychajliw et al.	Rat, poop, tar: Rodent activity at Rancho La Brea’s Project 23
Oei et al.	An azhdarchid pterosaur from the Kaiparowits Formation of southern Utah
Parry & Rowland	Age profile of terminal Pleistocene Columbian mammoths (*Mammuthus columbi*) from Southern Nevada
Shaw et al.	Predmore Microsite, El Golfo de Santa Clara, Sonora, México: The gift that keeps on giving
Thompson & Ferguson	A review of badger (*Taxidea taxus*) from the Pleistocene Booth Canyon local fauna, southeastern Idaho

6:00–8:00 pm	**KEYNOTE BUFFET DINNER AND ADDRESSES** (Gardner Student Center Ballroom, Dixie State University)
6:00–6:30	**DINNER**
6:30–7:30	**KEYNOTE ADDRESSES**
Andrew Farke & Robert Gay	Impacts of Potential Boundary Changes on Vertebrate Paleontology Research in Grand Staircase-Escalante and Bears Ears National Monuments

Sunday, February 18, 2018

FIELD TRIP: Late Triassic-Early Jurassic Paleontology of Southwestern Utah
Led by Andrew R. C. Milner and James I. Kirkland

9:45 am	Meet at St. George Dinosaur Discovery Site at Johnson Farm
10:00 am	Depart
6:30 pm	Return to St. George, UT

Very little was known about the paleontological resources of southwestern Utah prior to the discovery of spectacular dinosaur tracks within the Moenave Formation in St. George by Dr. Sheldon Johnson in late February 2000. Construction of the museum at the St. George Dinosaur Discovery Site at Johnson Farm (SGDS) resulted in greater attention to the resources within southwestern Utah and the discovery of many new localities, mostly within the Upper Triassic-Lower Jurassic Glen Canyon Group.

The field trip begins with an overview of discoveries at the SGDS along with a discussion of the controversy over the age of the Moenave Formation preserved there. This tour will put in place a background for the remainder of the field trip. We will visit extensive outcrops in the Warner Valley area to view the upper part of the Lower Triassic Moenkopi Formation, portions of the Upper Triassic Chinle Formation, the Triassic-Lower Jurassic Moenave Formation, and the lower part of the Kayenta Formation (the uppermost Kayenta and overlying Navajo Sandstone will be discussed from a distance).

Within Warner Valley (high clearance/4x4 vehicles recommended) we will visit several important localities: (1) Warner Valley Dinosaur Tracksite preserving ~400 dinosaur tracks in the lower part of the Kayenta Formation; (2) Olsen Canyon section within the Dinosaur Canyon Member of the Moenave Formation. This site preserves an Early Jurassic ichnofauna situated below the Triassic-Jurassic boundary within the end-Triassic extinction (ETE) interval; (3) approximately one-mile hike from the Chinle-Moenave contact, through the Dinosaur Canyon and Whitmore Point members of the Moenave Formation, and the Springdale Sandstone, and lower part of the "silty facies" of the Kayenta Formation.

Monday, February 19, 2018

FIELD TRIP: Tule Springs Fossil Beds National Monument, Nevada
Led by Kathleen Springer, Jeff Pigati and Josh Bonde

10:45 am	Meet at Aliante Hotel and Casino parking lot
11:00 am	Depart
4:30-5:00 pm	Return to Las Vegas, NV

Tule Springs Fossil Beds National Monument (TUSK) contains the largest and most diverse, open-site Rancholabrean, vertebrate faunal assemblage in the Mojave and southern Great Basin deserts. The field trip will begin at the site of the iconic 1960s Tule Springs expedition, where the history of the site and current work will be revealed. We will then travel to key sites in this large (nearly 23,000 acres), uniquely urban-interface national monument abutting the city of Las Vegas, NV and examine the stratigraphy, paleohydrology and chronology of TUSK's extensive groundwater discharge deposits (formerly desert wetlands), and the Tule Springs local fauna entombed therein.

We will reconstruct the detailed history of the deposits, revealed by geologic mapping, stratigraphic analysis and targeted radiocarbon and luminescence dating, ascending through nearly 500 ka of the Las Vegas Formation. We will examine key "bins of time" in the sedimentary sequence that contain vertebrate fossils and will discuss how cycles of wetland expansion and contraction in the middle-late Pleistocene were driven by climatic oscillations recorded in the Greenland ice cores, including Dansgaard–Oeschger cycles and other millennial and sub-millennial events.

ABSTRACTS of ORAL PRESENTATIONS*

**in order of presentation*

KEYNOTE ADDRESS

Impacts of Potential Boundary Changes on Vertebrate Paleontology Research in Grand Staircase-Escalante and Bears Ears National Monuments

Andrew Farke, Raymond M. Alf Museum of Paleontology at The Webb Schools, Claremont, CA, USA

Robert J. Gay, Colorado Canyons Association, Grand Junction, CO, USA

Southern Utah is home to a rich geological and paleontological record, which has received international attention through scholarly and popular publications, museum exhibits, news media, and via the establishment of national parks and monuments. Two monuments in particular—Bears Ears National Monument (BENM) and Grand Staircase-Escalante National Monument (GSENM)—have received recent attention in the scientific as well as the political realm.

Grand Staircase-Escalante National Monument (GSENM) was established by presidential proclamation in 1996, as the first national monument managed by the Bureau of Land Management. Paleontological and geological resources were specifically cited as an impetus behind the monument. This designation and its accompanying administrative and financial support facilitated numerous scientific discoveries in the following years. The primary stratigraphic record within the original monument boundaries includes the Permian through the Cretaceous, spanning such important events as the Permo-Triassic extinction, the Cenomanian-Turonian anoxic event, and the development of the Western Interior Seaway as well as its adjacent terrestrial ecosystems. As such, GSENM preserves a unique record of global change. Beyond this importance for understanding deep time events, the rocks of the monument have yielded fossils of numerous organisms critical for understanding the overall evolution and evolutionary relationships of life. Although the dinosaurs (such as *Teratophoneus* and *Kosmoceratops*) are best known, the holotypes for numerous fossil mammals, lizards, pterosaurs, marine reptiles, plants, and representatives of other clades originated within GSENM. In addition to questions of alpha taxonomy and phylogeny, many of these specimens have also been important for understanding issues such as biogeography, heterochrony, taphonomy, and functional morphology. Furthermore, GSENM is notable in the number of institutions working within the monument, as well as its field training opportunities for professionals and amateurs within the earth sciences.

Bears Ears National Monument (BENM) was established in late 2016, protecting over 1.3 million acres of existing federal lands. While the primary reason for the establishment of the monument was the numerous Native American historic and prehistoric sites and ties, the paleontological resources of the area were also considered significant. As such, President Barack Obama included many of the fossil-rich lands in the region as part of the monument.

BENM contains an exceptional record of terrestrial life from a period prior to the Permo-Triassic extinction (the Pennsylvanian-Permian boundary) into the Early Cretaceous. Fossil specimens have been reported in the region since at least the middle of the 19th century and significant, scientifically valuable discoveries have been made in the Valley of the Gods, White and Fry canyons, Indian Creek, and Comb Ridge. The region is especially significant for its intact record of the Triassic-Jurassic transition, including the end-Triassic extinction and the rise of the continental erg during this time period. The transition of vertebrates from sea to shore is also well exposed in the monument, providing crucial insights into this transition from western Pangaea.

Specific significant discoveries include Pennsylvanian-Permian ecosystems including plants, as well as aquatic and terrestrial vertebrates such as *Dimetrodon*, *Eryops*, and *Sphenacodon*. The rise of the dinosaurs is documented with neotheropod-like teeth from Comb Ridge, as well as numerous phytosaur, aetosaur, and new archosaur fossils from the latest Triassic. Utah's only published basal sauropodomorph (prosauropod) was found at Comb Ridge, and significant track sites also exist in the Lower Jurassic deposits of the monument.

Finally, numerous cave and fluvial deposits from the Pleistocene exist, documenting how plant and animal communities have adapted to the changing climate since the last glacial maximum.

A second presidential proclamation in 2017 reduced the size of GSENM by nearly 47 percent and formally divided it into three areas. Lands excluded from the monument include much of the Tropic Shale (and its record of the Cenomanian-Turonian extinction), type localities for several taxa, and numerous other paleontologically and geologically significant sites. A parallel proclamation attempted to reduce the extent of BENM to two smaller areas: Indian Creek and Comb Ridge/Elk Ridge. Although fossils and fossil sites on the excluded lands retain the basic protections that apply to "normal" federal lands (for the time being), they have lost the more rigorous protections, administrative support, and funding streams for research, management, and preservation that applied within the monument. Ongoing litigation renders the ultimate status of these excluded lands as uncertain.

PNEUMATICITY AND PELVIC KINESIS IN ARCHOSAURIA: IMPLICATIONS OF PHYSIOLOGICALLY UNIQUE RESPIRATORY MECHANISMS

BYRNE, Paul J., University of California-Davis, Davis, CA, USA.

The ability to process oxygen more efficiently than other organisms could have provided Dinosauria with the energy necessary for a highly active, bipedal lifestyle due to the prolonged retention of oxygen available for use in aerobic respiration. The air sacs, provided by the avian-like respiration system, could have also enabled dinosaurs to grow gigantic without overheating. A study by Wilson in 2011 defined a nomenclature for clarifying exactly what qualifies as pneumaticity using examples from basal to derived non-avian dinosaurs. By using Wilson's nomenclature to identify pneumatic areas in the vertebral column, which indicate the possible localities of air-sacs, the evolutionary history of the avian-like respiratory mechanism in Archosauria can begin to be traced.

Pneumatization of the vertebral column in basal to derived Archosauria closely resembles the pneumatization of the vertebral column in Avialae, suggesting the presence of an avian-like respiratory system. The presence of pelvic-kinesis in Archosauria also suggests that pelvic-assisted respiration may have been present in certain basal to derived archosaurs. In Archosauria, these respiration mechanisms greatly enhanced the efficiency of processing oxygen as well as aiding in thermoregulation. This may have been a critical catalyst for enabling bipedal locomotion in Dinosauria and flight in some pterosaurs. These two respiratory mechanisms thus serve as crucial component in the eventual gigantism and diversification of Archosauria.

These unique respiratory mechanisms may have also provided pterosaurs with the energy required for quadrupedal launching, the act of using both fore-and hindlimbs to initiate flight. Similarities/differences in the pneumatic regions of the vertebral column, sternal-rib-kineticism, and the presence of elaborate dorsal and ventral processes termed 'sternocostapophyses', suggest that pterosaurs had both the avian-like and pelvic-kinesis respiratory mechanisms seen in other archosaurs. Inferences can be made concerning how the mechanisms factored into what would have been necessary for quadrupedal launching; specifically, that these two respiratory mechanisms could have played a role in allowing pterosaurs to engage in quadrupedal launching.

Analysis of the morphological differences in vertebral column pneumaticity and/or pelvic kinesis within Pterosauria and Dinosauria, as well as interpreting the implications of these complex systems of respiration, suggests that these unique respiratory mechanisms could have enabled the rapid diversification and subsequent success of Archosauria.

ADDITIONS TO THE RYNCHOCEPHALIAN FAUNA OF THE CHINLE FORMATION (LATE TRIASSIC), AND PHYLOGENETIC, BIOGEOGRAPHIC, AND MORPHOLOGICAL IMPLICATIONS

KLIGMAN, Ben T., Division of Science and Resource Management, Petrified Forest National Park, AZ, USA.

Rhynchocephalians are common globally in the early Mesozoic but are only known from a few occurrences in the Triassic of the southwest USA. Recent fieldwork focused on collecting microvertebrates from the Chinle Formation of northeastern Arizona has resulted in the discovery of several diverse rhynchocephalian assemblages, including two new species.

Additionally, a re-assessment of the Placerias Quarry and Owl Rock microvertebrate assemblages housed at the Museum of Northern Arizona has revealed a wealth of rhyncho-cephalian material, also including several undescribed taxa. A phylogenetic analysis of the new rhyncho-cephalian material described in this study significantly increases the diversity of this group in the Chinle Formation. These new discoveries also add to the morphological diversity of Chinle tetrapods, exhibiting new dentition patterns and inferred feeding strategies. It is apparent that at this early stage in rhynchocephalian evolution, members of this group had diversified and specialized to occupy different feeding niches within the same ecosystem, including insectivory and herbivory. The biostratigraphy of rhynchocephalian taxa in the Chinle Formation, contextualized with U-Pb isotope chronostratigraphy, add to evidence of a vertebrate faunal turnover at the Adamanian-Revueltian transition (215 Ma). Additionally, the similarity of these rhynchocephalian assemblages to those from Upper Triassic rocks in Europe suggest biogeographic homogeneity of rhynchocephalian assemblages in Laurasia during the Late Triassic.

QUANTIFYING TEMNOSPONDYL TEETH INFOLDS TO TAXONOMICALLY PLACE PURPORTED ISOLATED TEMNOSPONDYL TEETH FROM THE UPPER TRIASSIC CHINLE FORMATION, ARIZONA

BEIGHTOL, Charles V., Division of Science and Resource Management, Petrified Forrest National Park, AZ, USA; Department of Biology, University of Washington, Seattle, WA, USA; GEE, Bryan M., Department of Biology, University of Toronto Mississauga, Ontario, Canada; PARKER, William G., Division of Science and Resource Management, Petrified Forest National Park, AZ, USA.

Metoposauridae is a family of temnospondyl 'amphibians' that are both abundant and biogeographically widespread within Late Triassic deposits. Although metoposaurids make up a large percentage of the aquatic vertebrate fossils, complete, in-place teeth are rarely found; often the crowns are broken off near the level of the jaw. The basal portion of the crowns still left in the jaw resembles the basal portions of two tooth morphotypes *Suchoprion sulcidens* Cope, 1878, and *Mastodonsaurus durus* Cope, 1866. Similar morphotypes of both these teeth are found in the Upper Triassic Chinle Formation at Petrified Forest National Park (PEFO), Arizona. These teeth are often found isolated from any diagnostic tooth-bearing elements, and their taxonomic affinity has not been verified. Verifying the taxonomic affinity of these teeth can be accomplished by assessing the complex infolding of dentine (plicidentine) within these teeth, a feature found throughout temnospondyls. A qualitative analysis has shown distinctions between plicidentine at the familial level among temnospondyls, but that analysis was unable to quantitatively analyze this distinction. Recently, fractal analyses have been used to quantitatively delimit species of ammonoids and equids based on the complexity of either their sutural patterns or enamel infoldings, respectively. This makes fractal analysis a potential candidate for quantifying the complex plicidentine in published temnospondyl teeth to identify which of the two tooth morphotype belongs to metoposaurids.

Here we use fractal analysis to quantify the plicidentine complexity of purported isolated labyrinthodont teeth from the Upper Triassic Chinle Formation (PEFO). We show that assessing fractals of an individual infold and segments of an individual infold yield consistent values for quantifying the infold complexity among the teeth sampled and allow for an assignment of a labyrinthodont tooth to a familial level among stereospondylomorph temnospondyls. We also show that the fractal analysis of the labyrinthodont teeth from PEFO possess plicidentine infolding patterns that conform to the infolding patterns of Metoposauridae. Furthermore, we confirm that the plicated Late Triassic tooth morphotype sometimes attributed to Metopo-sauridae, *Suchoprion sulcidens* Cope, 1878, is not a labyrinthodont tooth and represents a phytosaurian archosauriform. This analysis provides a rigorous assessment of plicidentine complexity making it an asset for identifying isolated teeth with plicidentine to a more exclusive taxon, and it may be an applicable approach for further characterizing other taxa with plicidentine, such as sarcopterygians and parareptiles.

FAUNA OF THE UPPER TRIASSIC REDONDA FORMATION OF EAST-CENTRAL NEW MEXICO

HUNGERBÜHLER, Axel, Mesalands Community College, Tucumcari, NM, USA; GÜRTLER, Gretchen L., Mesalands Community College, Tucumcari, NM, USA.

Since 2007, Mesalands Dinosaur Museum exploits a vertebrate-rich site in the Redonda Formation, the uppermost formation of the Upper Triassic Dockum Group in east-central New Mexico. In contrast to the

'classic' Redonda vertebrate sites, the new site is located at a lower stratigraphic level and yields a high amount of remains of terrestrial, rather than the usually dominant semiaquatic vertebrates. The faunal report presented here details occurrences of previously unknown taxa as well as important new anatomical information for taxa known from the region. Phytosaurs are represented exclusively by *Machaeroprosopus* (= *Redondasaurus*) *gregorii*, the defining taxon of the Apachean biozone. Evidence is presented that this form incorporated a third (dorsosacral) vertebrae into the sacrum in a way unique among archosauriforms. Osteoderms and postcranial elements of aetosaus are relatively abundant and allow a reassessment of the systematics of the three aetosaur taxa described previously from the Redonda Formation. For the first time, we demonstrate the occurrence of a shuvosaurid poposauroid close to, if not identical, to the genus *Effigia* in the Redonda Formation on the basis of cranial and numerous appendicular elements. Isolated cranial and appendicular elements indicate the presence of a large-bodied crocodylomorph. Dinosaurs are represented by a few isolated remains, including an ilium, a partial sacrum and several hindlimb elements.

LOOTING OF AN UPPER TRIASSIC SITE IN SOUTHEASTERN UTAH

GAY, Robert J., Colorado Canyons Association, Grand Junction, CO, USA; UGLESICH, Jessica, University of Texas-San Antonio, San Antonio, TX, USA; HUNT-FOSTER, ReBecca, Bureau of Land Management, Moab, UT, USA.

In 2017, initial excavation of an Upper Triassic Chinle Formation archosaur site within the then-boundaries of Bears Ears National Monument uncovered dismay when the field crew realized that it had previously been excavated. The lead author and his team discovered the site a year prior; specifically, a series of articulated vertebrae warranted the need for an excavation permit. Permit in hand, the 2017 field crew began re-exposing the vertebral column. It quickly became obvious that the deposit was extensive and numerous individuals were present. Oddly, however, there were no bones found anterior to the pectoral girdle of the initial specimen. A few hours later the tip of a snout was found in the location expected from a specimen of the size and position of the discovery specimen. Surrounding the snout, remains of decades-old plaster signified that the missing section between the snout and vertebrae was not a taphonomic bias, but rather the work of looters.

As soon as practical the district paleontologist was contacted about the possibility of the site having been looted. In a strange coincidence, the district paleontologist had, just weeks prior, handled a phytosaur skull reported to have been looted from the Chinle Formation of Fry Canyon which was missing the end of the snout. Based on this, we traced down this specimen's history. Originally excavated without a permit in the late 1990s, the skull and a partial postcrania was transported to Arizona by the excavator (a volunteer at a major regional museum). It was partially prepared and surrendered to park staff at Petrified Forest National Park. There, Bill Parker and Larkin McCormack identified it as *Pravusuchus* and later presented this identification at the 2017 Society of Vertebrate Paleontologists annual meeting. Afterwards the skull was transferred to the Bureau of Land Management in Utah for eventual curation at the Natural History Museum of Utah in Salt Lake City. As the skull was surrendered voluntarily with no precise locality data, no criminal case was pursued. This situation shows the need for increased education, monitoring, and protection around paleontological resources and highlights the vulnerability of fossil resources that remain unexcavated across the Bears Ears region. This rare combination of circumstances enabling us to relocate the site where this specimen came from is not the usual situation for looted fossils, which are often never recovered or recovered without their context, making this case a poignant reminder of what can be lost during looting.

ANATOMY, SYSTEMATICS, AND GEOCHRONOLOGY OF *DILOPHOSAURUS WETHERILLI*

MARSH, Adam D., Jackson School of Geosciences, University of Texas at Austin, Austin, TX, USA; Division of Science and Resource Management, Petrified Forest National Park, AZ, USA.

Thanks to popular culture and its charismatic cranial crests, *Dilophosaurus wetherilli* is one of the most widely-recognized theropod dinosaurs in preschool classes and graduate courses alike. During the Early Jurassic, *Dilophosaurus* was the largest animal to have ever lived on land in North America. Despite its inclusion in phylogenetic analyses of a wide range of archosaur groups, little clarity exists of the skeletal anatomy, taxonomy, ontogeny, and evolutionary relationships of *Dilophosaurus*. While *Dilophosaurus* is often interpreted to be the trackmaker of *Eubrontes* in the Kayenta Formation at places like Tuba City, AZ, and St. George, UT, the taxon is only known from five incomplete skeletons. Redescription of the holotype, referred, and previously undescribed specimens of *Dilophosaurus wetherilli* supports the existence of a single species of crested, large-bodied theropod from the Kayenta Formation of Arizona. Phylogenetic analyses conducted using each specimen of *Dilophosaurus wetherilli* as a terminal taxon result in each specimen being the sister taxon to the holotype. When all five specimens are included in such an analysis, they form a monophyletic group of non-averostran neotheropods in a grade of other stem-averostrans like *Cryolophosaurus* and *Zupaysaurus*. Newly recognized autapomorphies of *D. wetherilli* are found throughout the skeleton. The parasagittal nasolacrimal crests are uniquely constructed by a small ridge on the nasal process of the premaxilla, dorsoventrally expanded nasal, and tall lacrimal that includes a posterior process behind the eye. In addition to the biceps tubercle, the coracoid includes a ventral tubercle. A scalloped obturator process is present on the proximal ischium. A notch is located on the posteromedial corner of the distal tibia. Finally, the posterior centrodiapophyseal vertebral lamina bifurcates and reunites down the neck in larger individuals such that the single posterior centrodiapophyseal lamina present on the eighth vertebra is not homologous to that found on the third. Many of the features of the postcranial skeleton are derived compared to Late Triassic theropods and may be associated with an increase in body size in Theropoda through time or in *Dilophosaurus* as it grew. *Dilophosaurus* is found in the Silty Facies of the Kayenta Formation from two main sites in the Navajo Nation of Arizona. The various skeletons have been collected from the middle and near the base of the unit, however the fluvial Kayenta Formation is assumed to be time-transgressive and superpositional relationships must be verified with radiometric ages. Using U-Pb detrital zircon geochronology, the maximum age of deposition of the *Dilophosaurus* quarry at Gold Spring, AZ is 183.7±2.7 Ma and that of the holotype quarry near Tuba City, AZ is 199.5±3.7 Ma. These ages suggest that the time contained within the Kayenta Formation includes more of the Early Jurassic than previously hypothesized using vertebrate biostratigraphy and that *Dilophosaurus wetherilli* persisted for at least 14 million years.

THE MORRISON FORMATION IN THE WESTERN BLANDING BASIN, SOUTHEASTERN UTAH

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In 2016 and 2017, the Utah Geological Survey (UGS) partnered with the Bureau of Land Management (BLM) to conduct a paleontological inventory of a portion of the Morrison Formation (MF) west of Blanding, Utah on land along the eastern margin of the Bears Ears National Monument. This area was chosen for survey because the State Paleontological Database, managed by the UGS, indicated that few sites had been recorded in this area. The MF in this region is critical to understanding Upper Jurassic stratigraphy across the southern Colorado Plateau because it is the type area for several important Morrison units including the Bluff Sandstone, Recapture, Westwater, and Brushy Basin Members, and researchers disagree about stratigraphic nomenclature and correlation of the units. During several weeks of fieldwork, UGS personnel recorded over fifty new localities. Some sites in the Recapture have dinosaur bone indicating potential for significant discoveries in this unit.

A likely location for the original 1938 type area of the Brushy Basin Member was recognized on the north end of Black Mesa. We described a detailed reference section from 81.68 m of Brushy Basin Member between the top of the capping sandstone bed of the Westwater Member and the base of the Cretaceous Burro Canyon Formation. Smectitic mudstones between the upper capping sandstone bed and the main body of the Westwater suggest that the Salt Wash - Brushy Basin contact to the north may be somewhat older than that on the west side of the Blanding Basin. The Brushy Basin Member is well-known for containing abundant vertebrate fossils and many localities were discovered. Many sites contained isolated sauropod and other dinosaur bones and some sites had many bones eroding out over small areas that warrant additional exploration. Several sites have potential to produce vertebrate microfossils. One site is a multi-meter-thick plant debris bed, likely representing a marsh setting, that has numerous compressional plant fossils and petrified wood, in addition to bones and bone fragments. This site is quite unusual for the MF and resembles deposits better known in the Upper Cretaceous of the western U.S. and Canada. One laterally extensive organic mudstone near the top of the MF preserves a 10-cm volcanic ash that yielded an age of 150.67±0.32 Ma ($^{206}Pb/^{238}U$ and $^{207}Pb/^{235}U$ data, 95% confidence limits). Although one site found by the BLM had been vandalized by unauthorized excavation, there appears to be less vandalism to MF localities in this region than in other areas of the state.

EARLY CRETACEOUS SALT TECTONICS IN THE PARADOX BASIN OF EASTERN UTAH RESULTED IN THE UNIQUE PRESERVATION OF NORTH AMERICA'S TWO EARLIEST CRETACEOUS DINOSAUR FAUNAS IN GRAND COUNTY, UTAH

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Overlying a regional unconformity at the top of the Jurassic Morrison Formation, six Cretaceous dinosaur faunas are documented in the Cedar Mountain Formation of east-central Utah. Preserved in the Yellow Cat and overlying Poison Strip Members, the stratigraphically lower three faunas (early Aptian and older) are dominanted by polacanthid ankylosaurs, styracosternid iguanodonts, and massive-toothed brachiosaurid and turiasaur sauropods. A medial Aptian mass extinction led to their replacement by nodosaurine nodosaurid ankylosaurs, more basal tennotosaurian iguanodonts, and slender-toothed titanosauriform sauropods found in the overlying Ruby Ranch Member and in correlative late Aptian-Albian strata across North America. Preliminary analysis correlates the youngest lower Aptian polacanthid fauna preserved in the Poison Strip Member with the terrestrial fauna preserved at the base of the Cretaceous sequence in the Lakota Formation of the Black Hills based on a distinct armor type ("splates") in the polacanthids and the shared occurrence of the specialized styracosternid iguanodont *Planacoxa*. This faunal level may correlate to the upper Wealden of Europe prior to the extinction of European polacanthids and their replacement by struthiosaurine nodosaurids.

The two older polacanthine faunas are only known from the Yellow Cat Member at the base of the Cedar Mountain Formation, which is restricted to the northern Paradox Basin in Grand County, Utah. This, together with facies changes across the Salt Valley Anticline at Arches National Park, document that salt tectonics during the Early Cretaceous was the predominant control on deposition of the Yellow Cat Member, predating the development of a Sevier foreland basin during the medial Early Cretaceous. Biostratigraphic analysis of the Yellow Cat Member indicates that a regional calcrete (very mature paleosol) separates two distinctly different sedimentary sequences preserving two distinct faunas and represents a break of at least one to a few million years (evolutionary time) as distinct species of dromaeosaurs, turiasaurs, polacanthines and styracosternid iguanodonts occur on either side of this hiatus surface. Radiometric dates based on detrital zircons suggest that the upper Yellow Cat Member is either a maximum of 124 Ma (basal Aptian) as determined by one research group at around 135 Ma (Hauterivian -Berriasian) as determined by a second research group. Biostratigraphic analysis of mammals, ostracodes, charophytes, and palynomorphs suggests the older age is more likely. More dating of these strata is needed and is pending, but whatever the final age determination, it is clear that a gap separates these two Yellow Cat dinosaur faunas and, although older, the lower Yellow Cat fauna is Early Cretaceous in age. Previous work had suggested that this faunal level is part of the underlying Morrison Formation. If the older age is confirmed, the unconformity between the underlying Jurassic Morrison Formation and the base of the Early Cretaceous Cedar Mountain Formation would be reduced from about 25 to 10–15 million years.

OVERCOMING OBSTACLES TO INFERRING THE FUNCTIONAL MORPHOLOGY OF FOSSIL VERTEBRATE CLAWS

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A number of studies have attempted to correlate form and function in vertebrate claws, sometimes with the goal of inferring claw function in extinct taxa. However, the results of these studies either conflict with each other or have been largely inconclusive. In nearly all cases, claw curvature is the predominant metric used to describe claw morphology and study organisms are classified into 3 or 4 ecological categories. In fossil claws, the bony ungual may survive fossilization intact while the keratinous sheath, if it is even present, is rarely well-preserved. In modern animals, the correlation between ungual and sheath morphology is highly variable across taxa, such that relying solely on ungual shape to infer function most likely introduces considerable error. In order to make inferences of claw functional morphology more reliable for extinct vertebrates, I am attempting to overcome three main obstacles: the use of too few claw metrics, the use of ecological rather than functional categories, and the general lack of fossil sheath preservation.

The first obstacle is overcome by including more metrics in the analysis (in addition to curvature) that describe claw features which are biomechanically important. These include taper rate, cross-section shape, angle of attack, log spiral fitness, and others. Currently, the database I have been compiling contains 16 metrics that describe characteristics of both ungual and sheath morphologies (8 metrics each). The second problem is overcome by correcting and expanding the organism categorization scheme used in previous studies. Rather than classifying study organisms by ecology (e.g., predatory, arboreal, ground, etc.), I have been employing functional categories such as running, gripping, clinging, digging, grasping, etc. The third problem is overcome by establishing reliable mathematical relationships between ungual and sheath metrics or using sheath reconstruction algorithms based on known relationships in modern vertebrates. A better understanding of the morphological relationships between ungual and sheath will allow future researchers to more confidently estimate sheath parameters in extinct vertebrates.

Preliminary results have been encouraging thus far and some interesting patterns are beginning to emerge. Extremely high inner claw angles are characteristic of claws that are used for gripping (e.g., ospreys and felids). High outer/inner claw angle ratios may be a characteristic of claws used for clinging or hanging (e.g., tree sloths). Low, or even negative, claw angles indicate claws used for grooming (e.g., lemurs). There seems to be a tight relationship between the ungual and sheath taper rates with the sheath being about 0.46 times that of the ungual. As more data are collected, these and other relationships, along with their functional significance, will become more clear and reliable for inferring claw function in extinct vertebrates.

EARLY PALEOGENE VERTEBRATES FROM NORTHERN AND CENTRAL CALIFORNIA

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Paleocene and Eocene vertebrate-bearing sites are rare on the West Coast, with the exception of the remarkable exposures of southern California from Ventura through San Diego Counties. Previous reports from central and northern California have been limited to one Paleocene shark tooth site and Eocene fish scales from oil wells. Here we report on vertebrates from more than 20 sites in the northern and central part of California that range in age from early Paleocene to middle Eocene. Most are marine units for which vertebrates have not been previously reported and provide a glimpse into the Paleogene Pacific fauna.

Paleocene vertebrates include previously reported sharks from the Lodo Formation of Fresno County and newly recognized sites in the Laguna Seca Formation of Fresno County and Martinez Formation in Lake and Contra Costa Counties that have produced lamniform sharks, chimaeriforms, and myliobatid rays. We also report for the first time a fossil trionychid from the Carmelo Formation at Pebble Beach.

Eocene faunas include both teleosts and chondrichthyans. Units producing vertebrates include the Capay Formation in Sutter County, the Vacaville Shale and Markley Sandstone in Solano County, the Markley and Muir Sandstones and Nortonville Shale in Contra Costa County, the Domengine Formation in Kings County, and the Kreyenhagen Shale in Fresno County. The teleosts are principally Clupeiformes (herring); the only tetrapod from these Eocene faunas is postcrania of a bird.

Together these provide the first vertebrate records for seven of these geologic units and highlight the potential of these for future work to expand our knowledge of Paleogene Pacific vertebrate faunas

THE SKELETON OF *DIPLOBUNOPS* AND IMPLICATIONS FOR UNDERSTANDING VARIATION IN EARLY ARTIODACTYLS

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The middle Eocene is a time of incredible diversification among the artiodactyls (the even-toed ungulates, such as sheep, cows, deer). During this period, artiodactyls began to 'modernize' and many basal taxa arose that formed many of the taxonomic groups of artiodactyls that we recognize today (i.e, ruminants, camels, pigs). The genus *Diplobunops* is an intriguing taxon that is restricted to the late Uintan interval of the middle Eocene (~43–39 Ma) and has had a checkered taxonomic history: some scholars do not consider it a valid genus, while others think the opposite. Based on our study of closely related taxa and thorough investigation of this new specimen, we hypothesize that *Diplobunops* is a valid genus. Our study is the first to describe in detail the skeleton of *Diplobunops*. The area of the first lower molar is often taken as a proxy for body size and in this character, the upper end of the *Protoreodon* species range overlaps with that of *Diplobunops*, however, the postcranial comparisons indicate that *Diplobunops* was a more robust animal with stouter limbs than its close relative, *Protoreodon*. The strict consensus tree resembles that of Theodor and Foss (2005) but unlike the published tree of these authors, the addition of *Diplobunops* resolves the polytomy among early rumimant artiodactyls.

In 2013, a rather complete skeleton of *Diplobunops* (13-262) was found at a middle Eocene locality in the Uinta Formation, Uinta Basin, Utah. The skeleton was reconstructed, and measurements were taken using Mitutoyo digital calipers and an osteometric board. To evaluate the position of *Diplobunops* among other early ruminant artiodactyls, we performed a phylogenetic analysis based on the data matrix of Theodor and Foss (2005). We updated this matrix with characters for *Diplobunops*. Trees were generated using a heuristic search option in PAUP 4.0a152 and character evaluation was performed in Mesquite. We evaluated shape indices for major joint surfaces in order to evaluate any major differences in locomotor preferences. Skeletons of *Diplobunops* are available in museums, but none have been described in great detail or used in phylogenetic analyses. Our study is the first step in evaluating this genus and our preliminary data suggest that *Diplobunops* is a valid genus.

THE CAMELS OF THE MILK CREEK FAUNA (LATE MIOCENE, YAVAPAI COUNTY, ARIZONA)

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The Milk Creek Formation of Yavapai County in central Arizona contains Late Miocene fossil mammals bounded by a 14.0 Ma isotopic dating and biochronologically estimated at older than 9.5 Ma. Holdings of Milk Creek materials are found at five institutions across Arizona and at the American Museum of Natural History. The majority of the taxa belong to two Protolabinae camelids: *Michenia yavapaiensis* and *Protolabis coartatus*. The abundance of these two camelids far exceeds that of other taxa, which is highlighted in a compilation of Ted Galusha's 1956 collection and specimens collected by faculty and students at Yavapai College. James G. Honey, in a 2007 comparison of these camelids, rejected a hypothesis that they were sexually dimorphisms of the same species. This rejection is supported by the extensive abundance differences between the two taxa.

In addition to these two listed genera of camelids, post-cranial remains were located; both in the field and from the University of Arizona Laboratory of Paleontology collections, of a third camel type for this locality. The specimens for the recently located third camelid included a right astragalus. Using a linear regression model of the astragali areas, the body masses for specimens of *Protolabis coartatus*, *Michenia yavapaiensis* and this third camelid taxa were estimated and compared with some other fossil camelid collections. This third camelid taxa from Milk Creek is supported as belonging to a species of either *Aepycamelus* or *Hesperocamelus*.

EQUINE NAVICULAR SYNDROME IN THE FOSSIL RECORD

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Equine navicular syndrome (ENS) is one of the most common causes of chronic lameness in the athletic horse but is essentially unknown in ponies and donkeys. The pathophysiology is poorly understood but it is likely the result of a complex pathogenesis rather than a specific disease entity. The consensus appears to support a biomechanical component caused by increased bone medullary pressure and a possible vascular component. Generally, the syndrome affects the more mature riding horse, and appears more frequently in the forelimb than hindlimb. Commonly it does not appear until 8–10 years of age. ENS is overrepresented in some breeds (European Warmbloods, Quarter horses and Thoroughbreds) and rare in others (Arabians, Friesians). The syndrome has been thought to be caused by human intervention either by increased usage such as in jumping or improper breeding practices (i.e. larger body, with relatively smaller feet) since no studies have demonstrated its occurrence in natural populations of wild equids or feral populations of domestic horses.

In a previous study, distal sesamoids (n=193) from four fossil species of *Equus* from North American Pliocene and Pleistocene faunas were x-rayed. Lollipop lesions, characteristic of the syndrome in clinical studies of modern domestic horses were identified on the radiographs of some of the Pleistocene and Pliocene species. The presence of ENS in multiple fossil species suggests that increased usage by humans may not be the sole cause of the syndrome and that increased forces placed on the sesamoid from the evolutionary increase in body size of horses coupled with the transition from tridactyl to monodactyl feet may be a critical factor. For this study we have expanded our sample (n=47) of Pliocene and Pleistocene Equus and x-rayed the distal sesamoids of fossil tridactyl species, *Parahippus*, *Cormohipparion*, *Nannippus*, and other Miocene equidae (n=108).

SEEING NATURAL SELECTION IN THE VERTEBRATE FOSSIL RECORD

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Current papers in vertebrate palaeontology are largely concerned with description and the establishment of phylogenetic (genealogical) relationships. Often little attention is paid to evolutionary processes at the individual level. In the modern synthesis natural selection is seen as the failure to reproduce, that is to project genes into the next generation. This failure may be of two kinds, failure to reproduce successfully or failure to survive to (sexual) maturity. The fossil record consists of lots of dead animals, so it is conceptually plausible to find out if an individual died prior to reproduction, even if it may be difficult to determine if an individual failed to reproduce successfully. Clearly fossils of eggs, hatchlings, and neonates indicate death before any possibility of reproduction. Estimation of life tables, such as that of Erickson et al. for *Albertosaurus sarcophagus* can give an indication of when selection was acting during the life cycle. But conclusions can be made even from the study of individuals if their age relative to reproductive maturity can be estimated. For example, all known specimens of *Kunbarrasaurus* seem to represent immature individuals, which, if correct, would indicate that the population was undergoing selection. Such information would be useful, particularly in regard to determining whether populations prior to mass extinctions were already stressed by some kind of selection.

A EURHINODEPHINID (CETACEA; ODONTOCETI) FROM THE LATE MIOCENE MONTEREY FORMATION, SAN CLEMENTE ISLAND, LOS ANGELES COUNTY, SOUTHERN CALIFORNIA

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A fossil cranium, with teeth and ear bones, of a member of the primitive odontocete family Eurhinodelphinidae has been found in the Late Miocene Monterey Formation on San Clemente Island, off the coast of southern California. Eurhinodelphinids have symmetrical cranial vertices, extremely narrow and elongate rostra, the mesorostral gutter closed dorsally, the narrow mandible shorter than the rostrum, and homodonty. The fossil appears assignable to the eurhinodelphinid genus *Schizodelphis*. It appears to represent a previously undescribed species, notable by having an ossified lateral lamina of the pterygoid in the medial part of its orbit and relatively derived petrosal morphology. Early Miocene eurhinodelphinids are known from California, and the new specimen is the chronostratigraphically youngest known occurrence of the family in the North Pacific Basin, and perhaps globally.

SURGEON FISH FOSSILS AS PALEOCLIMATIC INDICATORS IN CALIFORNIA NEOGENE SEDIMENTS

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The State of California has an excellent record of Neogene marine sediments. They preserve a wealth of information on past ichthyofaunas. Attempts to make paleoclimatic interpretations of past California ichthyofaunas are rare. In 2002 we set out the hypothesis that fossil records of *Mola* in California sediments can be used as an indicator of the Mid Miocene Climatic Optimum (MMCO). We here announce the occurrence of teeth of the acanthurid *Prionurus* in middle Miocene sediments of California and propose that their presence also is an indicator of the MMCO. The Acanthuridae (surgeon fish) are a group of advanced herbivorous marine teleosts that specialize in scraping algae. As such, they are restricted to the photic zone. Teeth of this family can take a variety of shapes, but those of *Prionurus* resemble mittens or gloves. The specimens that form the basis of this abstract constitute the first fossil record of the genus. Today, the northern most records of *Prionurus* in the eastern Pacific are in the lower half of the Sea of Cortez, Baja California. Teeth of *Prionurus* occur in the following California formations:

1. Round Mountain Silt, Bakersfield (15.2–16.0 Ma based on magnetic stratigraphy).
2. Lower part of the Monterey Formation, Templeton.
3. La Vida Member of the Puente Formation, San Dimas (no older than 15.25±0.08 Ma based on underlying Glendora volcanics).
4. Topanga Formation, Orange County. Multiple specimens are known from two localities along Eastern Transportation Corridor. Volcanic rocks in part of the Topanga Fm. of Orange County are dated at 15.4 +1.3 Ma.

Teeth of *Prionurus* are also known from Los Indios Member of the Rosarito Beach Formation of Baja California. A basalt underlying that member has been dated at 16.1±2.1 Ma. The MMCO is the warmest interval in the last 23 million years; it ranges from approximately 17–14.75 Ma. The best date estimates for the *Prionurus* fossils all fall between 16 and 15 Ma. It is true that most of these records lie on the Pacific plate, and have traveled a substantial distance northward since deposition. However, the Round Mountain Silt records near Bakersfield lie on the North American plate. That rock unit is also the most northerly occurrence of *Mola* fossils in North America.

TETRAPOD SWIM TRACKS IN TIME AND SPACE: WHAT ARE THEY TELLING US AND HOW DO WE DEAL WITH THEM?

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Swim tracks have long been a subject of controversy because they often exhibit incomplete or irregular morphologies. This morphological variation is a result of the highly variable conditions under which they are supposed to have formed; by buoyant/bottom-walking animals in subaqueous environments. The discovery of abundant swim track sites in the Lower Triassic Moenkopi Formation of Utah raises questions about the processes and factors controlling swim track preservation and the spaciotemporal distribution of localities. Despite a growing literature that is beginning to officially recognize swim tracks as distinct from other vertebrate traces, standardized and quantitative methods for describing and analyzing them have yet to be implemented.

The Torrey Member of the Moenkopi Formation was deposited under marine deltaic conditions and shows a pervasive lack of bioturbation. This phenomenon is observed in modern brackish environments where frequent salinity and temperature fluctuations create a stressful environment that keeps biological diversity low. In the case of Lower Triassic deposits such as the Moenkopi, the effect may have been exacerbated due to delayed ecologic recovery following the end-Permian mass extinction. These unique factors (stressful environments coupled with delayed recovery) have been hypothesized to be responsible for producing widespread unmixed, firmground substrates ideal for registering and maintaining detailed subaqueous traces. The deposition of heterolithic bedding in certain environments (e.g., deltas and oxbow lakes) increases the subsequent preservation potential of these traces. Thus, Lower Triassic deltaic deposits (e.g., Moenkopi) contain a disproportionately large amount of swim tracks compared to older or younger formations.

To begin investigating potential patterns in global swim track occurrences, I have compiled a database of global swim track occurrences with information about location, formation, age, preservation, paleoenvironment, ichnotaxonomy, specimen numbers, and proposed trackmakers. This database, originally comprising 143 tracksites, was first published in Geology nearly 3 years ago. It has since grown to over 180 individual sites. The data are normalized to account for epoch duration (worldwide) and outcrop area (North American sites only). Preliminary results from this large sample suggest that patterns in the preservation and spaciotemporal distribution of swim tracks are real and worth investigating. 83% of swim tracks localities are found in terrestrial paleoenvironments and 43% of localities are interpreted as either lacustrine or marine deltaic/estuarine. Marine deltaic sites make up 29% of all swim track localities while lacustrine and floodplain deposits comprise 12% and 13%, respectively. 68% of swim track localities preserve tracks exclusively as natural casts (convex hyporelief).

To avoid confusion and maintain consistency in the literature, a standardized terminology distinct from that used for terrestrial tracks needs to be developed and employed for describing swim tracks. The terminology proposed by McAllister in 1989, in which the terms footmark, footmarks, and traceway are subaqueous correlates to the terms track, tracks, and trackway, is a good start and should be expanded upon. Likewise, a standard practice for measuring swim track parameters like that proposed by Milner and Lockley in 2016 is also needed. Furthermore, if rigorous ichnotaxonomic approaches are not feasible, standardized criteria should be adopted for identifying and interpreting swim tracks. Examples of such criteria originally proposed by McAllister in 1989 include digit reflectures, posterior overhangs and kick-off scours; features that indicate trackmaker buoyancy. Additional criteria could be gleaned from ichnologic studies of extant organisms.

POSTER ABSTRACTS

GEOGRAPHIC, STRATIGRAPHIC, AND ECOLOGICAL DISTRIBUTION OF TURTLE TAXA FROM THE UINTA FORMATION, UINTA BASIN, UT

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This study examines the distribution of turtle specimens collected from more than 66 stratigraphically constrained fossil localities in the Uinta Formation, Uinta Basin (46.2–42 MA) with the goal of assessing how sympatric turtle taxa utilized the ecospace and partitioned the various ecological niches available to them. ArcGIS was used to plot the UTM coordinates of 600 turtle fossils recovered from six different cryptodire families to evaluate the geographic distribution of each turtle taxon. At numerous localities, several turtle taxa overlapped, especially river turtles (baenids), pond turtles (geoemydids), and soft-shelled turtles (trionychids). The large-bodied geoemydids were the most abundant taxon, and were recovered from the largest number of localities. Not surprisingly, the terrestrial tortoises (testudinids), the taxon least tied to large bodies of water, had the most extensive geographic distribution. The stratigraphic distribution of Uinta Basin turtle taxa was also evaluated, and revealed that the smaller-bodied, highly aquatic taxa, *Anosteira* and *Bridgeremys*, were predominantly located higher in the section (Uinta C, Ui3 biochron). The more terrestrial cf. *Hesperotestudo*, *Gopherus*, and *Planetochelys* were recovered more frequently lower in the section (Uinta B, Ui2 biochron). The more abundant taxa, such as geoemydids and baenids were found throughout the section, but those found at the top of the section were smaller in average body size than their counterparts lower in the section.

To evaluate how Uintan turtle communities utilized the available ecospace, ecological data via both extant analogs as well as direct measurement from the fossils were compiled for each taxon. These variables included diet, sociality, body size, and substrate use (i.e., obligate aquatic, semi-aquatic, bioturbation [mud burrowing], or terrestrial). A Principal Components Analysis was used to explore the ecospace and assess how Uintan turtle taxa distributed themselves into niches. Despite the fact that many turtle taxa overlapped in geographic and stratigraphic distribution, the PCA revealed a partitioning of niche space. As expected, the only fully terrestrial family, testudinids (tortoises) were positioned furthest in ecospace from the others. Trionychoid taxa, both large-bodied trionychids and small carettochelyids, occupied adjacent niche space, and likely reduced competition with sympatric geoemydids and baenids by delving to the deep channel portions of the river systems. These findings suggest that Uintan turtle communities reduced competition for resources by occupying different ecological niches within the available ecospace.

HISTORY OF FOSSIL RESEARCH AT MILK CREEK, ARIZONA (LATE MIOCENE) AND THE YAVAPAI COLLEGE COLLECTION

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Reed's 1950 brief paper is the first published description of the Milk Creek fossil material of Yavapai County in central Arizona. The Milk Creek Formation contains fossil mammals of latest Barstovian and largely Clarendonian ages. The lower fossil bearing strata are bounded by a 14.0 Ma isotopic dating and biochronologically estimated at older than 9.5 Ma. Reed collaborated on two surveys in 1949 which confirmed that the Milk Creek Formation represents a regionally important mammalian fossil site. Since 1956, nearly continuous surveys and efforts have resulted in six collections of materials from the Milk Creek Formation. Five of these are in Arizona, while the largest single collection is part of the Frick Collection held at the American Museum of Natural History in New York, NY. A summary of the history of the Milk Creek collections is presented here. Also summarized is a description of the taxa, dominated by Protolabinae camelids, and skeletal elements in the most recent collection by faculty and students at Yavapai College in Prescott, Arizona.

A PRELIMINARY INVESTIGATION INTO THE EVOLUTION OF CLAW SPECIALIZATION IN VERTEBRATES: HOW COMMON IS IT?

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In the animal kingdom, many vertebrates use their claws for different functions. Some animals have specialized one or several of their claws on a single hand/foot to perform a specific function. We conducted a preliminary investigation to look at just how common an evolutionary occurrence claw specialization might be and whether it occurred more frequently in some clades than in others. We searched for examples of claw specialization in both extinct and extant vertebrates using museum specimens, photographs and a review of the literature. The criteria used to identify instances of claw specialization were (in order of importance) differences in the function, morphology and size of the claws on a single hand or foot. Because function inferred from the fossil record is, in most cases, unreliable, it was only used as a criterion in extant species where claw function has been documented.

Although our investigation is only preliminary, claw specialization may have occurred more often than might be expected. Thus far we have found at least 23 such occurrences in extinct and extant vertebrates, although there are certainly more examples still to discover. 10 of these occurrences are in non-avian dinosaurs, 6 are in birds, 6 are in mammals and 1 is in drepanosaurs. Of the 10 non-avian dinosaur occurrences, 5 are in therapods, 4 are in sauropodomorphs and 1 is in ornithopods. Within birds, there are surprising occurrences of specialization in Charadriiformes (e.g., puffins and skuas) and an example of specialization very reminiscent of deinonychosaurs in Cariamidae (seriemas). Diverse mammals including the cheetah, marsupial lion, beavers, and primates also have specialized claws. Reptiles make up 73.91% of all specialized claw occurrences with Dinosauria making up 69.57% of all occurrences.

Based on our preliminary results, claw specialization appears to have occurred most often in reptiles, specifically within Dinosauria. This suggest that dinosaurs may exhibit more plasticity when it comes to the evolution of specialized claws than do mammals. Finally, convergent evolution almost certainly plays a major role in claw specialization as unrelated taxa have similar claw morphologies, sometimes on different digits. Homoplasy has been suggested for the grooming claws in early primates and for cursorial claws in the cheetah and the wolf. It is also worth noting that we found an example of behavioral convergence between beavers and primates where each group has morphologically distinct, specialized claws that are used for the same function: grooming.

MICROFOSSIL SORTING FOR A "MOUSE'S EYE VIEW" OF RANCHO LA BREA

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The La Brea Tar Pits might be best known for the saber-toothed cats, dire wolves, and mammoths that have been excavated from our grounds, but it is in the matrix surrounding the fossils of these large animals that we find innumerous "microfossils" critical to understanding past ecosystems. In the collaborative "Mouse's Eye View" research project, we are using these microfossils to reconstruct food webs in order to shed light on how organisms at various trophic levels interacted during the late Pleistocene, with an emphasis on small mammals and plants.

For decades, volunteers in the Fossil Lab at the La Brea Tar Pits Museum have helped sort through matrix, pulling out microfossils such as seeds and bits of wood, bird vertebrae, turtle shell fragments, lizard jaws, insect wings, and mouse leg bones, that are valuable for various research applications. As an engaging, educational activity, sorting matrix is also perfect for community scientists and students. We partnered with teachers in Los Angeles to involve middle and high school students in sorting microfossils for use in the Mouse's Eye View project. To do this, we developed a microfossil sorting kit that is mailed to classrooms, completed, and returned to the museum. Naturally, we don't expect our student community scientists or their teachers to be expert microfossil identifiers from the start, so we developed an online La Brea Webs iNaturalist project to aid in identification.

Microfossil sorting kits are currently in classrooms, reaching over 600 students across Los Angeles. Over time, we aim to grow and expand this project to more schools, to learn more about how best to engage individuals of all ages in microfossil sorting, and how to ensure accurate sorting from minimally-trained contributors.

METHODS AND POTENTIAL PROBLEMS IN BUILDING A NEW EVOLUTIONARY TREE OF ANTILOCAPRIDAE

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Artiodactyls are known for their diverse headgear shapes. The shape of their horns, pronghorns, ossicones, and antlers play key roles in how they interact with their environment and each other. In extant families, these shapes can be categorized with body size to predict interspecies behavior and mating systems. Larger, recurved horns are typical of gregarious, large-bodied animals that fight for mates. Smaller spike-like horns are more characteristic of small-bodied, paired mates that live in closed environments. A diverse fossil group of artiodactyls, antilocaprids, have traditionally been distinguished by their horn cores. There were many species of this family in the Miocene but today only one remains. Whether this diversity loss is from environmental factors or competition is currently unclear. A phylogeny of antilocaprids will allow comparisons of the evolution of antilocaprid headgear and associated behaviors to those established for other artiodactyls, but previous systematic work relied heavily on headgear characters. Here, we discuss our plan to conduct a phylogenetic analysis of the Antilocapridae with an emphasis on non-headgear characters. This phylogenetic systematic revision will organize Antilocapridae at the genus level, testing established hypotheses of their evolutionary relationships. Also included in the phylogeny will be extant exemplars of Giraffidae, Camelidae, Cervidae, and Bovidae as outgroups. So far, we have 3 post-cranial characters, 25 cranial characters, and 32 headgear characters to score on eighteen antilocaprid genera, and we are seeking additional character sets to build our phylogeny. Through the phylogenetic analysis we will be able to establish their ancestral headgear morphology, clarifying whether antilocaprids became more gregarious and widespread into herds from small more monogamous pairs, as has been inferred for other families of artiodactyls. We are still in the early stages of data collection, but we foresee the potential pitfalls of choosing characters with differing resolution across genera and long branch issues in the phylogeny. We seek insights in the relative importance of headgear characters and examples of ecological analogues as the project proceeds and we approach our goal of understanding antilocaprid headgear evolution.

FROM CLASSES TO CABINETS: A CURATORIAL WORKFLOW TO ENGAGE COMMUNITES IN FOSSIL COLLECTION CURATION

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The La Brea Tar Pits and Museum is a public facing research institution home to ongoing excavations of historically active asphalt seeps within Los Angeles. These seeps were indiscriminate with what was captured and preserved as any organism immersed in the seep was protected from abiotic and biotic forces of decomposition. This creates a treasure trove of Quaternary fossils for curation and accession in to the museum collection.

The asphalt seeps generate literally tons of matrix to sort through for smaller fossils. While exciting, the vast size and quantity of salvaged matrix pose issues with specimen curation and management; e. g., how do we separate research quality specimens from the endless low-quality fossils and rock matrix? Even with a very active volunteer base that participates in sorting, rate of completion is limited by person availability and management oversight. Developing a curatorial workflow that sends bulk matrix to local schools to be sorted based on the needs of the institution creates a mutualistic relationship where the museum receives large amounts of help in consolidating research quality specimens, while students get hands on experience with real La Brea deposit matrix sorting real fossils. This workflow will follow microfossil matrix from post preparation through rounds of sorting, identification, and final curation for research applications. This semester signifies round one of workflow trials.

A NEW SPECIES OF *XEROBATES* FROM THE EARLY PLEISTOCENE OF SONORA, MEXICO: IMPLICATIONS FO THE PLEISTOCENE BIOGEOGRAPHY OF GOPHER TORTOISES

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A new species of *Xerobates* from the earlier Pleistocene of Pozo Coyote, Sonora, Mexico, represents a non-fossorial gopher tortoise closely related to *Xerobates berlandieri*, a species now restricted to the Gulf of Mexico drainages of Mexico and Texas. It has been hypothesized (Murphy et al, 2016) that *X. morafkai* diverged from *X. agassizii* 3 to 5 million years ago (Ma) following the embayment of the lower Colorado River at about 5.3 Ma. However, the fossil record of *X. agassizii* complex (*agassizii+morafkai+evgoodei*) in Arizona is limited to the latest Pleistocene (Rancholabrean) and Holocene (McCord, 2002; Van Devender, 2002). The earlier Pleistocene (Irvingtonian) records of gopher tortoises within or near the current geographic ranges of the *X. agassizii* complex in Arizona instead belong to the *Gopherus* complex (*polyphemus +flavomarginatus+donlaloi*), while earlier Pleistocene gopher tortoises in southern California are referable to the *X. agassizii* group. The Pleistocene record is further complicated by the occurrence of a new species of a *Xerobates berlandieri*-like tortoise from northwest Sonora, immediately adjacent to the current distribution of *X. morafkai*. As the fossil record now stands, it does not appear to support the hypothesis of separation of *X. agassizii* and *X. morafkai* by the Colorado River embayment 3–5 Ma. Alternative scenarios include the possibility that these tortoise populations diverged in the late Pleistocene (>1 Ma) or that speciation occurred in geographically limited areas or environments poorly sampled by the fossil record. The new Sonoran fossil appears to have co-existed with a *Gopherus* complex-like tortoise. The possible co-association of a Late Pleistocene *X. berlandieri* (=*X. auffenbergi* Mooser 1972) on the southern Mexican Plateau with yet another *Gopherus* complex-like tortoise suggests that at the extremes of their Pleistocene ranges, *Xerobates* and *Gopherus* may have experienced limited sympatry, while likely remaining ecologically separated. Finally, the existing fossil record of gopher tortoises offers no evidence to support the idea that ancestral *X. berlandieri* reached its present geographic distribution via dispersal from the Pacific southwest across the southern U.S. or northern Mexico. A more likely scenario is that the ancestors of *X. berlandieri* first arose on the Pacific slope of Mexico (the new Sonoran fossil reflecting part of this earlier distribution) and subsequently spread eastward across the southern Mexican Plateau to the Gulf Coast.

TAPHONOMY OF AND NEW BURROWS FROM THE DIGGING DINOSAUR *ORYCTODROMEUS CUBICULARIS*

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The mid-Cretaceous (Albian-Cenomanian) Wayan Formation of eastern Idaho and the Vaughn Member of the Blackleaf Formation of southwestern Montana both have vertebrate assemblages heavily dominated by the burrowing dinosaur *Oryctodromeus cubicularis*. This taxon occurs in three lithofacies and can be divided into three distinct taphofacies dependent on degrees of articulation and association. Articulated specimens (taphofacies A) occur in bioturbated sandstones; articulated to associated specimens in pedogenic mudstones, siltstones, and fine-grained sandstones (taphofacies B); and isolated skeletal elements (taphofacies C) are found within the debris flow deposit of the Robison Bonebed (RBB). Two broad taphonomic modes are recognized: articulated to associated skeletons (mode B) which are represented by twelve specimens, and dozens of isolated elements (mode A) from the RBB.

A suite of taphonomic observations suggests that burial within unrecognized burrows can be inferred as a typical mode of preservation for partial to near complete skeletons of *Oryctodromeus*. The Wayan and Vaughn represent an unusual occurrence of Cretaceous fossil assemblages dominated by a fossorial vertebrate taxon. Additional occurrences of *Oryctodromeus* burrows from the Wayan and Vaughn are reported as well with the overall morphology and sizes being like the holotype burrow. These recent studies on *Oryctodromeus* demonstrate the need for more actualistic taphonomic studies on fossorial vertebrates.

TRACKWAYS OF *PLATYKOPUS ILYCALCATOR* FROM THE WHITE NARROWS FORMATION (PLIOCENE), NEVADA

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Tracks and trackways attributed to bear (Ursidae) are comparatively rare in the fossil record. One well known example is the ichnotaxon *Platykopus ilycalcator*, first described from the White Narrows Formation of Nevada (earliest Pliocene) and designated based on specimens housed at the Raymond M. Alf Museum of Paleontology. The fossils were collected by Ray Alf and his students in the mid-20th century and have been figured and briefly described in several publications. In addition to isolated tracks designated as ichnotypes and paraichnotypes, a slab with trackways provides information on variation in this ichnotaxon. The slab (RAM 218), collected in thirteen individual pieces, has thirteen visible and measurable tracks. The larger tracks were interpreted as pedal impressions; the pes of *Platykopus* was larger than the manus (as in modern bear). The pedal tracks average around 15 cm wide and 11 cm long, contrasting with 13 cm wide and 11 cm wide for the manual imprints. The thirteen tracks are oriented in three discrete trackways. Due to the incomplete margins of the track slab and the size similarity in all prints, we suggest two possible interpretations: 1) a single individual backtracked its own path (with the change in direction not preserved); or 2) multiple individuals walked in different directions.

EXTINCTION, EXTIRPATION, AND (RE) INTRODUCTION OF BEARS IN CALIFORNIA

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Bears are an important facet of California's ecological and human history, with the extirpated California grizzly bear (*Ursus arctos*) featured on the state flag. Today, California has only black bears (*Ursus americanus*), with the staggered loss of grizzlies about 100 years ago and a likely disappearance of short-faced bears (*Arctodus simus*) around the Pleistocene/ Holocene transition. The ecological consequences of these losses have yet to be quantified, despite the 2016 proposal to re-introduce grizzlies in the Sierra Nevadas and a 1933 black bear range expansion via translocation from Yosemite to Southern California by the Fish & Wildlife Service. Here, we use the fossil record to provide a "conservation paleobiology" perspective on modern bear distributions in California. We compiled a dataset of Quaternary and modern ursid localities collected from online databases (Neotoma, VertNet), museum collections, the primary archaeological and paleontological literature, and the citizen science platform iNaturalist. From locality data alone, we determined that a 1933 "introduction" of black bears into the San Gabriel Mountains and San Bernardino was in fact an unrecognized "rewilding" of the species into its former Pleistocene range.

We developed species distribution models for the Pleistocene, Holocene, historic (<1930 AD), and present distribution of ursids, including an assessment of what grizzly ranges would be today in the absence of persecution. Rancho La Brea (RLB) is one of two sites

documented in California where all three bears (*U. arctos*, *U. americanus*, *A. simus*) have been reported, providing an important opportunity to evaluate the effects of sympatry, such as competitive interactions, niche partitioning, and character displacement. We present morphological assessments using RLB ursids to resolve the identity of *Ursus* postcrania, laying the groundwork for testing ecological hypotheses of survival and coexistence of these bears through time. Radiocarbon dating and stable isotope analyses will help us to refine our understanding of how these three ursids coexisted in space and time, and possible effects of the reintroduction of grizzlies into black bear habitat.

RAT, POOP, TAR: RODENT ACTIVITY AT RANCHO LA BREA'S PROJECT 23

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The La Brea Tar Pits of Los Angeles is world-renowned for its Late Pleistocene mammalian megafauna, including dire wolves, giant sloths, and saber-tooth cats. These fossils are excavated from the sediments of active asphalt seeps in Hancock Park in west LA's Miracle Mile neighborhood. In 2006, the Los Angeles County Museum of Art, which shares the park, built an underground parking structure that resulted in twenty-three salvaged, intact, asphalt-impregnated deposits in boxes ranging from ~9,000–123,000lbs. These deposits are collectively referred to as Project 23. The first and largest of the salvaged fossil deposits, Box 1, was excavated in several stages from 2008-2016. Like many asphaltic fossil deposits previously discovered in the park, most Project 23 fossil deposits have been found within fluvially deposited sediments, predominantly sands and gravels. While the main fossil deposit in Box 1 comprised numerous large and small vertebrate remains in asphaltic sand and gravel, other areas consisted of mats of leaf litter, concentrations of invertebrates, including large sections of articulated millipedes, and partially articulated turtles in asphaltic fine-grained sand and silt, suggesting a different and lower energy taphonomic process.

The unique taphonomy of Project 23's Box 1 represents an opportunity to elucidate La Brea's Late Pleistocene microfauna as context for its megafauna. Matrix from lower levels of central excavation grids, when cleaned of asphalt, revealed a large mass of rodent fecal pellets mixed with a dense accumulation of vegetation, including leaves and sticks. Such rodent feces may constitute the first coprolites from Rancho La Brea, or could indicate modern contamination from invasive black and brown rats, *Rattus sp*. We provide an ecologically-informative hypothesis-testing framework for evaluating whether rodent feces in an urban excavation area are coprolites or contamination. No fresh rodent feces were observed during excavation, and fecal pellet-containing grids were interior, separated from exterior edges by other grids, and separated from the box floor by at least 50 cm, or two excavation levels. A random sample of 200 fully-intact pellets measures an average length of 10.41 ± 1.04 mm and width of 4.02 ± 0.34 mm. The shape and size of the pellets is suggestive of *Neotoma*, the wood rat, whose teeth have been recovered from Box 1. The association of feces with clumps of vegetation further supports a potential presence of a woodrat midden, which are widely used in Quaternary studies for ecological reconstructions. A survey of 40+ camera trap nights has not documented modern *Rattus* activity within Project 23 boxes. Radiocarbon dates provide the ultimate verdict for coprolite or contamination for Box 1.

AN AZHDARCHID PTEROSAUR FROM THE KAIPAROWITS FORMATION OF SOUTHERN UTAH

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Although the Kaiparowits Formation (late Campanian) of Grand Staircase-Escalante National Monument, southern Utah, is increasingly well known for its vertebrate fossils, pterosaurs remain virtually unknown from this assemblage. Indeed, diagnostic pterosaur specimens from late Campanian terrestrial environments of North America are poorly known as a whole—most are isolated elements that can, at best, be constrained to Azhdarchoidea. In 2015 and 2016, the Raymond M. Alf Museum of Paleontology (RAM) recovered an associated skeleton from the middle unit of the Kaiparowits Formation. This individual (RAM 18659) includes a right scapula, both coracoids, right humerus, partial right ulna, partial radius, partial fourth metacarpals, femora, a vertebra, and other indeterminate elements, (all)? of which have been documented using photogrammetry and laser scanning. The scapulocoracoids are unfused, and in conjunction with bone surface porosity, we hypothesize that the specimen was not osteologically mature ("juvenile"). The humerus is 147 mm long, and the wingspan is estimated at ~2.8 m. Features such as a tall and rectangular deltopectoral crest, a deep coracoid flange, and forelimb proportions identify the fossil to Azhdarchidae. However, the dorsal and ventral condyles of the fourth metacarpals have a unique "hooked" morphology, suggesting that RAM 18659 is a taxon new to science. The anatomy is not congruent with the corresponding articular surface on the first wing phalanx of *Navajodactylus borei* (Kirtland Formation), and neither is the anatomy consistent with that in *Quetzalcoatlus* spp. Numerous differences in the humerus, fourth metacarpals, and overall limb proportions distinguish RAM 18659 from the similarly-sized *Montanazhdarcho minor*. RAM 18659 definitively establishes that azhdarchids were present in the Kaiparowits Formation, expanding the known geographic and geologic ranges for azdarchids.

AGE PROFILE OF TERMINAL PLEISTOCENE COLUMBIAN MAMMOTHS (*MAMMUTHUS COLUMBI*) FROM SOUTHERN NEVADA

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The Gilcrease Cauldron Paleontological site is located in Southern Nevada, approximately four kilometers west of Tule Springs Fossil Beds National Monument (TUSK), East of Kyle Canyon alluvial fan. This historically active spring site has produced more than one hundred partial and complete Columbian mammoth (Mammuthus columbi) cheek teeth within unconsolidated spring sediments. For this study, 58 mammoth molariform teeth were selected from the Gilcrease Cauldron site that were either complete or complete enough to determine the age of the animal at death in African elephant equivalent years (AEY) for the purpose of constructing an age profile from the tooth assemblage. A set of standard tooth measurement and identification standards for this analysis was compiled after extensive literature review. Radiocarbon dates of a subset of these teeth range from 14336-20567 cal BP, toward the end of the LGM (Recalibrated from Vetter, 2007). This age range corresponds to Member E of the Las Vegas Formation, which is interpreted to record the shift at Tule Springs from wet meadows to individual spring pools and flowing streams (Springer et al., 2017). We constructed an age profile for this assemblage, which could suggest selective mortality of juveniles, although the cause needs further investigation. There are characteristics of this dataset that vary from the stair-step shape of a "Type A" non-selective age profile, such as the very high proportion (>50%) of juveniles represented in this death assemblage, and no representation of individuals >48 AEY. This pattern could suggest selective mortality for younger individuals (<12 AEY).

These fossil teeth are part of a private collection through the Gilcrease Orchard Foundation, which is being catalogued for the first time into the Las Vegas Natural History Museum collection as a loan. This extensive collection was originally excavated in the early 1990's and includes thousands of bone fragments, as well as teeth from other Pleistocene mammals, including rodents, horse (*Equus* sp.), bison (*Bison* sp.), and camel (*Camelops hesturnus*). All mammoth teeth used for this study, as well as notable specimens from the remainder of the collection are also being catalogued with NextEngine 3D laser scanners and converted into object and printable files for use on emerging platforms such as MorphoSource and iDigFossils.

PREDMORE MICROSITE, EL GOLFO DE SANTA CLARA, SONORA, MÉXICO: THE GIFT THAT KEEPS ON GIVING

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Microsites are an underappreciated treasure trove providing insight into the interpretation of the prehistoric ecosystem. The Predmore Microsite (PMS) is an elevated and weathered area that was an abandoned meander channel in the ancient Colorado River that persisted as a backwater, probably marginally connected to the main river, especially during floods. The pools slowly filled with sediment during overbank flooding. The microvertebrates are therefore a time-averaged accumulation. Moreover, the present

surface-concentrated microvertebrates are probably a winnowing of an unknown thickness of sediment. This site was discovered in 2002. It is an east-facing, windswept exposure that has yielded >4,000 fossil specimens. There have been 16 separate surveys of this site over the past 15 years.

Methods utilized for recovering specimens at the PMS are two-fold. Field staff at the base of the site work a pathway upslope on their hands and knees searching and picking as they go, while a team works a designated linear area approximately one meter wide to a depth of about 3” and 20–30 meters long, shoveling material that is double-screened onsite; this concentrate is carried off-site to a laboratory to be water-washed and sorted, and for the recovered fossils to be identified using a dissecting microscope.

Taxa found at the PMS include fish, turtle, lizard, snake, bird, insectivore, rodent, and carnivore. This sample supports the hypothesis that during the Irvingtonian Land Mammal Age (~1.5 mya), El Golfo had extensive local, riparian habitats supporting a diverse biota along the ancient Colorado River delta, which had subtropical climates. The PMS has yielded 4437 specimens, representing 36% of the total recovered from the El Golfo badlands explored by our research team. Interestingly, 51% of the total collection has been found at 15 different microsites, thus emphasizing the importance of microsites. The PMS, in particular, is a rich source of information for building the Irvingtonian regional paleo-environmental picture in northwestern Sonora, Mexico.

A REVIEW OF BADGER (*TAXIDEA TAXUS*) FROM THE PLEISTOCENE BOOTH CANYON LOCAL FAUNA, SOUTHEASTERN IDAHO

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Badgers are a rare occurrence in fossil localities. Previously, the badger (*Taxidea taxus*) was reported from the Booth Canyon local fauna based on a single mandible collected in 2002. Additional specimens have been recovered over the last 5 years, including partial crania and mandibles. These specimens fall within the size range of modern *T. t. jeffersonii*, with one particularly large individual equivalent in size to the largest specimens described from central Alaska. *T. t. jeffersonii* is the current subspecies endemic to the northwestern United States, including Idaho, and southeastern British Columbia. This large skull collected from Idaho is greater in size than any previously reported badger specimens from Pleistocene localities in the continental United States. Morphologically, there appears to be no significant difference between these new Pleistocene specimens and modern *T. t. jeffersonii*. Currently, it can’t be determined whether the largest specimen represents an unusually large individual of *T. t. jeffersonii* or a new subspecies. Further research, including genetic analysis, would provide the answer to this question and shed new light on the fossil distribution and evolution of badgers in North America.

Megapnosaurus **enter the waters of Lake Dixie in southwestern Utah to feed on semionotid fishes. Such behaviors would have resulted in the formation of thousands of dinosaur swim tracks at the St. George Dinosaur Discovery Site at Johnson Farm.**

-Artwork by Robert Milner